The University of Manitoba Field Station Delta Marsh

1971 Annual Report Number 6

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University of Manitoba Field Station
(Delta Marsh)

SIXTH ANNUAL REPORT
1971

Edited by

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We wish to extend our appreciation to
Dr. H. Albert Hochbaum for the cover illustration.

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[1]This paper was omitted from the Fifth Annual Report (1970) through an unfortunate oversight.

DIRECTOR'S REPORT FOR 1971

This year saw a wide range of research and teaching at the Station and consequently heavy demands on the facilities. Eight projects were undertaken, four continued from the previous year and four new studies were initiated. The first group included investigations of habitat and food use by white-tailed deer; the relationship between evapotranspiration in *Phragmites* and water table fluctuations; the ecology of the hard- and soft-stem bulrush (*Scirpus acutus* and *S. validus*) and the effect of the Assiniboine Diversion on the southern end of Lake Manitoba. New research projects covered an equally wide range of topics, namely: life cycle studies of two nematodes (*Rhabdias* sp.) in frogs and toads; a survey of soil and water fungi in the marsh; the effect of fire on *Phragmites* and the mapping of lakeshore vegetation.

It is a pleasure to acknowledge the continued financial support from the Department of Mines, Resources and Environmental Management, the National Research Council, Ducks Unlimited, Canadian Industries Limited and the University of Manitoba. In addition, this year two of our summer assistants were supported by the Opportunity for Youth program.

We were pleased to welcome two other researchers: Mrs. C. H. Nelson, who spent three days continuing her work on downy ducklings, and Dr. B. J. Richardson, who collected blood samples from redbacked voles and deer mice for enzyme studies.

Four projects were concluded in 1971. T. O. Acere was awarded an M.Sc. for his stickleback population study, while D. Bernard and D. Brown should complete their M.Sc. theses in the spring of 1972. Dr. J. Wright's ecological study of benthic fauna has yielded a wealth of information, particularly with respect to the effects of freezing on invertebrates. His publication should be in press in the near future. The importance of winter research is also emerging from the white-tailed deer studies of Dr. E. Kucera. Our long-term objective is to obtain an understanding of the dynamics of the marsh ecosystem, and each project brings it a little nearer.

The Station was used for 334 resident-weeks. The following staff, graduate students and technicians were present for all or part of the summer:

Faculty	Graduate Students
Dr. J. Gee (Zoology)	A. J. Macaulay (Botany)
Dr. E. Kucera (University Field Station)	E. E. Mowbray (Botany)
Dr. J. M. Shay (Director)	J. Pearn (Botany)
	F. Phillips (Botany)
	M. Quaye (Zoology)

Station Staff	Summer Assistants	
Mr. N. Mulder	T. Cantlon	L. Landreth
Mrs. G. Mulder	G. Connor	D. Paton
Mrs. I. Garnham	R. Gray	R. Scarth
Miss P. Wickstrom	R. A. Janusz	

Informal seminars were given by the staff and graduate students, and we were glad that members of the Delta Waterfowl Research Station joined us and also reciprocated the invitation.

November Seminar

The Fifth Annual Seminar, held on November 20, attracted a diversified audience from the Canadian Wildlife Service, Delta Waterfowl Research Station, Department of Mines, Resources and Environmental Management, Environment Canada, Brandon University and a number of departments from our own University. Dean Connor opened the proceedings. Eleven papers were presented by individuals who had worked at the University Field Station (8) and the Delta Waterfowl Research Station (3). Comments indicated that the quality of the papers and their illustrative material was excellent and that the value of this seminar grows each year for both participants and the audience.

Teaching

Five courses made use of the Station facilities during the summer and fall.

In July, two Summer Session half-courses were held in their entirety at the Station. Both had a capacity registration of 15 students.

Introductory Ecology (Botany 1.336) was conducted by Dr. J. M. Shay. Students studied field techniques and sampled plant and animal populations in a range of terrestrial and aquatic habitats. Individual projects were also undertaken.

Ecology (Zoology 22.334) was instructed by Dr. J. Gee, assisted by D. Bernard and involved a study of animal populations and the effects of environmental factors on their distribution and abundance in local habitats. Students also conducted individual projects.

All those involved agreed that the combination of lectures and field work in both courses was valuable.

Shorter field work sessions involved *Chordate Zoology* (Zoology 22. 220), instructed by Dr. P. Lukens, where students spent one day examining the marsh environment and its associated fauna, and *Plant Ecology* (Botany 1.452) where five students spent a weekend in early October studying ordination techniques with Dr. J. M. Stewart.

Intensive three-day field work programs were held in September for *Introductory Ecology* (Botany 1.336 or Zoology 22.229). Enrollment for this course (98) tripled from that of last year. The class was divided into four groups with instruction given by Drs. Gee, Longton, McLaughlin and Shay, assisted by A. J. Macaulay, E. E. Mowbray, R. Moyshenko, J. Pearn and F. Phillips. During their three days, the students learned vegetation sampling techniques, made insect, aquatic fauna and small mammal collections and took early morning bird walks.

Visitors

In mid-March 25 members of the Manitoba Naturalists' Society (formerly the Natural History Society) spent the weekend studying winter ecology and so enjoyed themselves that they left a donation of $40.00 for the Station. Two hundred and forty participants in the International Limnological Congress toured the facilities and held a barbecue at the Station on June 14, as organized by Dr. G. Robinson. On August 12 we held an Open House, primarily to enable the Mayor and Council from Portage la Prairie, Aldermen from the Rural Municipalities and members of the Provincial Government to become acquainted with the program at the Station. Displays and talks about ongoing projects were presented and, judging by the lengthy discussions and the interest the visitors showed in our activities, it was a very successful day. Ninety Manitoba naturalists spent August 22 examining the flora and fauna of the area with the assistance of A. J. Macaulay and E. Kucera.

Facilities

The facilities for teaching, research and accommodation are gradually improving. The central area of Macdonald Building B was converted into two laboratories with the minimum of alteration. The interiors were painted by the Station staff, in time for use by the summer courses. Gradually during the rest of the summer, the exteriors and roofs of Building A (now called Criddle) and B were laboriously painted by summer assistants. The unmodified ends of B were used for sleeping accommodation in September.

Our experience with the large numbers in the fall courses emphasized that the kitchen facilities must be improved. It is quite unreasonable to expect the cooks to produce meals for 35 or more in a family-sized kitchen. Plans for the conversion of Murray's Cottage into a dining centre for up to 50 are now in their final stage of preparation. The removal of the dining room from Mallard Lodge will allow for the expansion of lounge-seminar space. We also hope that funds will be forthcoming to allow us to acquire another Macdonald building to augment the sleeping accommodation and replace the bedrooms that will be lost in the conversion of Murray's.

The only major setback came on July 9 and 10, when severe storms washed away the palisade and a considerable portion of the bank in front of Mallard Lodge and to the west, bringing the lake precariously near the buildings. The emergency was remedied, in part, by dumping limestone riprap, hauled from Stonewall, in front of the Lodge. Additional protection should be provided for all the buildings west of the Lodge in the near future.

Staff

Dr. J. Wright returned to Britain in January after completing two years as a Post-doctoral Fellow at the Station. His enthusiasm as a researcher, competence as a naturalist and frieldly cooperation were appreciated by all his associates.

Mr. Venema left the staff in March. Owing to financial exigencies of the University, his position was not filled. The need for an assistant for the Director is keenly felt and will become increasingly necessary as the use of the Station continues to expand.

General

The summer courses had larger enrollments and were received more enthusiastically than we expected. It was encouraging that the participants felt that the best way to study biology is in the field.

While maintaining our research program, I think we can make a valuable contribution to education by increasing the number of such credit courses given at the Station. We can also become a centre for a variety of short field biology courses for students, teachers and the general public. All indications are that there is a rapidly growing number of people interested in the natural history and ecology of the province. I believe we should try to satisfy their needs. There may well be a marked change in the use made of the Station for teaching purposes, which could become a major activity in the future.

I attended the Organization of Inland Biological Field Stations meeting in Fort Collins in September and visited their Field Station at Pingree Park. Field station programs and funding were the major topics for discussion, and considerable emphasis was placed on the need for stations that operate year-round.

We were pleased to welcome Dr. R. Jones as the new Director of the Delta Waterfowl Research Station and appreciated his help and that of his staff on many occasions. I am also grateful for the opportunity provided me to discuss the ecology of the Delta Marsh with his Board of Trustees. Warm thanks are extended to the Department of Mines, Resources and Environmental Management for their continued interest and cooperation in our work. I should also like to thank the Portage Country Club for allowing us to

expand our use of their property for research purposes.

Finally, I would like to express my appreciation to all the staff, graduate students and others who made 1971 a successful year.

Jennifer M. Shay
Director

Mercury Levels in the Assiniboine Diversion and Southern End of Lake Manitoba

Supervisor: Dr. J. M. Shay
Department of Botany

R. A. Janusz
Department of Zoology

Introduction

The Assiniboine River floodway links the Assiniboine River and Lake Manitoba, its purpose being to carry spring flood water from the river to the lake as a flood control. It was first used from April 17 - May 8, 1970 with a maximum flow of 10,000 c.f.s. At that time preliminary studies were initiated on the flora and fauna of the southern end of Lake Manitoba to determine the effect of water entering via the Diversion. It was felt that this should be a continuing study. In 1971, the Diversion was used from April 15-21 with a maximum flow of 2,700 c.f.s. The presence of mercury in the Assiniboine River added impetus to the need for a long term study of the flora and fauna of the southern part of the lake, hence this investigation.

Objectives

1) To determine the effect on existing mercury levels of water entering Lake Manitoba via the Assiniboine Diversion, by collecting and preserving representatives of the fauna for mercury determinations.

2) To make a qualitative comparison of the fauna in a natural stream (Cram Creek) and an artificial stream (Assiniboine River Floodway) both entering into the southern end of Lake Manitoba.

Methods

A) A qualitative comparison was made using 20 sampling sites (Figure 1) in Lake Manitoba, the Assiniboine River Floodway, Cram Creek and the Assiniboine River. Bottom, plankton and some dipnet samples were collected at these sites.

B) Sites 1 (Cram Creek), 10 (Assiniboine River), and 12 (Assiniboine River Floodway) were chosen for bulk sampling and mercury level determinations.

C) At all sites bottom samples were collected for organic determinations and water samples for chemical analysis. Water level fluctuations were recorded and data obtained for contouring the Diversion outlet.

A) Qualitative Comparison of Fauna

Three samples were taken at each site:

1. Bottom samples using a Petersen or Ekman dredge depending on the compactness of the sediments. Samples were washed through a 400 u sieve net and the residue bottled, labelled* and returned to the laboratory. Formalin (10%) was used as a fixature and after 48 hours specimens were sorted using a flotation technique with a sucrose solution of specific gravity 1·1. The animals were then preserved in 70% ethanol.

2. Plankton samples were collected with a 75 u cone drag net and returned to the laboratory. Gluteraldehyde (3%) was used as a fixature and preservative. The original sample was filtered and the residue concentrated into 14 ml.

3. Dipnet samples were taken where the fauna was suitable. In the laboratory they were fixed in 10% formalin, sorted after 48 hours and preserved in 70% ethanol.

B) Sampling for Mercury Determinations

Bulk samples were collected with fine mesh dipnets and returned immediately to the laboratory. They were hand sorted, placed in "Whirl-Pak" bags, labelled, and frozen for later identification and weighing. Mercury level determinations were undertaken by the Fisheries Research Board during the fall.

C) Sediment Samples, Water Level Changes and Water Samples

1. Samples of bottom sedmiments were obtained from the 20 sites with the 15 cm Ekman and Petersen dredges and frozen for later organic determinations. The samples were oven dried at 97°C for 24 hours weighed then ignited for one hour at 525°C in a muffle furnace and the organic content calculated.

2. A series of 7 transects were used in the sampling area at the Assiniboine Diversion outlet. Depth readings were taken every 20 m along each transect to determine the bottom contours.

3. Three depth gauges to measure water level fluctuations were set up at sites 1, 12 and in front of Mallard Lodge. They were read every third day.

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* All samples were coded as follows: Lot number; site; type of sample. (E=Ekman, P=Petersen, D=dipnet, CDR=cone dragnet, Hg=a bulk sample) month, day.

4. On August 3 water samples were obtained from sites 1, 9, 10 and 11 for mercury analysis by the Fisheries Research Board. On August 26 and 30 water samples were obtained from sites 1, 5, 10, 11 and 16 for analysis of conductivity, pH, turbidity, color, total hardness, total alkalinity, total phosphorus, nitrogen, dissolved oxygen and chemical oxygen demand.

Results and Discussion

Water Chemistry

Results indicate that the Assiniboine River Floodway, the lake, and Cram Creek waters were generally similar in late August (Table 4). Analysis of water from the Assiniboine River indicates that turbidity and phosphorous content are both significantly higher in the river than at the southern end of the lake. Spring use of the floodway would carry phosphorus into the lake and the turbid waters would affect its color.

Water Level Fluctuations

Water levels (Figure 2) show an overall drop due to seasonal drying, with wind tides causing erratic fluctuations. South winds move water out of the marsh via the channels, while north winds drive water into the marsh. Wind tides therefore, produce a flushing action - reduced at the Assiniboine Diversion because of the presence of the outlet sill and adjacent gravel road. The high level of July 25 was due to a storm piling water behind this obstruction.

Lake Manitoba Contours at Assiniboine Diversion

The Lake Manitoba contours show a series of sand bars offshore, except at the outlet structure where the scouring action of spring flood-waters has eliminated them.

Mercury Level Determinations

A total of 49 samples of aquatic animals were analyzed by the Fisheries Research Board and showed an overall range of 0.02-0.32 ppm. Table 1 and Table 2 compares the three sampling areas by grouping the organisms according to their feeding habits and the Mercury levels found in the water of the sampled areas are given in Table 3.

Mercury readings in the water are in fact quite low. D'Itri (1972) gives a natural background level for normal stream, river, and lake waters as 0.01-0.1 ppb. with mean 0.03. The levels shown in Table 3 are indicative of normal background mercury levels and possibly are higher than the mean given by D'Iltri due to variation caused by naturally occurring complex

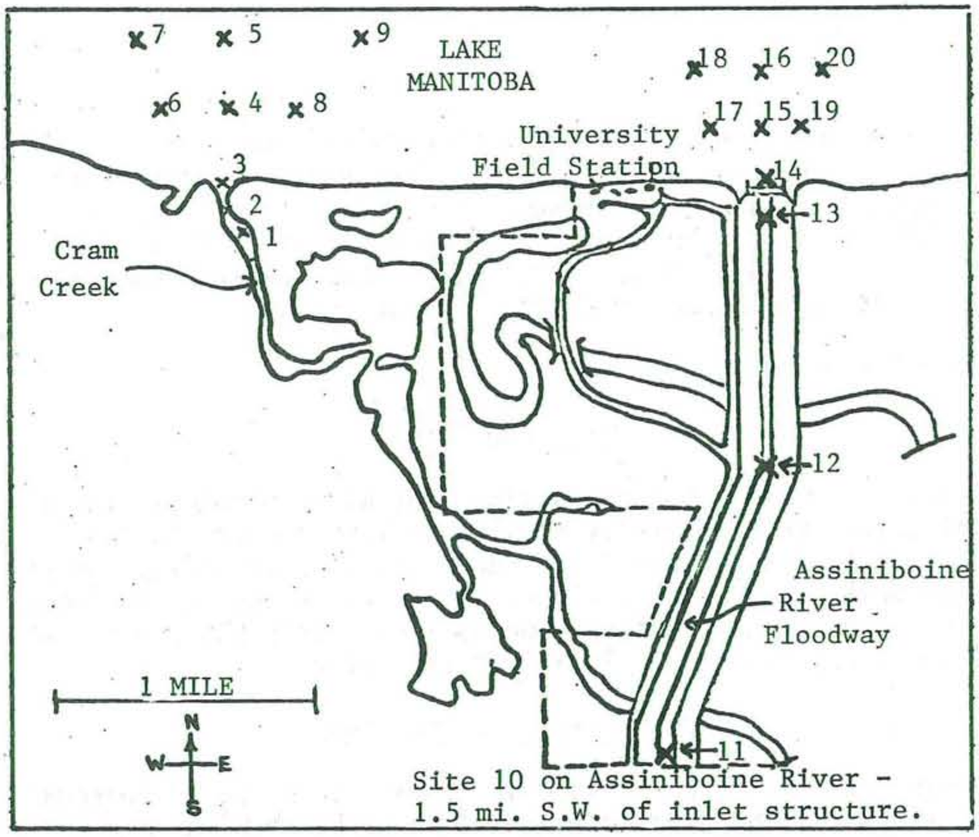

Fig. 1. Sampling sites in Lake Manitoba, Cram Creek and the Assiniboine River Floodway

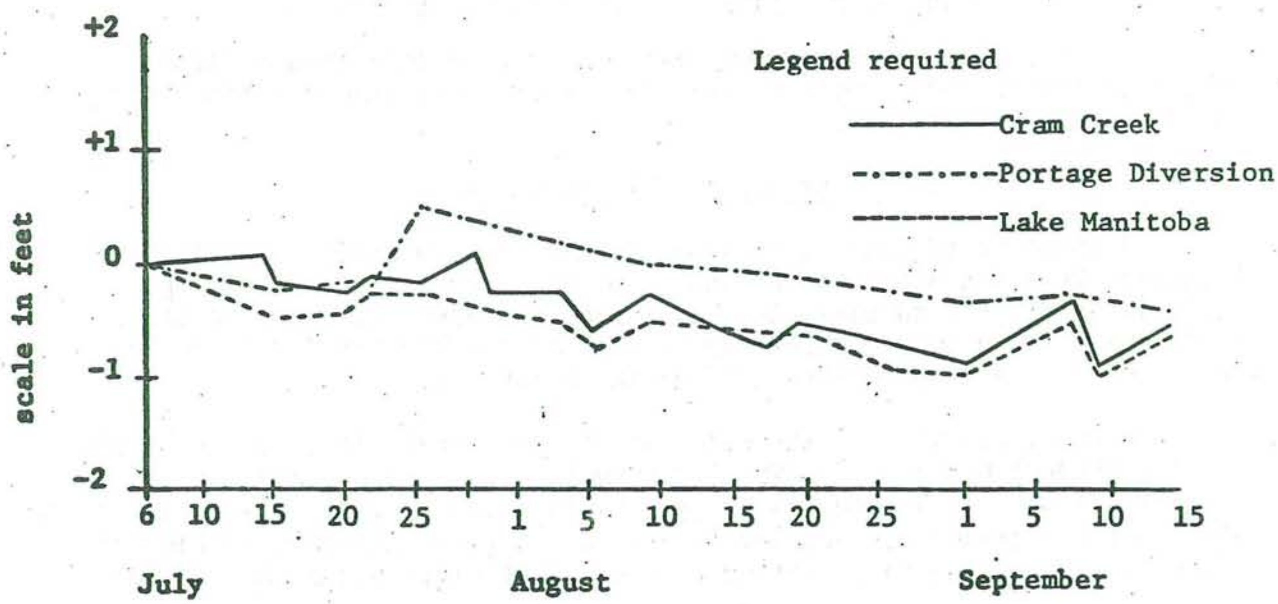

Fig. 2. Water level fluctuations in Lake Manitoba, Cram Creek and the Assiniboine River Floodway

TABLE 1

LISTING OF MERCURY LEVELS INTESTED ORGANISMS BY AREA

	GENERAL TAXA	SPECIFIC	NO. SAMPLES	Hg LEVELS (ppm) RANGE	MEAN
ASSINIBOINE RIVER	Corixidae	*Trichocorixa sp.*	1		0.05
	Ephemeroptera	*Hexagenia sp.*	2		0.02
	Anisoptera	*Dromogomphus sp.*	2	0.03-0.04	0.04
	Ictaluridae	*Ictalurus melas*	1		0.05
	Decapoda	*Orconectes sp.*	10	0.02-0.14	0.08
CRAM CREEK	Corixidae	Miscellaneous	1		0.02
	Anisoptera	*Aeshna sp.*	1		0.08
	Gasterosteidae	*Eucalia inconstans*	2	0.04-0.06	0.05
	Belostomatidae	*Lethocerus sp.*	1		0.06
	Notonectidae	*Notonecta sp.*	1		0.18
	Amphipoda	*Hyalella azteca*	3	0.05-0.09	0.07
		Gammarus sp.	1		0.13
	Gastropoda	*Lymnaea stagnalis*	2	0.02-0.06	0.04
		Physa sp.	2	0.02-0.05	0.04
ASSINIBOINE DIVERSION	Corixidae	Miscellaneous	1		0.16
	Anisoptera	*Sympetrum sp.*	1		0.08
	Gasterosteidae	*Eucalia inconstans*	3	0.08-0.17	0.14
	Belostomatidae	*Lethocerus sp.*	1		0.30
	Notonectidae	*Notonecta sp.*	2	0.14-0.32	0.23
	Amphipoda	*Hyabella azteca*	3	0.02-0.10	0.05
	Coleoptera	*Gyrinus sp.*	2	0.09-0.10	0.10
		Laccophilus sp.	2	0.22-0.26	0.24
	Gastropoda	*Stagnicda sp*	1		0.04
		Physa sp.	1		0.04
		Lymnaea stagnalis	1		0.04
		Helisoma campanulata	1		0.03

TABLE 2

MERCURY LEVELS (ppm) IN ORGANISMS GROUPED INTO AREAS AND FEEDING HABITS

FEEDING HABITS	ASSINIBOINE RIVER		CRAM CREEK		ASSINIBOINE DIVERSION		ORGANISMS INCLUDED IN CATEGORY
	Range	Mean	Range	Mean	Range	Mean	
Phytoplankton and Periphyton			0.02-0.06	0.04	0.03-0.04	0.04	Gastropoda
Zooplankton			0.04-0.06	0.05	0.08-0.17	0.14	*Eucalia inconstan*
Detritus		0.02					Ephemeroptera (larvae)
Omnivores	0.05-0.09	0.07	0.02-0.13	0.08	0.05-0.16	0.11	Decapoda, Corixidae, Amphipoda
Predators on Benthic and Littoral Invertebrates	0.04-0.05	0.05	0.08-0.18	0.11	0.08-0.32	0.19	*Ictalurus melas*, Anisoptera, Hemiptera Coleoptera
COMBINED	0.04-0.09	0.05	0.02-0.18	0.07	0.03-0.32	0.12	

ions (D'Itri, 1972). Levels in the region of 0.2 ppb would give some grounds for concern.

TABLE 3

Mercury Levels in Water

Area	Hg (parts/billion)
Cram Creek	0.07 p.p.b.
Lake Manitoba	0.08
Assiniboine River	0.06
Assiniboine Diversion	0.06

Table 2 indicates at least in the case of Cram Creek the process of biological magnification of mercury, although the small number of samples does not make this conclusive for all three areas. Levels in the predators, which are at the end of the aquatic food chain range from 666 to 5333 times greater than levels in the water from which they were taken. D'Itri (1972) gives the magnification for Northern pike, a terminal predator as 3,000 times. The similarity of these figures suggests that a food chain related biological magnification of mercury is occurring at the southern end of Lake Manitoba and that this magnification is relatively large. When the combined data are reviewed and the three areas compared, the Assiniboine River Floodway shows the highest mean value, with Cram Creek and the Assiniboine River showing lower figures for mercury. While it is not possible to determine reasons for this, water chemistry data (Table 4) show that while the Assiniboine River Floodway has the highest pH of the three areas its alkalinity is only about half that found in either the Assiniboine River or Cram Creek. These results contradict each other but if in fact at this time water within the Diversion had acquired a more acidic nature than the other areas it could possibly retain more mercury, and it would follow that higher mercury levels could be found in organisms living there. (D'Itri, 1972).

Qualitative Comparison of Fauna

The sampling sites were grouped into 9 areas and the data were grouped according to the area in which they were situated. (Table 5, and Figure 1). The fauna found in bottom samples (Tables 6 & 7) show a high proportion of Oligochaetes in the Assiniboine River Floodway and in Lake Manitoba at the Floodway outlet particularly in area 4 with 29.8 organisms per sample. The areas associated with the Floodway all show higher values for Oligochaetes than the areas associated with Cram Creek with the exception of Cram Creek area 7.

TABLE 4

WATER CHEMISTRY

CODE	SITE	CONDUCTIVITY Milli mhos	pH	TURBIDITY JTU	COLOUR (true)	TOTAL HARDNESS mg/l $CaCO_3$	TOTAL ALKALINITY mg/l $CaCO_3$	TOTAL PHOSPHOROUS (PO_4) mg/l	TOTAL NO_3^- $N^+O_2^-$ mg/l NO_3^-	C.O.D. mg/l	TEMP. °C	DISSOLVED O_2 ppm
5	Lake Manitoba	2.146	8.59	24.9	10	429.0	229.8	43	---	41.0	19°	9.8
1	Cram Creek	2.206	8.79	13.4	25	426.0	239.1	91	---	56.6	20°	8.3
16	Lake Manitoba	2.166	8.59	20.0	10	39.7	230.2	74	---	40.0	19°	9.3
11	Ass'n River Floodway	2.204	8.88	5.30	25	436.8	159.9	52	.002	23.4	21.6°	11.9
10	Ass'n River	0.808	8.14	71.0	40	321.0	262.1	293	.019	23.8	21.9°	5.5

TABLE 5

CLASSIFICATION OF AREAS FOR DATA GROUPING

AREA	DESCRIPTION	SAMPLING SITES INCLUDED
1	Lake Manitoba, offshore Cram Creek. Mud bottom	5,7,9
2	Lake Manitoba, offshore Assiniboine River Floodway. Mud bottom	18,16,20
3	Lake Manitoba, offshore Cram Creek. Sand bottom	4,6,8
4	Lake Manitoba, offshore Assiniboine River Floodway. Sand and mud bottom	17,15,19
5	Lake Manitoba, at mouth of Cram Creek	3
6	Lake Manitoba, at mouth of Assiniboine River Floodway	14
7	Cram Creek	1,2
8	Assiniboine River Floodway	11,12,13
9	Assiniboine River	10

TABLE 6

MAIN CONSTITUENTS OF BOTTOM SAMPLES

AREA	GENERAL TAXA	NO. SAMPLES	MEAN NO. ORGANISMS	RANGE	SPECIFIC TAXA INCLUDED
1	Oligochaeta	4	1.25	0-5	
2		8	5.25	0-11	
3		3	1.33	0-4	
4		9	29.82	0-167	
5		2	1.00	0-2	
6		4	4.25	0-10	
7		3	7.33	3-12	
8		8	5.00	0-19	
9		2	0	0	
1	Tendipedidae	4	11.00	4-19	*Pelopia sp.* and others
2		8	28.25	4-58	*Tendipes sp.* and others
3		3	13.00	11-15	
4		9	7.11	1-18	*Tendipes sp.* and others
5		2	13.50	7-20	
6		4	5.00	0-14	
7		3	22.33	2-60	*Tendipes, Pelopia, Cryptochironomus sp.* and others
8		8	21.25	1-53	*Tendipes sp.* and others
9		2	5.00	3-7	

TABLE 7

MINOR CONSTITUENTS OF BOTTOM SAMPLES

AREA	GENERAL TAXA	SPECIFIC TAXA	TOTAL NO. ANIMALS
1	NONE		
2	Diptera	Tabanidae	3
	Ephemeroptera	*Hexagenia sp.*	2
	Spaeriidae	*Pisidium sp.*	13
	# Groups represented = 3		
	# Types represented = 3		
3	Sphaeriidae	*Musculium sp.*	2
	# Groups represented = 1		
	# Types represented = 1		
4	Diptera	Heleidae	2
	Coleoptera	Cytiscidae	1
	Sphaeriidae	*Pisidium sp.*	3
		Muscutium sp.	4
		Sphaerium sp.	1
	# Groups represented = 3		
	# Types represented = 5		
5	Coleoptera	*Gyrinus sp.*	1
	Trichoptera	Phryganeidae	1
	Hirudinea		2
	# Groups represented = 3		
	# Types represented = 3		
6	Amphipoda	*Hyalella azteca*	2
	# Groups represented = 1		
	# Types represented = 1		

TABLE 7 (CONT'D)

AREA	GENERAL TAXA	SPECIFIC TAXA	TOTAL NO. ANIMALS
7	Diptera	Heleidae	1
	Coleoptera	Elmidae	1
	Hydracarina		1
	# Groups represented = 3		
	# Types represented = 3		
8	Diptera	Tabanidae	1
		Heleidae	5
	Ephemeroptera	*Hexagenia sp.*	3
		Caenis sp.	17
	Coleoptera	Elmidae	1
	Trichoptera	*Oecetis sp.*	3
	Zygoptera	*Agrion sp.*	3
	Hemiptera	Corixidae	1
	Amphipoda	*Hyalella azteca*	31
	Sphariidae	*Musculium sp.*	4
	Hydracarina		1
	Cladocera		1
	# Groups represented = 10		
	# Types represented = 12		
9	Ephemeroptera	*Hexagenia sp.*	19
	Lepidoptera		1
	Collembola		1

The numbers of Chironomid larvae are similar in the Floodway and Cram Creek, but in the mouths of these outlets and in the immediate offshore areas, Cram Creek shows a higher proportion of Chironomids than the same regions associated with the Floodway. In the region most distant from the outlets the Assiniboine River Floodway shows a higher average number of Chironomid Larvae.

Other organisms found in bottom samples (Table 7) indicate that a greater variety is associated with the Assiniboine River Floodway than with Cram Creek.

Table 8 includes organisms found in dipnet, and sieve net samples. Here too the trend appears to be toward greater variety of fauna associated with the Assiniboine River Floodway. The only exceptions lie in the areas at the mouths of the two outlets, area 5 (Cram Creek) and area 6 (Assiniboine Diversion). When all types of samples are considered this exception is again indicated. This may be because of a layer of detritus of several cm on the lake side of the Floodway outlet sill, and the lack of vegetation caused by the outlet structure. Cram Creek, a natural outlet has a more gradual shift from marsh to lake as regards substrate, water depth, and vegetation. Towards the end of the summer it harboured at its mouth masses of floating vegetation which provided excellent habitat for typical marsh fauna. Pennak (1953) pointed out that a marsh type of habitat such as Delta Marsh is the ideal situation for finding a large variety of freshwater invertebrates, and emphasizes the tranquil nature of "small, weedy lakes and ponds" (Pennak, 1953). In comparing the nature of Cram Creek near its entrance to the lake with the Assiniboine River Floodway within the Delta Marsh this seems to account for the difference in various types of invertebrate fauna. The Floodway when not in use is subjected to less flushing action than the creek, due to the outlet sill which often prevents scouring. The retention of water behind the sill has been mentioned earlier, and it appears that the sill is an effective method of cutting off the Floodway and establishing it as a marsh type habitat, rather than a waterway for most of the season.

It is not suggested that the Assiniboine River Floodway is a polluted system, for it sustains a healthy aquatic fauna, the relatively high numbers of Oligochaeta and Tendipedidae (Chironomidae) associated with Lake Manitoba near the floodway indicate a change from the "natural" condition of the lake near Cram Creek. Pennak (1953) in reviewing a typical fresh-water habitat speaks of indicator organisms of polluted waters, and cites tubificid Oligochaetes and Tendipedid larvae as important in this respect. An increase in the numbers of these animals would certainly be expected, as a result of the increased amount of nutrients provided by waters passed through the Floodway, and the data presented here indicate that an increase has taken place. Here perhaps, is an early manifestation of the cumulative effect which will be exerted by the Floodway on Lake Manitoba with its continued use.

TABLE 8

FAUNA FROM OTHER SAMPLING METHODS

AREA	GENERAL TAXA	SPECIFIC TAXA
1	NONE	
2	NONE	
3	NONE	
4	NONE	
5	Trichoptera	
	Zygoptera	Agrionidae
	Hemiptera	Corixidae
	Amphipods	*Hyalella azteca*
	Pisces	*Perca flavescens*
		Eucalia inconstans
6	NONE	
7	Trichoptera	
	Anisoptera	*Aeschna sp.*
	Hemiptera	Corixidae
		Notonecta sp.
		Lethocerus sp.
	Amphipoda	*Hyalella azteca*
		Gammarus sp.
	Gastropoda	*Amnicola sp.*
		Promenetus sp.
		Lymnaea stagnalis
		Physa sp.
	Pelecypoda	
8	Coleoptera	*Gyrinus sp.*
		Haliplus sp.
		Laccophilus sp.
	Trichoptera	
	Zygoptera	
	Anisoptera	*Sympetrum sp.*
	Hemiptera	*Ambrysus sp.*
		Lethocerus sp.
		Corixidae

TABLE 8 (CONT'D)

AREA	GENERAL TAXA	SPECIFIC TAXA
		Notonecta sp.
		Gerris sp.
	Amphipoda	*Hyalella azteca*
	Gastropoda	*Stagnicola sp.*
		Physa sp.
		Helisoma campanulata
		Lymnaea stagnalis
	Hirudinea	
	Pisces	*Eucalia inconstans*
9	Diptera	Heleidae
		Tabanidae
	Ephemeroptera	Baetidae
		Pentagenia sp.
		Hexagenia sp.
	Coleoptera	
	Zygoptera	
	Anisoptera	*Dromogomphus sp.*
	Hemiptera	*Trichocorixa sp.*
		Other Corixidae
		Ranatra sp.
	Amphipoda	*Hyalella azteca*
	Hydracarina	
	Decapoda	*Orconectis sp.*
	Pisces	*Ictalurus melas*

Conclusions

The Assiniboine River Floodway Diversion is similar in several ways to Cram Creek its counterpart in this study. Superficially it resembles Cram Creek and the Delta Marsh through which it passes. The water present in the Floodway in late summer is similar to that of Lake Manitoba and Cram Creek, but subtle differences exist even though the Floodway is only in its second year of use. These differences are transmitted to Lake Manitoba every spring when the floodway is in use, and with the current interest in preserving existing ecological conditions any adverse effects of this transmission should be determined and changes in the flora and fauna in both Lake Manitoba and the Marsh monitored on a regular basis. This project has indicated that the Floodway is have an effect on Lake Manitoba at its entrance to the lake. Further and more discriminating investigations should prove or disprove this and determine whether or not this change is likely to be beneficial or detrimental.

Acknowledgements

Thanks are given to the following for their assistance and advice in conducting this project: Dr. H. E. Welch, Dr. A. Hamilton, Dr. R. Green, Mr. T. Cantlon, Mr. J. Gibbons, and the staff at and associated with the University Field Station, Delta Marsh.

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Food Habits and Winter Habitat Use of White-tailed Deer (*Odocoileus virginianus*) in the Delta Marsh

E. Kucera

University Field Station (Delta Marsh)

Introduction

For the past 30 years, Delta Marsh has supported a more-or-less isolated population of white-tailed deer (*Odocoileus virginianus*). To learn more about this population and its relations to environmental factors, it is of primary importance to obtain adequate information about population size and composition and how the available space and food sources are used. This study has been designed to obtain this information, and on that basis, an attempt will be made to estimate the carrying capacity of Delta Marsh and to indicate appropriate management of deer in this area.

As winter is the critical period for deer, special attention has been given to the winter conditions.

Methods

Observation forms (Fig. 1) were used to record all deer from May 1970 until October 1971. Records of deer observed from August 1 to October 31 were used to calculate the pre-hunting age composition of the population and November 1 to January 15 for the post-hunting age composition. The age of 19 individuals was determined by tooth wear (Severinghaus, 1949).

In January, February and March 1971 aerial flights (one and one half hour duration) covering the whole marsh west of and including Clandeboye Bay were used to census deer. Two observers and the pilot-observer participated.

Regular field work was carried out on the 7.1-mi.^{2} area (Fig. 1) described in the University Field Station 1970 Annual Report. A transect system consisting of rectangular grid of approximately 2-m wide trails produced by a caterpillar tractor was established in January 1971. The transects, seven running in north-south direction, eight in east-west direction, divide the area into 42 squares 500 x 500 m (25 ha) each. This grid provided permanent reference points, facilitated observa-

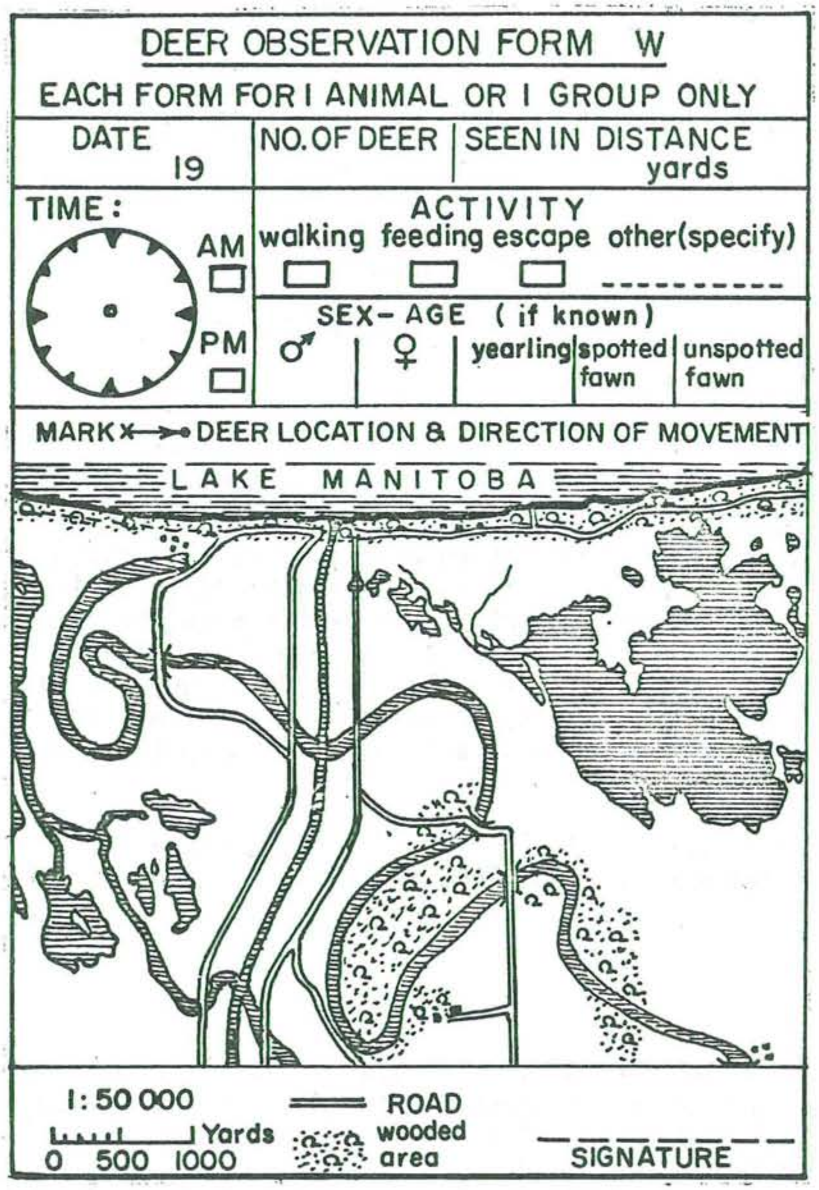

Figure 1. Deer Observation Form

tion of deer and made it possible to check areas otherwise inaccessible. A complete track and pellet count along all the transects (48.5 km) was made from February 15-18, 1971. Tracks entering or leaving, trails crossing and pellet groups on the transect were recorded in absolute numbers. Tracks following the course of the transect were recorded on a three-point scale: abundant (2), scarce (1) and none (0).

Four sets of environmental measurements were taken at ten-day intervals in 63 permanent stations located northwest (against the prevailing winds) approximately 10 m from the transect crossings and from extensions of transects in the ridge along the lake shore.

Measurements taken were as follows: (1) snow depth, hardness and the thickness of discernible layers, (2) temperature at ground surface, snow surface and 75 cm above the snow surface and (3) windspeed (measured by a "Dwyer" windmeter) at 75 cm and directly above the snow surface. The factor of dry shade atmospheric cooling (windchill) was calculated and compared with the one calculated for data recorded at the meteorological station at the University Field Station (Mallard Lodge).

Sixteen rumens were examined, two of road-killed deer, one killed by poachers, five shot during the 1970 hunting season and eight collected especially for the study. The rumen contents were preserved in 4% formalin. From each, a 300-cc sample was washed on a 30-mesh screen and analysed for forage-class composition (mono- and dicotyledons) by the point-frame method (Chamrad and Box, 1964). In addition, all discernible parts, mainly seed, were separated and identified.

Two female fawns and one adult doe, all collected in September 1971, were autopsied and searched for parasites.

Results and Discussion

Population

One thousand, one hundred and seventy-six observation forms were completed, representing 3,551 individual deer. The numbers of deer seen during the aerial surveys were as follows: 185 on January 14, 371 on February 18 and 223 on March 16. It is estimated that there were about 400 deer present in the marsh in winter 1970-71.

The calculated percent composition of the herd in males, females and fawns prior to and following the hunting seasons is summarized in Table 1. The fawn crop expressed as pre-hunting fawns/doe ratio was 0.53 in 1970 and 0.96 in 1971.

Age structure of the population is shown in Fig. 2. It is characterized by preponderance of fawn and yearling classes indicating a fast population turnover.

Habitat Use

The results of the track and pellet count are given in Table 2. The number of tracks, trails and pellet groups per 100 m of given vegetation type indicates the frequency of use by deer. These data clearly reveal that the most important vegetation types are the meadow and wood. The number of pellets found in the wood was high, as it is used as a resting place. Meadows are the favourite feeding ground and deer have been observed coming out of the wood to graze. In addition to the

TABLE 1

Composition of the Deer Population in 1970 and 1971

	Percentage Males	Percentage Females	Percentage Fawns
Pre-hunting 1970	12	58	30
Post-hunting 1970	8	45	47
Pre-hunting 1971	12	45	43

TABLE 2

Results of Track and Pellet Count on the Transects, February 15-18, 1971

Vegetation Type	Length of Transects (m)	Use of Transects	Tracks/100 m	Percentage	Trails/100 m	Percentage	Pellet Groups/100 m	Percentage
Phragmites	7,200	1.27	4.01	5.0	0.6	15.8	0.26	4.2
Scolochloa	6,710	0.62	5.25	6.5	0.4	10.5	0.28	2.5
Meadow	8,220	1.74	47.27	58.7	0.6	15.8	0.89	14.4
Emergent	4,760	0.43	0.63	0.8	0.2	5.3	0.06	1.0
Wood	3,110	1.94	23.31	29.0	2.0	52.6	4.70	75.9
Totals	30,000		80.47	100.0	3.8	100.0	6.19	100.0

meadow, deer used the transects as convenient passageways in the wood and stands of dense *Phragmites*.

It is interesting that the rank of use of each vegetation type (as expressed by the number of tracks/100 m) is negatively correlated with its mean snow depth. Although the snow probably was not deep enough to completely restrict deer movements during 1970-71 winter, it may have been another reason for the preference of certain types.

The vegetation types vary in their potential for lowering the impact of wind and hence the dry shade atmospheric cooling (windchill) factor. Table 3 shows that windchill factor was lowest in the wood and *Phragmites* types which are both preferred resting areas. Despite the good protection from wind it offers, the ridge is hardly ever used in winter, owing to unfavourable snow conditions (Fig. 3). Snow, blown over the lake, accumulates in the ridge, often up to 4 m deep and progresssively reduces the area accessible to the deer.

TABLE 3

Values of Dry Shade Atmospheric Cooling (Windchill) Factor (kg cal./m/hr.) in Different Vegetation Types[1]

Windchill Factor	*Phragmites*	*Scolochloa*	Meadow	Emergent	Wood	Ridge
75 cm above snow surface	900	1,000	1,000	1,000	380	728
At the snow surface	780	920	900	820	380	567

[1]Corresponding windchill factor, calculated from data obtained from the anemograph, has a value of 1,100.

Forage Utilized

All but one of the rumens contained exclusively non-woody plants. It contained *Rosa* and *Symphoricarpos* fruits and twigs which made up 22% of the sample. The proportion of monocotyledons and dicotyledons in the samples during the year is shown in Fig. 4. Dicotyledons composed the major part of the diet throughout the year. This further supports the conclusion relating to the importance of the meadow vegetation where most dicotyledons are found. The proportion of monocotyledons is slightly higher in spring and fall, which is correlated with the new growth of grasses (first green forage available) in the spring and the second growth of grasses which occurs at the time of the fall rains, especially along the mown roadsides.

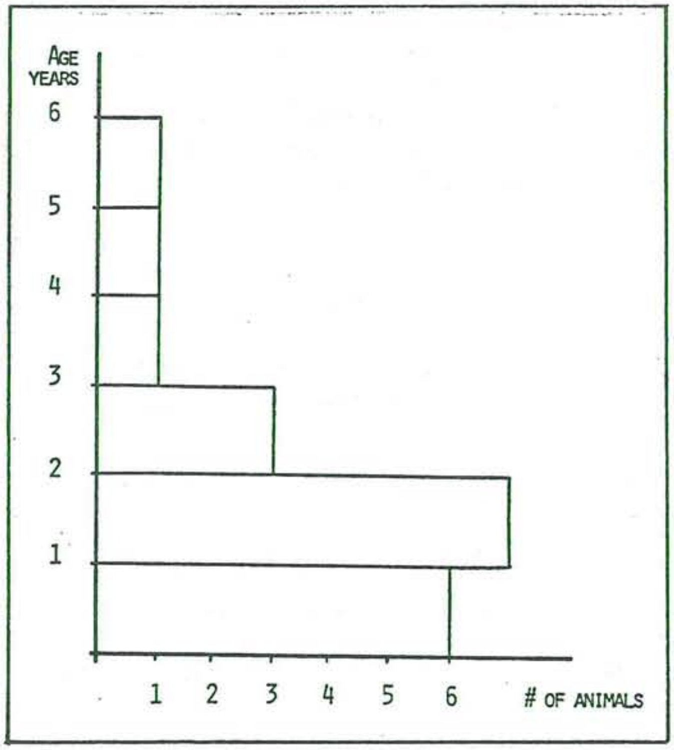

Figure 2. Population age structure.

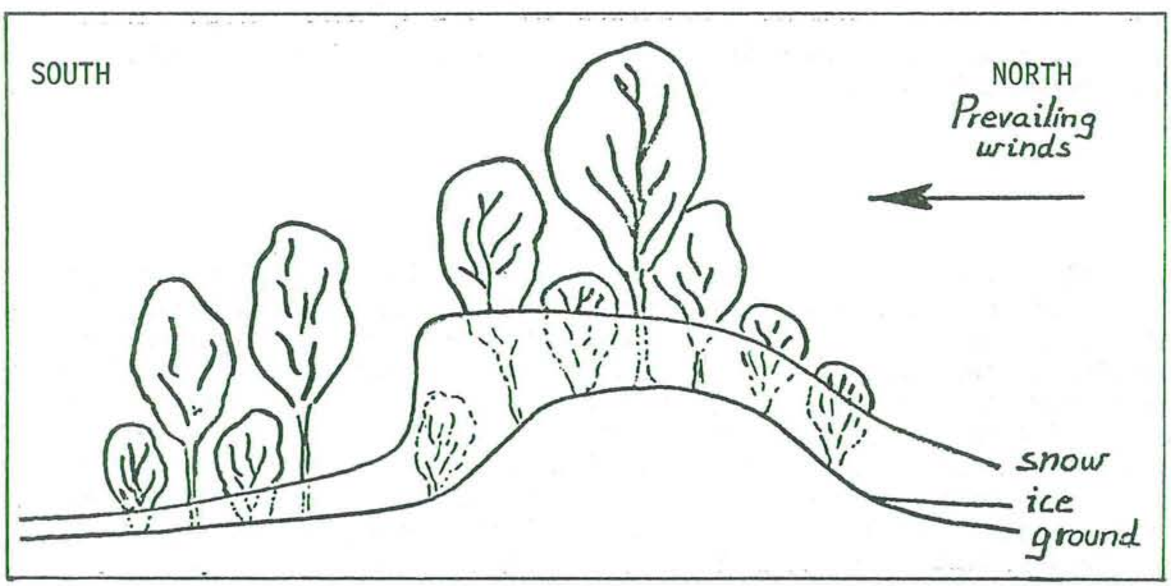

Figure 3. Diagram of forested ridge at Delta showing snow accumulation.

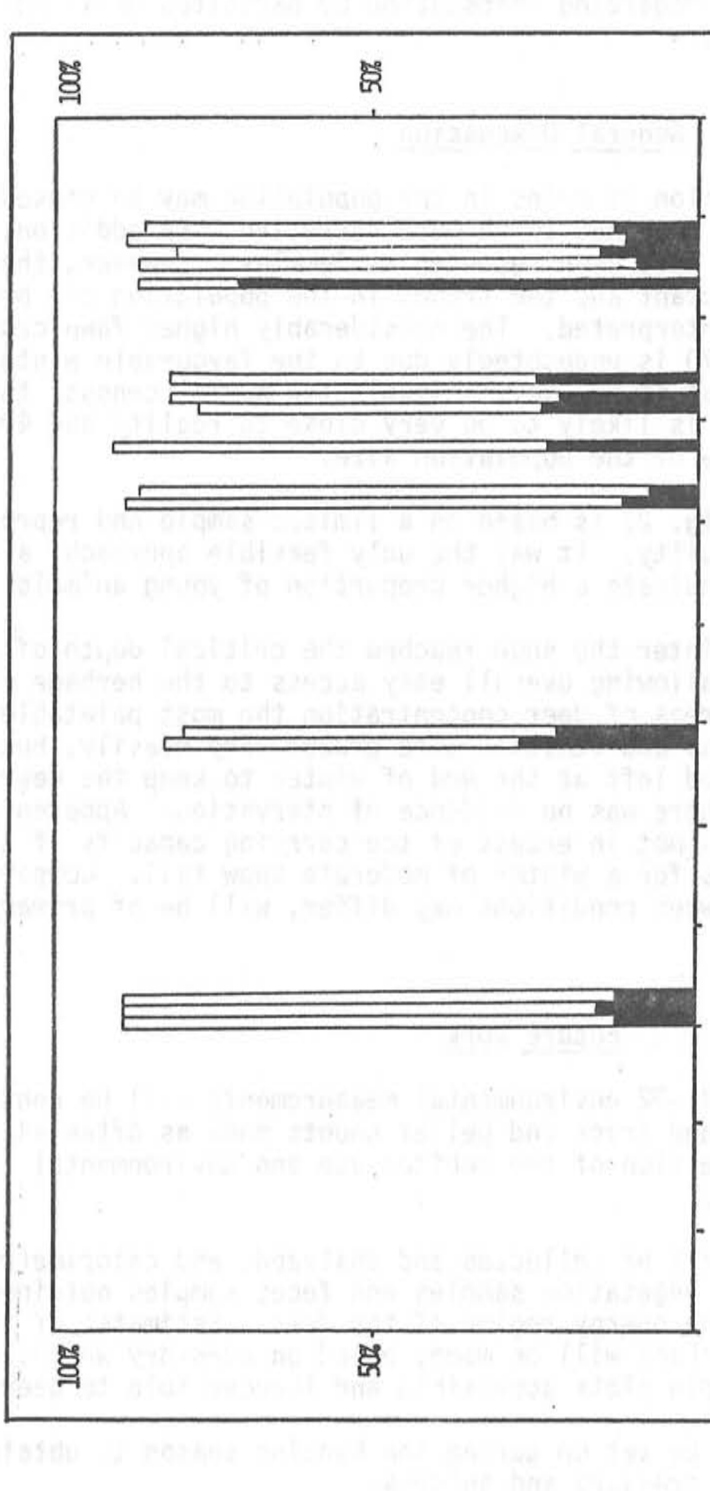

Figure 4. Histogram of monocotyledon and dicotyledon contents of 16 deer rumen.

Parasites

One of the three deer autopsied (a female fawn) was slightly infested with *Dictiocaulus viviparus*. No parasites were found in the other two deer. Little can be said regarding infestation by parasites until more animals have been examined.

General Discussion

The estimated proportion of males in the population may be biased to some extent, as bucks are inclined to be more secretive. In addition, spike bucks may sometimes have been recorded as females. However, the bias should be fairly constant and the trends in the population can be assumed to be correctly interpreted. The considerably higher fawn crop of 1971 as compared to 1970 is undoubtedly due to the favourable winter conditions. As the habitat is uniquely suitable for aerial census, the highest count of February is likely to be very close to reality and 400 deer a reasonable estimate of the population size.

The age structure (Fig. 2) is based on a limited sample and represents the structure of the mortality. It was the only feasible approach, although other field data indicate a higher proportion of young animals.

During the 1970-71 winter the snow reached the critical depth of 50 cm in only a few places, allowing overall easy access to the herbage (Table 4). In the main areas of deer concentration the most palatable species, *Sonchus*, *Melilotus* and *Cirsium*, were grazed very heavily, but there was still enough food left at the end of winter to keep the deer in fairly good condition. There was no evidence of starvation. Apparently the present population was not in excess of the carrying capacity of the Delta Marsh. This applies for a winter of moderate snow fall. Comparison with the 1971-72 winter, when conditions may differ, will be of primary importance.

Future Work

During the winter 1971-72 environmental measurements will be continued at ten-day intervals and track and pellet counts made as often as possible. More precise expression of the habitat use and environmental conditions will be sought.

More rumen samples will be collected and analyzed, and calorimetric values of rumen contents, vegetation samples and feces samples obtained to make an appraisal of the energy regime of the deer. Estimates of the available and utilized herbage will be made, based on oven-dry weight of material clipped from sample plots accessible and inaccessible to deer.

A check station will be set up during the hunting season to obtain information about hunting pressure and success.

TABLE 4

Snow Depth[1]

Vegetation Type	Number of Snow Stations	Average Depth, February 11-13	Range, February 11-13	Average Depth, February 21-23	Range, February 21-23	Average Depth, March 4-5	Range, March 4-5	Average Depth, March 14-15	Range, March 14-15	Relative Depth
Phragmites	5	38.4	32-48	27.2	20-40	27.6	17-37	19.8	10-27	4
Scolochloa	13	36.2	31-42	29.5	20-40	26.2	17-32	18.7	11-27	3
Meadow	12	33.6	23-40	20.7	8-31	16.6	7-27	12.5	0-30	1
Emergent	8	46.0	34-65	35.8	30-56	32.9	23-55	28.3	15-55	6
Wood	3	32.0	30-36	26.3	26-27	21.3	19-26	18.6	17-20	2
Ridge	7	37.1	33-46	30.4	23-39	26.8	19-34	22.8	17-27	5

[1]Depths are given in centimetres.

Acknowledgements

The study was supported by the Manitoba Department of Mines, Resources and Environmental Management. I wish to thank Dr. W. O. Pruitt, Jr. for advice and consultation, Dr. J. M. Shay for suggestions and help with technical problems and all the residents of the Field Station who added to the amount of information available for analysis by recording their observations of deer.

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A Survey and Mapping of Vegetation Along the Southern Shore of Lake Manitoba

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Department of Botany

Introduction

During the past two years there have been intermittent discussions regarding the advantages and disadvantages of lowering the level of Lake Manitoba. Many facets of each argument relate to the vegetation and the changes which could occur if the water were lowered. Little is known, however, concerning the structure and composition of the existing lakeshore communities. In order to provide basic data of this nature, it was decided to survey and map the emergent and aquatic vegetation along a portion of the lakeshore.

Methods

The area selected lay between the Assiniboine Diversion outlet and Cram Creek, 3 km to the west. In July and August 1971 the beach was staked into 100-m units for reference points as the mapping progressed. Every 5 m a transect was laid at right angles to the beach, and the distribution of each species along the transect was recorded. The transects extended from the edge of the beach ridge vegetation, which was seldom more than 12 m from the water's edge, into the lake to a distance not exceeding 100 m. Beyond this distance, water depth made effective mapping impossible.

Concurrent with species identification and mapping, cover was estimated and values assigned following a modified Braun-Blanquet scheme, *i.e.*, value 1 = 0-5% cover, value 2 = 5-25% cover, value 3 = 26-50% cover, value 4 = 51-75% cover and value 5 = 76-100% cover.

The nature of the bottom was recorded using arbitrary terms (sandy, silty, clayey and organic) to describe texture. A compactness index of 1-3 was used for the range of firm through soft conditions, evaluated by how far a weight would settle into the bottom sediment.

This procedure was followed for 90% of the survey. Approaching Cram Creek, the extent, height and density of the emergent species between the beach ridge and the water made it virtually impossible to plot and measure accurately. From 2,750 m only the shoreline emergents (up to 10 m from the water's edge) were mapped. Aerial photographs are being used to complete mapping of those areas not covered by ground work.

When the wind was from the north, mapping was frequently impossible and therefore could only be carried out when there was a south wind or little or no wind at all. Consequently, water depth was not recorded because of the great variability. Water level data from the Water Resources Branch will be used to provide daily and mean monthly levels. This information will supplement that derived from field work to give an overall picture of conditions.

Results

The survey showed four emergent species to predominate: *Scirpus americanus* and *S. validus*, *Phragmites communis* and, to a lesser extent, *Typha latifolia*. Other herbaceous species (*Carex*, *Mentha*, *Sagittaria*, *Cirsium* and *Plantago*) and *Salix* were found in those areas where the ridge and the lake were widely separated and infrequently inundated. Only two submerged species were recorded: *Potamogeton pectinatus* and *P. richardsonii*. Although the data have not been fully analysed, some general observations can be made.

The mean width of the stands of emergent species was 14.5 m and of submergent aquatics 32.5 m. It must be noted that the aquatics extended well beyond the 100 m mapped. As mentioned previously, although water depth prohibited mapping of these stands, their occurrence was recorded.

Along any 100-m length, cover by emergents averaged 60% and aquatics 75%. Again wide variations were noted. In the east, cover (both emergent and aquatic) was generally well below the mean of 60% but increased as we moved westwards toward Cram Creek where complete (100%) cover was recorded for several transects.

Discussion

The information derived from this survey provides base line data regarding the shoreline vegetation along Lake Manitoba. Such information has not previously been available and will be valuable in the event of a change in the lake level. It is believed that knowledge of present conditions will aid in predicting what will occur if a specific change is implemented. The sequences of succession that occur in the colonization of the shoreline are very evident in the west end, and extrapolation of these data will serve a useful purpose.

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

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Department of Botany

Introduction

For the past two field seasons, I have been studying some aspects of the ecology of the hardstem and softstem bulrushes (*Scirpus acutus* and *Scirpus validus*). My interest in these plants arises from two problems of practical importance:

1. Bulrushes are prominent members of many temperate emergent communities and are heavily utilized by ducks and muskrats for food and cover. Despite this fact, we know little about their ecology.

2. The second problem arises when one attempts to distinguish the *acutus* form from the *validus* form. It is often difficult to decide which "species" one is dealing with because a confusing array of variation exists between the two.

During the first field season, I examined a wide range of habitats and found an apparent difference in distribution of the two forms in Manitoba (Fig. 1). *Scirpus acutus* is distributed throughout the province, irrespective of soil types, while *S. validus* is restricted to non-calcareous clays and silts of lacustrine and deltaic origin.

Objectives

In order to compare the habitat requirements of these two "species" it is necessary to determine the nature of the environment in which each stand is found, how well the plants are growing and the taxonomic status of the stand.

Methods

Thirty-five stands were selected and data collected from each using a transect along the water-depth gradient with five side-transects running perpendicular to it. Along each side-transect, five sample plots of 0.2 m^2 were chosen at 1-m intervals (Fig. 2).

Environment

Analysis of environmental parameters has involved the two most-important factors, soil and water.

1. Soil analysis: five soil samples were taken at each site and analyzed for particle size distribution and organic content.

2. Water analysis: water depths experienced by each stand, as well as the seasonal fluctuations in water depth, were recorded for each stand. The following components of water chemistry were measured using Hach techniques: calcium, magnesium, sulphate, total dissolved solids, nitrate and nitrite nitrogen, iron and pH.

Stand Performance

Growth was assessed by measuring culm height, fertility and density obtained from 25 quadrats. Cover was obtained along the baseline transect and biomass (or standing crop) of root and short portions was obtained from five soil cores, each of 150-cm^2 surface area.

Taxonomic Status

In order to avoid the subjective decision of labelling a stand as *acutus* or *validus*, a hybrid index was employed, whereby individual taxonomic characters are scored as +1 if the expression of the character is like the *validus* form, -1 if like the *acutus* form and 0 if intermediate. The scores for all taxonomic characters used are then summed and a numerical measure of morphological affinity to the two forms is obtained. Ten characters were used, the *validus* form having a value approaching +10 and the *acutus* form a value approaching -10. The characters examined are: achene length:scale length; color of ripe achenes; length and width of achenes; amount of red-spotting on scales; midrib of scale excurrent or not; arrangement of spikelets; length of rays of inflorescence; pattern of branching of rays; culm color and ratio of culm diameter to number of aerenchymal cells.

Results and Discussion

In this report the data for two of the 35 stands are presented.

Stand 1 is an old and well-established hardstem stand with vigorous growth. Stand 5 is a softstem stand growing in a recent borrow pit; small clumps of softstem are scattered sparsely throughout. Table 1 compares several environmental parameters. The low organic content and large clay component of the soil at site 5 reflect a rooting medium which is essentially mineral soil. The high conductivity is probably due in part to the high concentrations of calcium, magnesium and sulfate ions which are approaching what I feel may be limiting concentrations for the *validus* form. This may be part of the explanation for the relatively low cover and biomass values from site 5 (Table 1).

TABLE 1

Comparison of Stand Performance, Taxonomic Status and Water and Soil Analyses for Sites 1 and 5

	Site 1	Site 5
Biomass (gm/m^2 oven-dried)		
Shoot	666.98	3.43
Root (including rhizome)	10,113.60	97.76
Total	10,780.58	101.19
Density (culms/m^2)	108.99	1.03
	(S.D. = 11.90)	(S.D. = 0.58)
Cover (percentage)	100	3.3
Fertility	75	74
Hybrid Index	-6	+7
Soil		
Organic matter (percentage)	15.39	5.39
Texture: percentage sand	51.1	6.8
percentage silt	26.0	33.1
percentage clay	22.9	60.1
Water		
Conductivity (millimhos/cm^3)	1.04	2.53
Alkalinity (ppm $CaCO_3$ equivalent)	400	110
Calcium (ppm)	310	550
Magnesium (ppm)	110	1,190
Iron (++, ppm)	0	0
Sulfate (ppm)	225	315
pH	8.5	8.5

A comparison of the root and short biomass data (Table 1) for both stands illustrates the high proportion of the total biomass which is comprised of roots and rhizomes. In general, the shoot biomass ranges from 3 to 6% of the root biomass.

One of the important environmental factors appears to be the annual water level regime. Fig. 3 illustrates the pattern of water level changes experienced at site 1 during the mid-June to mid-October period. The net decrease over the summer was 6 cm. The sharp rise on July 26 is attributed to a severe storm with strong north winds which carried lake water into the marsh; pre-storm levels were attained again within 10 days. The pattern of steadily declining water levels at site 5 (Fig. 4), with a net drop over the summer of 23 cm, is typical of the regime experienced by most softstem stands. By midsummer, water levels in softstem stands have usually dropped below the soil surface. Such water level regimes appear to be necessary for the seedling establishment of the *validus* form, and four softstem stands have been examined which are known to have originated recently from seedlings. In each instance the softstem volunteered after a period of drawdown in which wet mud was exposed. There are no records in the literature of seedling establishment of the *acutus* form.

From the preliminary results, it appears that the *validus* form is a colonizer of disturbed areas, such as borrow pits and ditches, or of natural areas which have had a recent history of low-water periods. As a result of the temporary nature of the aquatic habitat in which most *S. validus* stands are found, they are of relatively minor interest in marsh management. Twenty-four stands of softstem bulrush were examined systematically for evidence of muskrat and waterfowl use; only two had resident muskrats, as suggested by active lodges. These two stands also had coot nests. Both these areas are artifically managed and were flooded after the initial establishment of softstem.

By comparison, 19 of the 32 *S. acutus* stands examined harboured muskrat lodges, and the following nests were found:

	Number of Stands	Total Number of Nests
Coot	17	20
Canvasback	9	10
Ruddy duck	3	3
Redhead	3	3
Yellowheaded blackbird	5	23
Redwinged blackbird	2	2
Short-billed marsh wren	1	1
Western grebe	1	1

The greater use of the hardstem bulrush by marsh-dwelling birds and by muskrats is due to the influence of water regimes rather than intrinsic difference in the vegetation itself. *S. acutus* is the form which is most common in marsh habitats, and *S. validus* is typical of marginal wetland habitat.

Conclusions

The preliminary data show that there are differences in the environmental requirements of these two forms of bulrush. *S. acutus* tolerates a wide range of magnesium, calcium and sulfate ion concentrations and is generally found in permanent bodies of water. The *validus* form is more typical of shallow, temporary waters. As a result, the *acutus* form is more important in marshes.

The third field season will add further information on the ecological requirements, taxonomic status and conditions for establishment of both forms. Management implications will then be deduced.

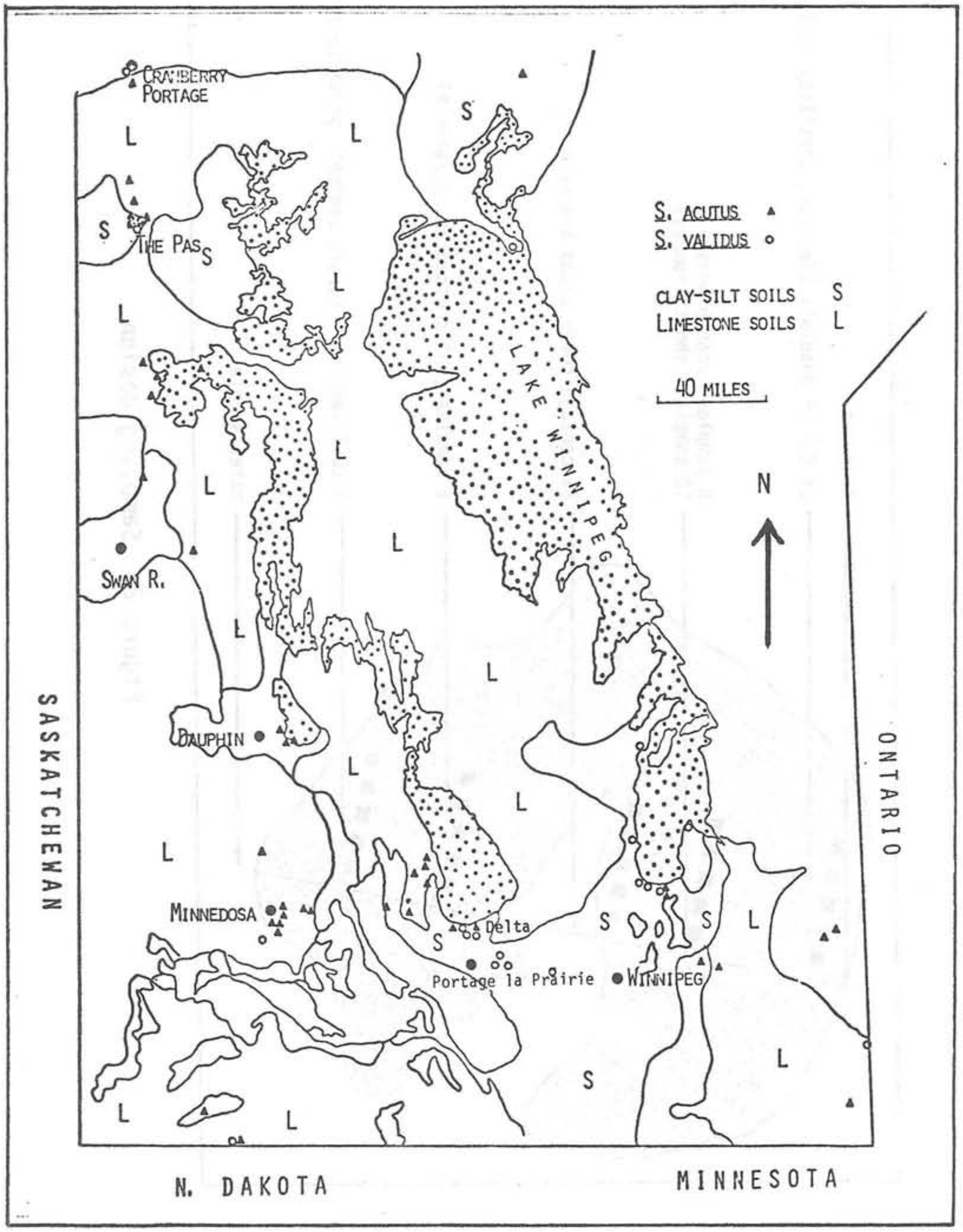

Figure 1. Distribution of *Scirpus acutus* and *S. validus* in southern Manitoba.

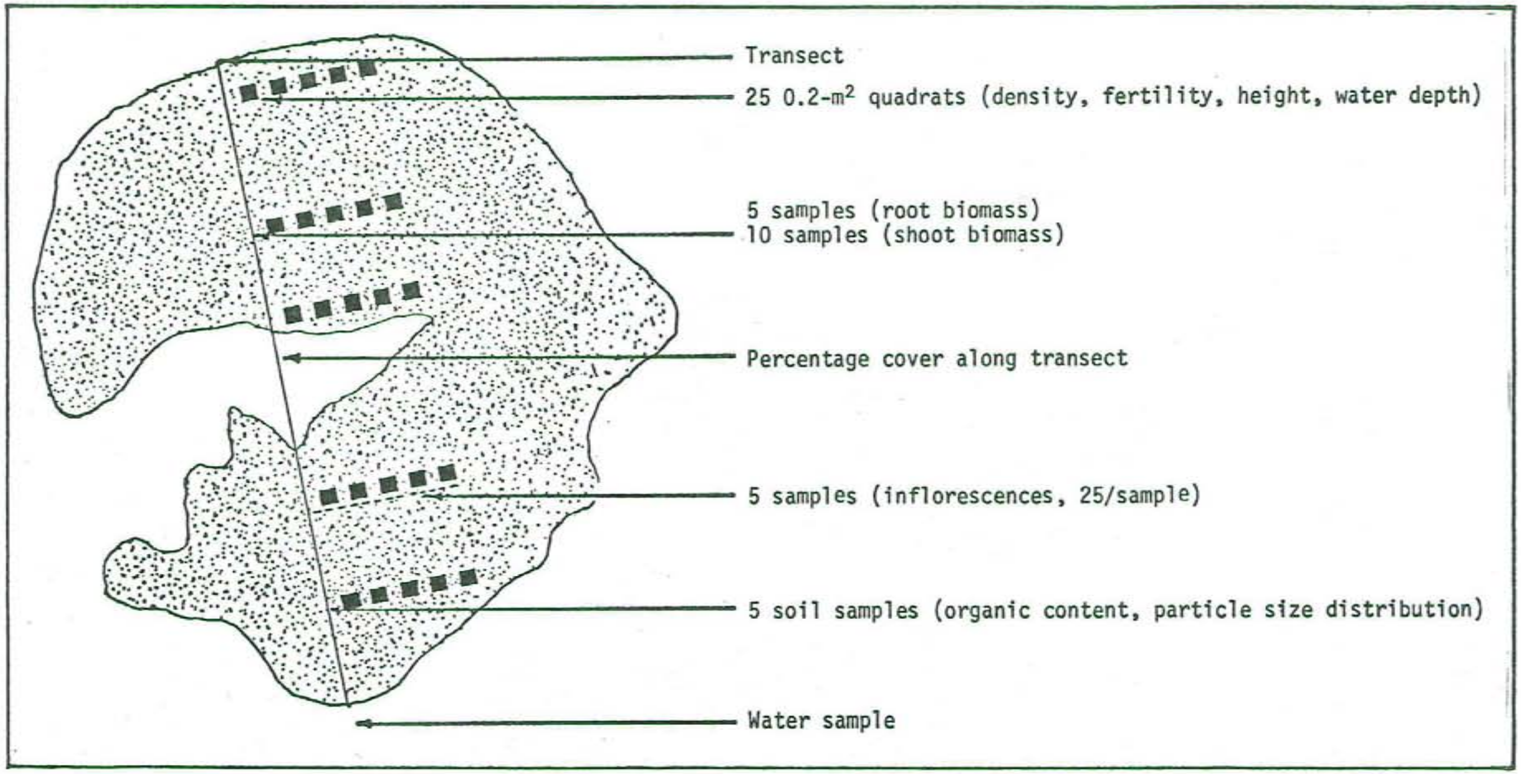

Figure 2. Sampling design.

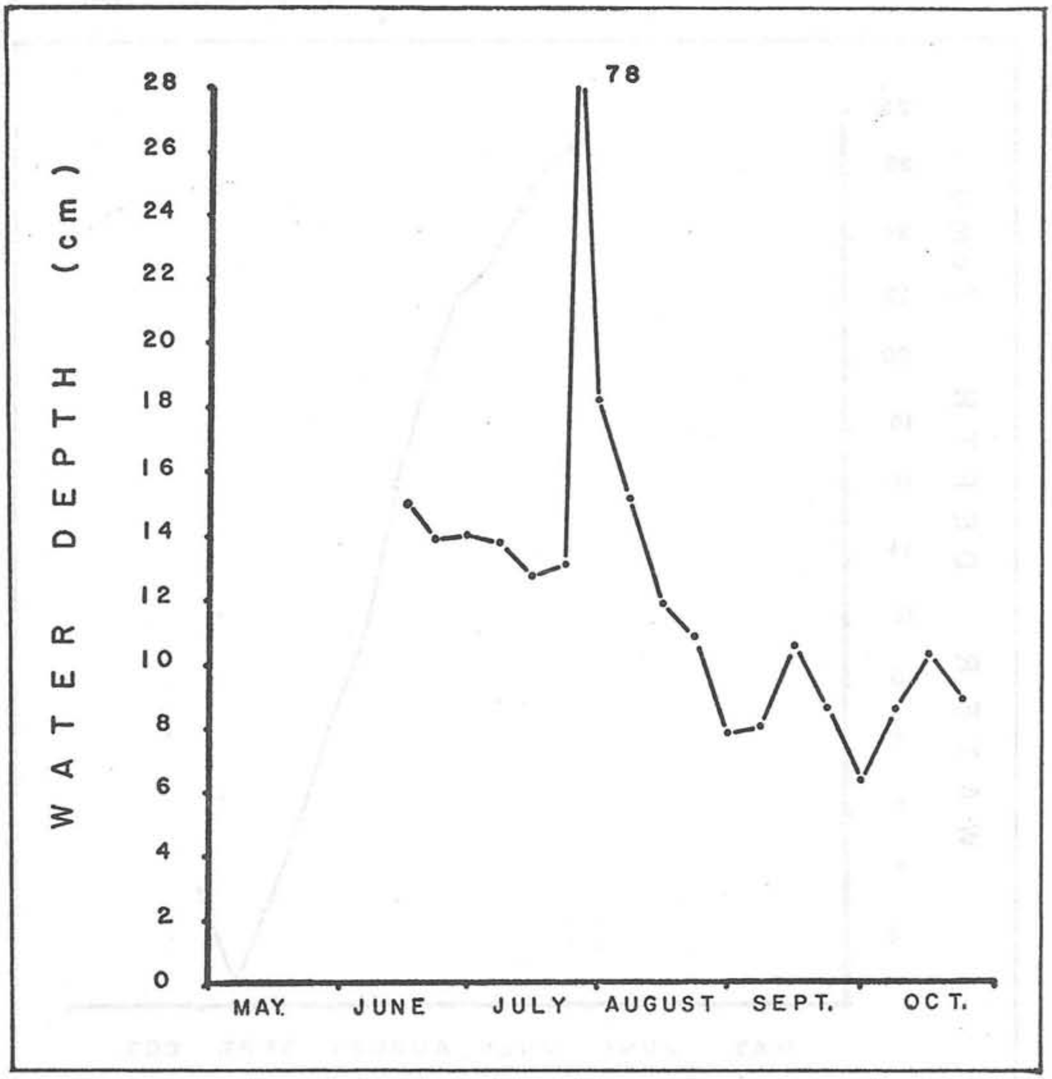

Figure 3. Water level changes, 1971 at Site 1 (*Scirpus acutus*).

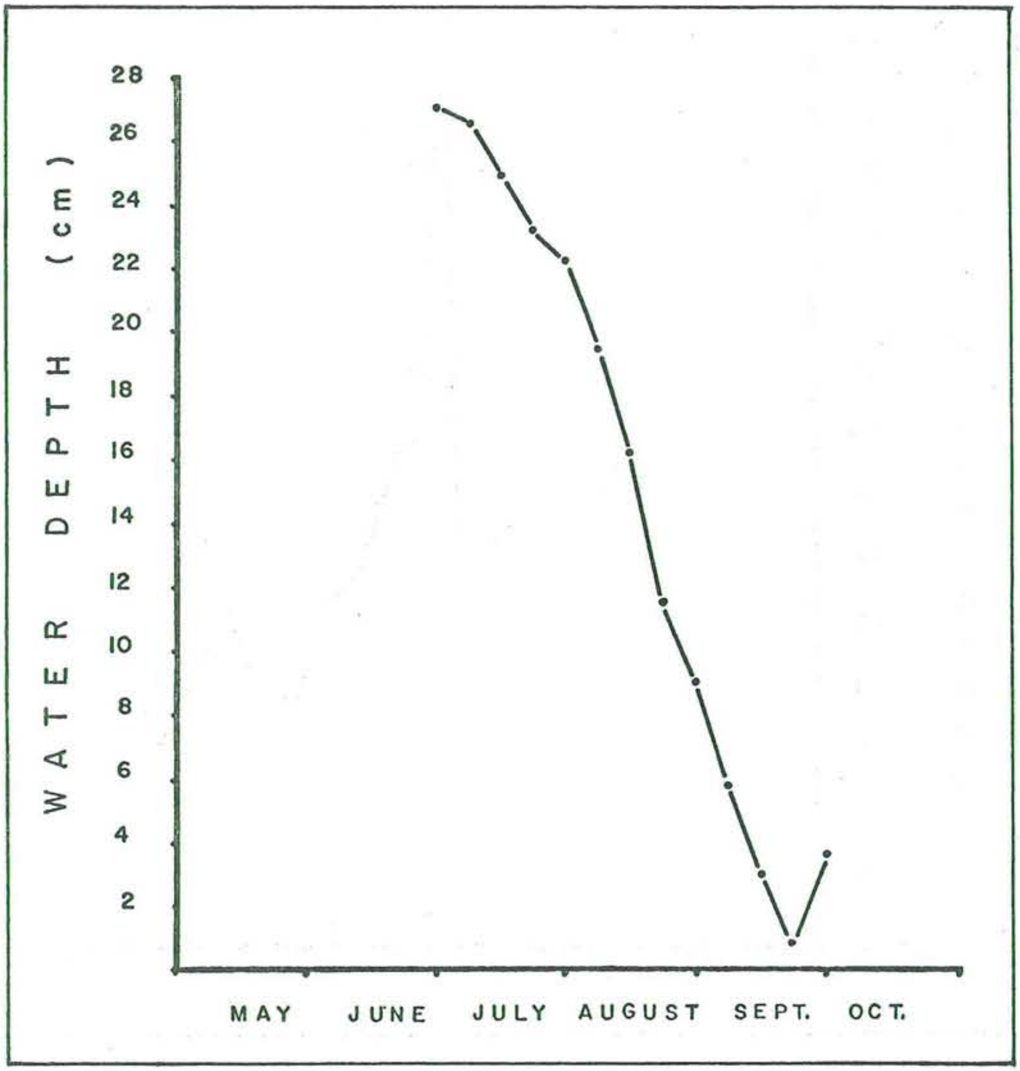

Figure 4. Water level changes, 1971 at Site 5 (*Scirpus validus*).

Preparatory Research for Studying the Effects of Prescribed Burning on *Phragmites communis* Trin. in the Delta Marsh

E. E. Mowbray

Department of Botany

Objectives

1. To determine the effect of prescribed burning on *Phragmites* and associated flora.

2. To determine if fire results in an increase or decrease of faunal populations or change in species composition.

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

Methods

Vegetation data, including species composition, density, height, productivity, light penetration and percentage with inflorescence, were collected from a combination of quadrats and transects. The quadrats were 1 m^2, subdivided into quarters. A total of 608 quadrats were sampled. Plant material was clipped from separate 0.25-m^2 quadrats at maximum growth for productivity estimates. Live and dead materials were dried and weighed separately.

A schedule to burn the sites has been set up. Three sites were burned in the fall of 1971.

Results

The mean frequency for eight species in the sites sampled is as follows:

Phragmites communis	100%
Cirsium arvense	85%
Mentha arvensis	80%
Stachys palustris	62%
Sonchus sp.	55%
Urtica dioica	37%

Lycopus sp. 29%
Teucrium occidentale 12%

The mean height of *Phragmites* from data taken during the second and third week of August was 193 cm.

Density of *Phragmites* on the sites varied from 55-77 live stems/m^2 and 18-73 dead stems/m^2.

Mean dry weight of clippings from 50 quadrats was 46 g for live material and 32 g for dead material.

The percentage of *Phragmites* with inflorescence was 57%.

Future Work

The study was begun this summer, and accomplishments to date are preliminary in nature. Baseline data for the sites have been accumulated and more substantial findings should be forthcoming in 1972, when the effects of burning on the sites can be monitored.

Proposed plans for 1972 include:

1. Setting up instrumentation to monitor the microclimate, including snow accumulation data, on the sites and controls.

2. Live trapping of small mammals and toe clipping as a means of estimating increases or decreases in their populations.

3. Nest surveys.

4. To take a series of aerial photos at the sites using infra-red film.

5. To continue to gather vegetation data.

A Preliminary Investigation into the Fungal Flora of Delta Marsh

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Department of Botany

Introduction

The University Field Station has, over the past five or six years, carried out a research program on various aspects of the marsh ecosystem. As a part of this program it is desirable to have a general index of the fungal flora. It is desirable 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, abundance and seasonal succession of soil fungi, aquatic fungi and fungi associated with the living dominant marsh vegetation.

Methods

Four habitats were selected for the sampling of soil fungi: the wooded ridge separating the lakeshore and the marsh, a pure stand of *Phragmites communis*, a wet meadow site between the West Dike Road and the Diversion, and a deciduous wood called Oxbow Wood. Four sampling sites for aquatic fungi are located at the mouth of Cram Creek, in Crescent Pond, in the east and west portions of the Blind Channel, and in a borrow pit on the east side of the West Dike Road (Fig. 1).

A general survey of the fungi found on the dominant marsh vegetation will also be conducted, but no specific sampling sites have been set aside.

Soil fungi are obtained at each site by random sampling of litter and 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 and litter (Fig. 2).

The fungal population of soil is heterogeneous and Phycomycetes,

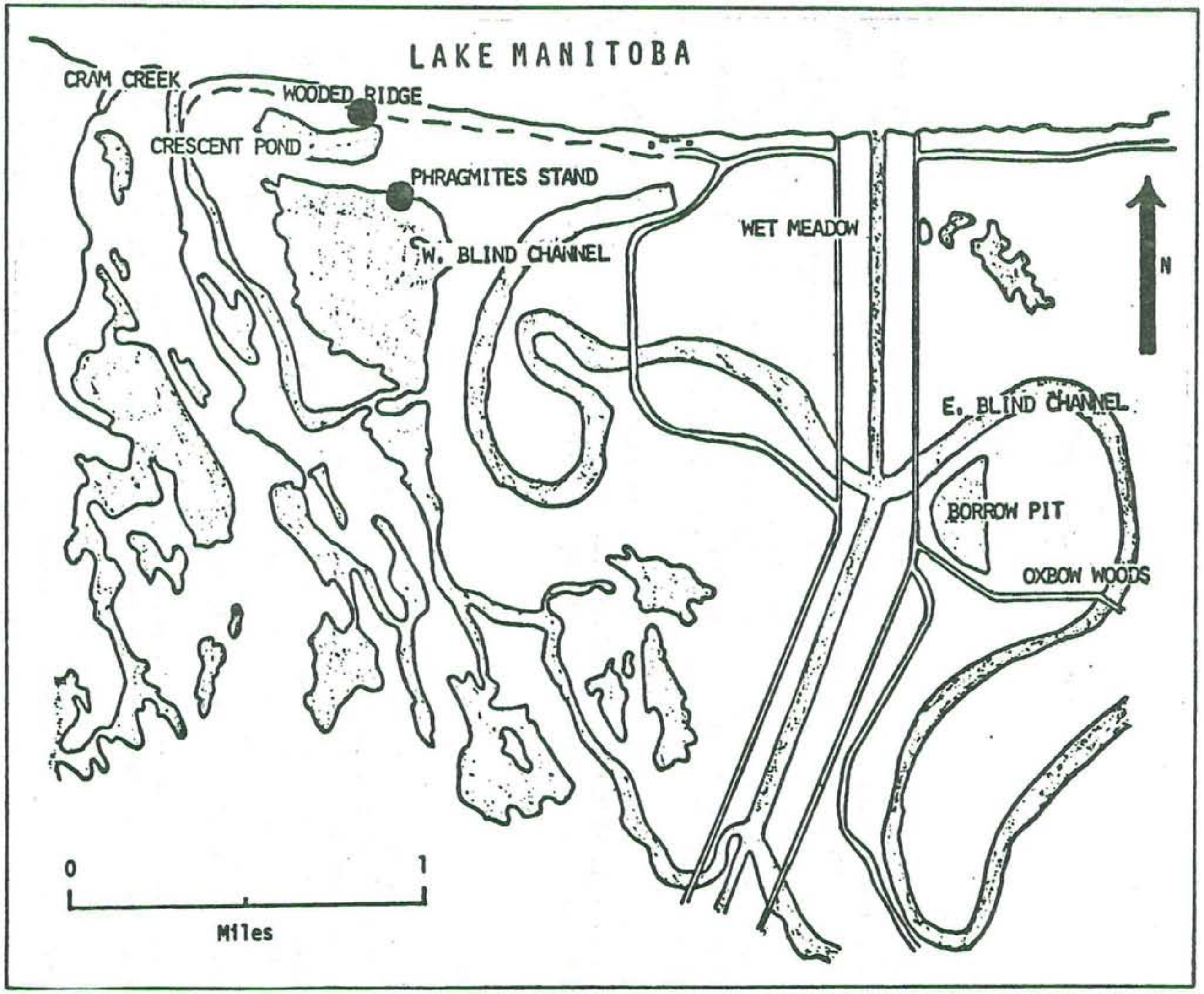

Figure 1. Sampling Sites.

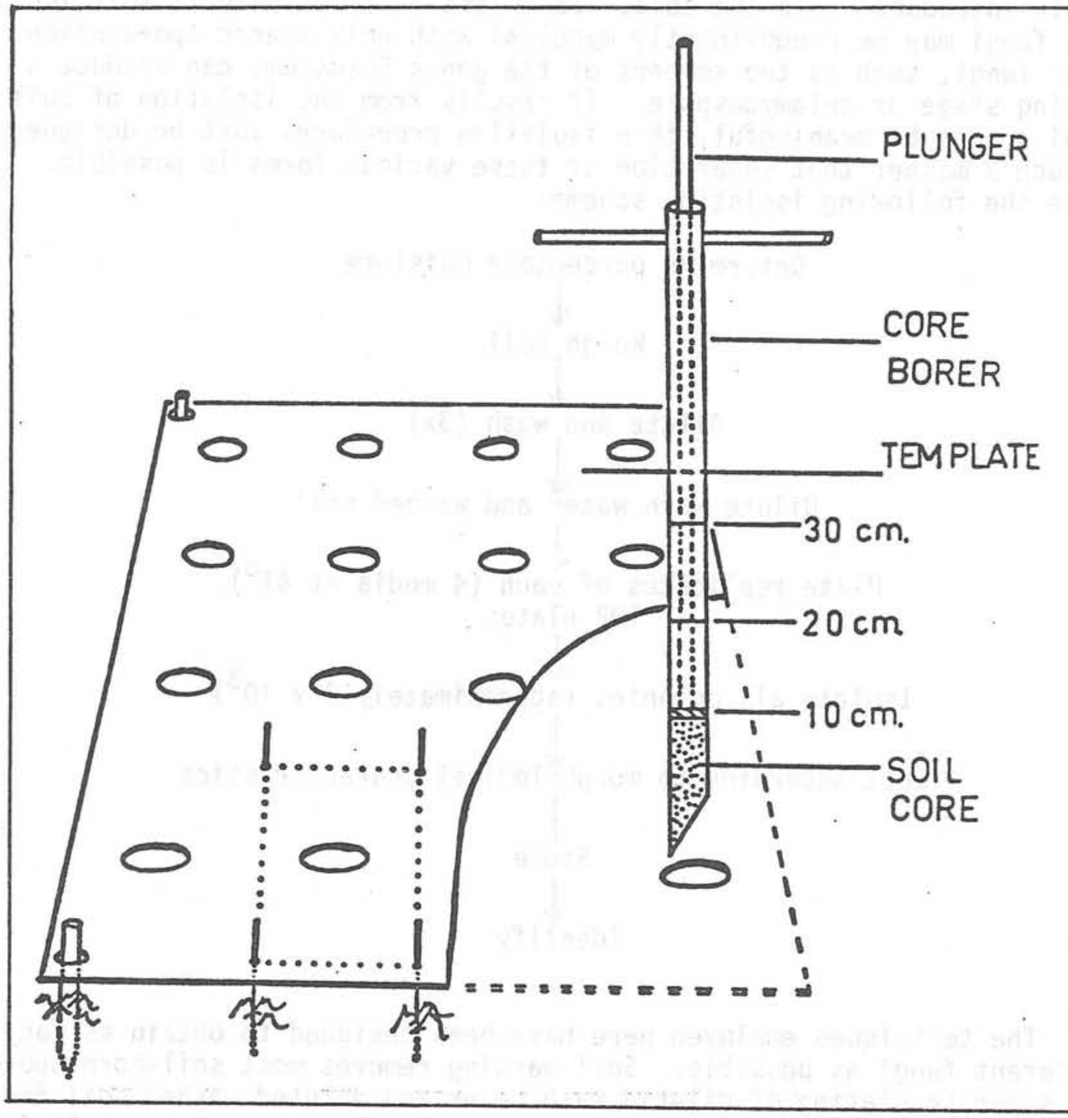

Figure 2. Soil sampling equipment.

Ascomycetes, Basidiomycetes and Fungi Imperfecti are routinely isolated from soil. However, not all fungi isolated from soil 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:

Determine percentage moisture
↓
Weigh soil
↓
Dilute and wash (3x)
↓
Dilute wash water and washed soil
↓
Plate replicates of each (4 media at $4T^{o}$)
192 plates
↓
Isolate all colonies (approximately 2×10^{3})
↓
Sort according to morphological characteristics
|
Store
↓
Identify

The techniques employed here have been designed to obtain as many different fungi as possible. Soil washing removes most 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 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 the 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 $25^{o}C$, should assist in eliminating nutritional selectivity of the media to particular fungi. The procedure should also give an impression of the temperature regimes at which different fungi are active in the soil.

Aquatic fungi are obtained by use of bait techniques and by gathering of filtered and unfiltered water samples. These samples may contain fungal spores, motile states of aquatic Phycomycetes or hyphal elements growing on various living or non-living organic matter. Baits such as pollen, cellulose and insect chitin are suspended in bait bottles *in situ*. Unfiltered water samples are collected with a 1-liter Van Dorn water sampler and filtered samples with a 25-liter plankton sampler.

Subsequent to collection, fungi are isolated, pure cultures obtained and these are then identified.

As previously mentioned, a general survey of dominant marsh vegetation for both parasites and saprophytes will be carried out over the next growing season.

Results

In order to indicate general results from soil isolation alone, of 6,000 pure isolates, at least 150 distinct species appear to be present. It is possible that additional species will be identified as culturel 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.

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

Net Radiation and its Relationship to Evapotranspiration of *Phragmites communis* Trin. in the Delta Marsh

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Department of Botany

Introduction

In *Phragmites communis* Trin. evapotranspiration rates are primarily dependent on the environment, since this reed appears to have little or no control over the rate of water loss. The environmental parameters which affect the rate of evapotranspiration are atmospheric relative humidity, wind speed and the amount of energy available. This paper discusses the energy parameter as it relates to evapotranspiration in *Phragmites*.

The energy available at the earth's surface falls into two broad classes: long wave radiation and short wave radiation. Long wave radiation is emitted by the atmosphere and by the water, soil or plants at the earth's surface, as a function of the temperature of that mass.

The sun's rays are the sources of the short wave radiation which comes to the earth. Of the short wave component impingent on the earth's atmosphere, only about 65% gets through to the earth's surface on a clear day after atmospheric scattering and absorption have taken their toll. On contacting the earth's surface, reflection and absorption dissipate another portion.

Because of the complexity of the whole radiation exchange, it is difficult to make accurate estimates of the fractions involved. The only satisfactory means of determining the amount of radiant energy available at the earth's surface is by direct measurement with a net radiometer.

Methods

During the growing season of 1971, net radiation data (Rn) were recorded over a stand of *Phragmites* in the Delta Marshes using a CSIRO Net Radiometer (Fig. 1). This instrument is responsive to both long and short wave radiation. The head consists of two blackened plates, each covered by a polyethylene dome which is transparent to all wavelengths between 0.2 and 50 μ. One plate faces upward to receive the short wave sun and sky radiation and the long wave atmospheric radiation, while the other is directed downward to receive the reflected radiation and the long wave reradiation from the earth's surface. Each plate has thermopiles incorporated in its surface to transform the heat energy produced by the impingent rays to an electrical impulse. The upper impulse is positive while the lower one is negative. By connecting these together, the lower impulse produced by the long wave reradiation and reflected solar radiation is subtracted from the upper incoming factor to give a net impulse corresponding to the net radiation. The millivolt output can then be recorded and converted to energy values.

Evapotranspiration (Et) values for *Phragmites* were obtained from small hydrostatic lysimeters (29 cm in diameter and 39 cm deep, Fig. 2). These were modified from Courtin and Bliss (1971), the inside container being a 5-gallon bucket and the outside container a 100-pound grease keg. The inner tube was filled with water and connected to the stand pipe. The height attained was that at which the weight of the water column plus the atmospheric pressure balanced the presssure exerted on the inner tube by the weight of the lysimeter.

When evapotranspiration was proceeding, the inside container became light due to water loss. Because it had lost weight, the pressure on the inner tube was reduced and simultaneously the water column in the stand pipe. The difference in the levels in the stand pipe then became the index for the amount of water which had been lost. The details of the experimental organization and other equipment involved were described in Phillips (1970).

Three of these lysimeters were installed in each of two sites, A and B, early in May 1971. The sites differed primarily in the depth of the shallow ground water table below the soil surface, site A having a higher water table than site B.

Results and Discussion

With the help of Miss Landreth, the net radiometer records from seven days during the summer, beginning with June 17 and ending with September 1, were analysed. The values obtained were converted from gm cal./cm^2 to depth equivalents of water evaporated (ml) using the relation: 59 cal./cm^2 = 1 mm/cm^2.

Daily evapotranspiration totals were then calculated for these days and the Et/Rn ratio was computed as a measure of the proportion of net radiation used in the evapotranspiration of water from a *Phragmites* community.

The Et/Rn ratios for June 17, July 1 and 13, August 5, 13 and 23 and September 1 are shown in Fig. 3. It is important to note that more net radiation was used in evapotranspiration at site A than at site B when net radiation values were high. Site A, having a higher water table, had more water available than site B and hence evapotranspirational losses were greater. Another interesting point arises from the inference that early in the growing season of the plant, *i.e.*, June 17, the evapo-

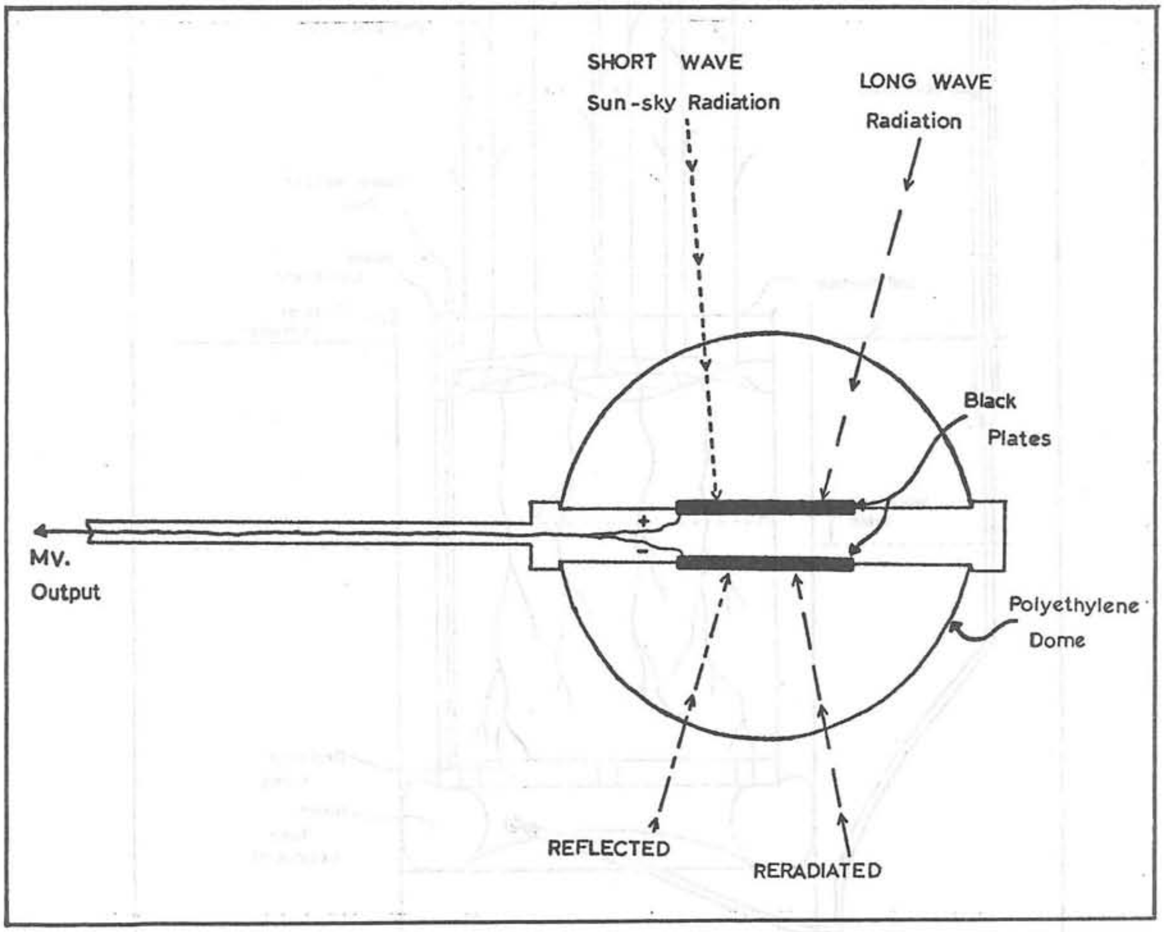

Figure 1. Diagram to show major components of the CSIRO net radiometer.

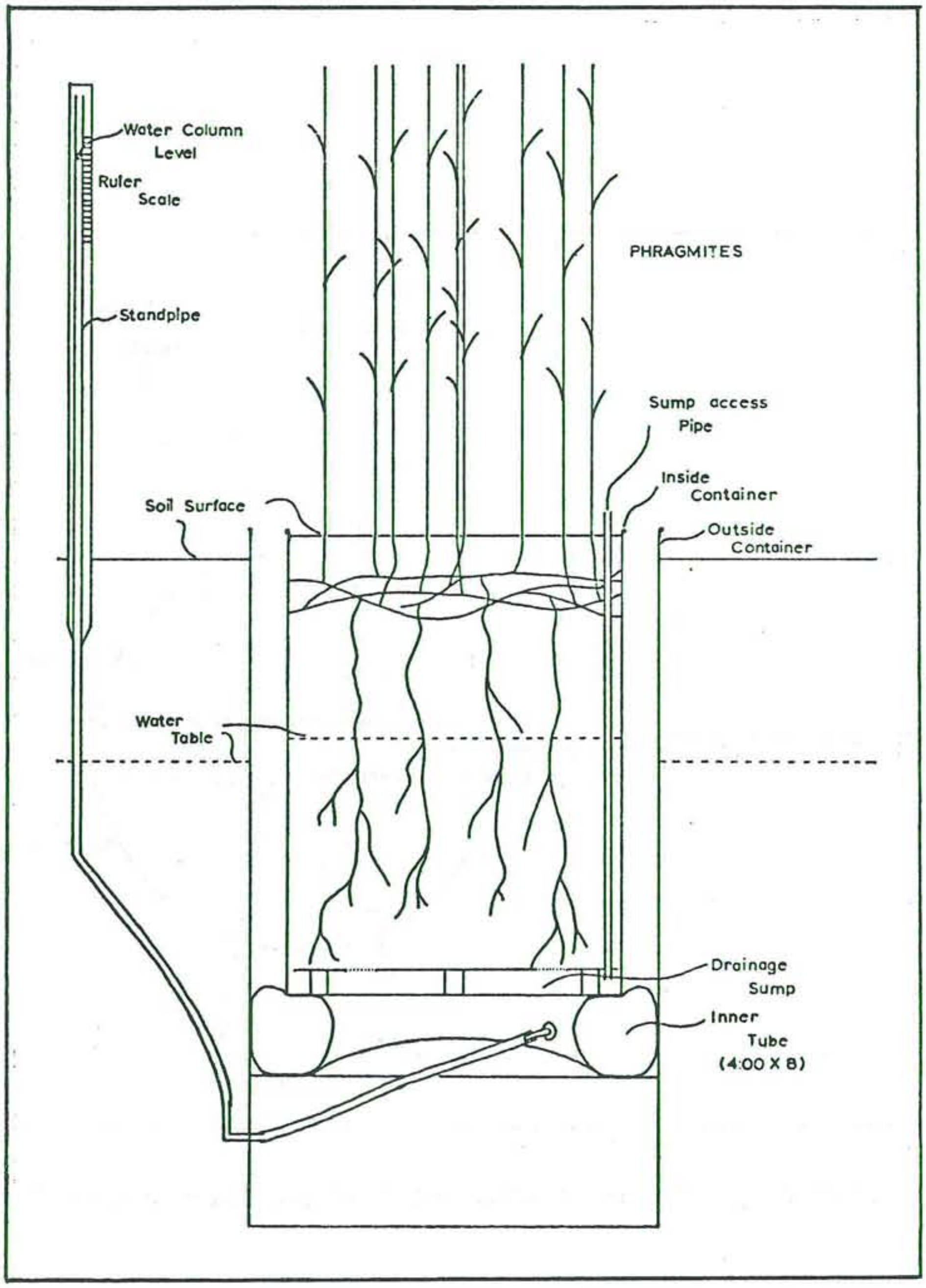

Figure 2. Diagram of lysimeter.

transpiration rates were low in relation to net radiation. This effect is probably the result of low leaf numbers per plant and hence minimal transpiring surface areas.

On the other hand, even though the net radiation values were almost the same on July 1 as on June 17, the transpiration values were lower and hence the Et/Rn ratio was lower. Since leaf areas had increased by this date, one would expect the ratio to have increased as well. The decrease which is noted was the result of a higher relative humidity. The mean relative humidity for June 17 was 54% while that for July 1 was 70%. Consequently, the vapour pressure gradient at the leaf surface was reduced resulting in a reduction of the rate at which the water vapour could diffuse into the atmosphere.

The very high values for the ratio on August 5 correspond with the achievement of maximum leaf area, together with inflorescence development and flowering which involve high metabolic activity. Another investigator (Hobbs, 1969), working with soft wheat, reported increasing transpiration until flowering and then a steady decline as the plant activity diminished. In keeping with this, the ratios declined from August 5 to August 23 in response to only a slight reduction in the net radiation. This may be a response to the seasonal drop in water table and hence reduced water availability.

On a cloudy dull day, such as August 13 or September 1, the Et/Rn ratio was reduced considerably. The lower ratio was mostly due to increased relative humidity on the cloudy days. The sharp drop in the "A-ratio" on September 1 may be the result of reduced leaf area due to die back, which by this time had occurred to a greater extent at site A than at site B.

Fig. 4 shows the relationship which exists between evapotranspiration and net radiation. As expected, the linear relationship between these two parameters is different for each site, more net radiation being used in evapotranspiration at site A than at site B. Another result which could have been predicted from Fig. 2 (August 13) also follows here, namely, the relationships between evapotranspiration and net radiation approach one another when net radiation values are low. The rather low correlation coefficients are partly due to an insufficient sample size but also result from the inclusion of early season values with a low Et/Rn ratio. If the evapotranspiration and net radiation values for June 17 and July 1 had been deleted, the slopes of both lines would have increased and the correlation coefficients whoul have become 0.99 and 0.96, respectively.

Conclusion

Referring again to Fig. 3, it is noteworthy that evapotranspiration may use 80% or more of the net radiation received by a *Phragmites* community on a clear day in midsummer.

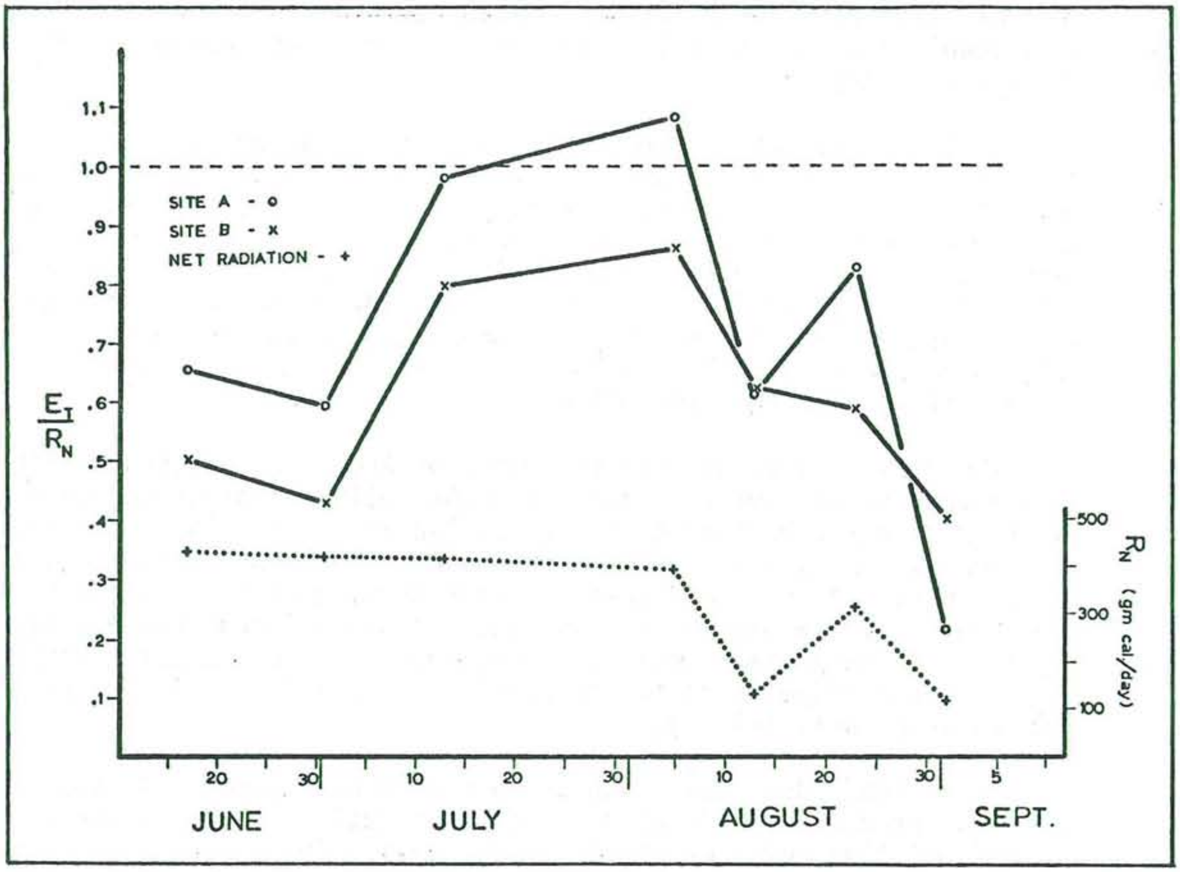

Figure 3. E_T/R_N values for the 1971 summer.

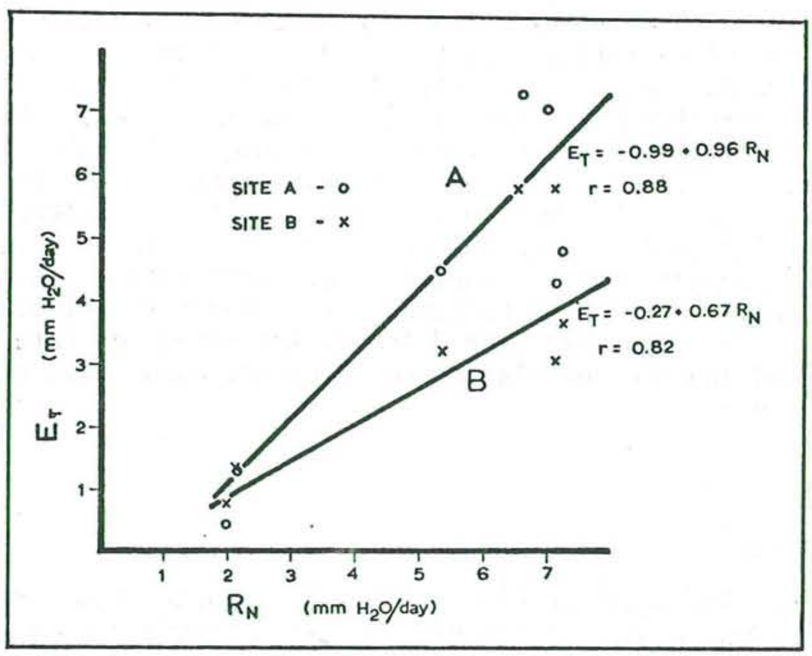

Figure 4. The relationship between evapotranspiration and net radiation.

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Life Cycle and Comparative Morphology of *Rhabdias* (Nematoda) from *Rana pipiens* and *Bufo hemiophrys* and the Incidence of Helminth Parasites Existing in the Lungs of these Amphibians

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Introduction

Life Cycle of *Rhabdias*

The life cycle of *Rhabdias* follows two basic patterns. Parthenogenetic females that live in the lungs lay eggs which are passed out of the lungs to the intestinal tract. These eggs hatch in the intestine and are passed in the feces where they develop through a series of stages. Typically, nematodes go through five developmental stages, each separated by a molt, before they reach the adult stage:

$$\text{Egg} \longrightarrow \text{First stage} \xrightarrow{\text{(molt)}} \text{Second stage} \xrightarrow{\text{(molt)}} \text{Third stage} \xrightarrow{\text{(molt)}}$$

$$\text{Fourth stage} \xrightarrow{\text{(molt)}} \text{Adult}$$

The events that take place in *Rhabdias* development can be represented diagramatically (Fig. 1).

A Brief History of Taxonomy of *Rhabdias*

Rhabdias bufonis was described by Schrank in 1788 from European amphibians. Up to 1929, workers in North America gave the same name to the *Rhabdias* found in North American amphibians. It was left to Walton to propose in 1929 that the North American *Rhabdias* was different from that in European amphibians and that *R. bufonis* was absent from North America. His conclusion was based on differences in size and biology of *R. bufonis* from those he studied from North America:

1.	*Rhabdias bufonis*	9-11 mm	Heterogonic
2.	*Rhabdias* from North America	4-6 mm	Homogonic

On this basis, he proposed the new name *Rhabdias ranae* for the North American specimen. In a later paper (1936), he also studied material from some North American toads and concluded that they were also *R. ranae*. Since Walton's work, Fantham and Porter (1948) reported *Rhabdias bufonis* from bull frogs in Quebec. Also, during the summers of 1968 and 1969, Hylnka (1970) found *Rhabdias* in both *Rana pipiens* and *Bufo hemiophrys* from the University Field Station, Delta Marsh. Specimens from *R. pipiens* were smaller than those from *B. hemiophrys*, and Hylnka concluded those in the frogs were probably *R. ranae* and those in *Bufo*, *R. bufonis*. However, he based his distinction on size differences alone, without information on the biology of the two. His conclusion also suggested a contradiction with Walton's statement, *i.e.*, that *R. bufonis* was absent from North America.

Therefore, further studies are needed to establish the proper identity of these nematodes.

Interspecific Relationships

In addition to taxonomic studies of *Rhabdias*, the association of these nematodes with the lung trematode (*Haematoloechus*) was studied.

Mazurmovich (1957) observed that the lung trematode *Haematoloechus* and the lung nematode *Rhabdias bufonis* never occurred together, suggesting infection with one precludes infection with the other. On the other hand, Markov (1955) showed that in *Rana temporaria*, another lung trematode (*Haplometra cylindracea*) often occurred together with *R. bufonis* and that the two were not antagonistic.

Objectives

1. To establish identity of *Rhabdias* in *Rana pipiens* and *Bufo hemiophrys* by morphological and biological studies.

2. To investigate the interspecific relationships of the trematodes co-existing with *Rhabdias* in the lungs of these amphibians.

Materials and Methods

Frogs and toads were collected in the vicinity of the University Field Station, and the lungs were examined for nematodes and trematodes.

The alimentary tracts of the amphibians were examined for various developmental stages of *Rhabdias*. Eggs were dissected from the uteri of adult parasitic nematodes and used for life cycle studies.

Results

One hundred and seventeen frogs and 77 toads were examined. Of the 117 frogs, 55 were infected with lung nematodes alone, 17 with trematodes alone, 33 with both helminths and 12 uninfected. Twenty-two toads were infected with nematodes alone, 18 with trematodes alone, 26 with both nematodes and trematodes and 11 uninfected. Analysis of these data by the χ^2 test showed that no interspecific relationships exist between the lung nematodes and trematodes in the amphibians.

Morphological Studies

The data assembled are given in Tables 1-3.

TABLE 1

Morphological Data for Parasitic Females[1]

	From *Bufo hemiophrys*	From *Rana pipiens*
Body length	7.5-14.5 mm	6.5-8.5 mm
Body width	0.16-0.29 mm	0.20-0.28 mm
Oesophagus	0.62-0.75 mm	0.54-0.60 mm
Tail length	0.29-0.50 mm	0.23-0.28 mm
Vulva from anterior end	3.9-7.5 mm	3.9-4.8 mm
Buccal cavity	0.015-0.025 mm	0.015-0.020 mm

[1]n = 10.

TABLE 2

Dimensions of Eggs[1] in Females

	From *Bufo hemiophrys*	From *Rana pipiens*
Length	108-125 μ	94-106 μ
Width	51-63 μ	43-56 μ

[1]n = 10.

Embryonated eggs obtained from the lungs of *Rana pipiens* and *Bufo hemiophrys* did not show any matching in the lungs. These eggs were carried to the intestinal tract where they hatched into rhabditiform juveniles. There was no evident morphological difference between newly hatched male and female juveniles.

TABLE 3

Measurements of First Stage Rhabditiform Juveniles

	From *Bufo hemiophrys*	From *Rana pipiens*
Length	416-540 μ	390-470 μ
Width	22-30 μ	25-30 μ
Buccal cavity	4-6 μ	7-10 μ
Oesophagus	107-150 μ	103-126 μ
Genital primodium	205-317 μ	208-285 μ
Nerve ring	76-98 μ	68-87 μ
Anus	47-61 μ	48-60 μ
Ratio of male:female	4:10	1:10

Development of the second and third stages can take place either in the intestinal tract or outside it. There were no differences between these stages and the first stage rhabditiform juveniles, except for an increase in size and development of genital primordia.

The fourth stage juveniles develop outside the intestinal tract. The final free-living stages (Fifth stage) differentiate into males and females.

These free-living stages copulate, after which the males die within 24 hours. The females develop on the average two embryonated eggs around the region of their vulva. These hatch inside the females, feed on the contents of the females and then break loose from the females. The second generation juveniles are different from the first generation in that they have strongyloid type of oesophagus. The third stage juveniles become infective. These penetrate the skins of frogs or toads, as the case may be, where they come to live in the peritoneal cavity. From here they shed the cuticle and finally work their way into the lungs where they become parthenogenetic females.

No basic differences were observed in the life cycle of *Rhabdias* from toads and frogs.

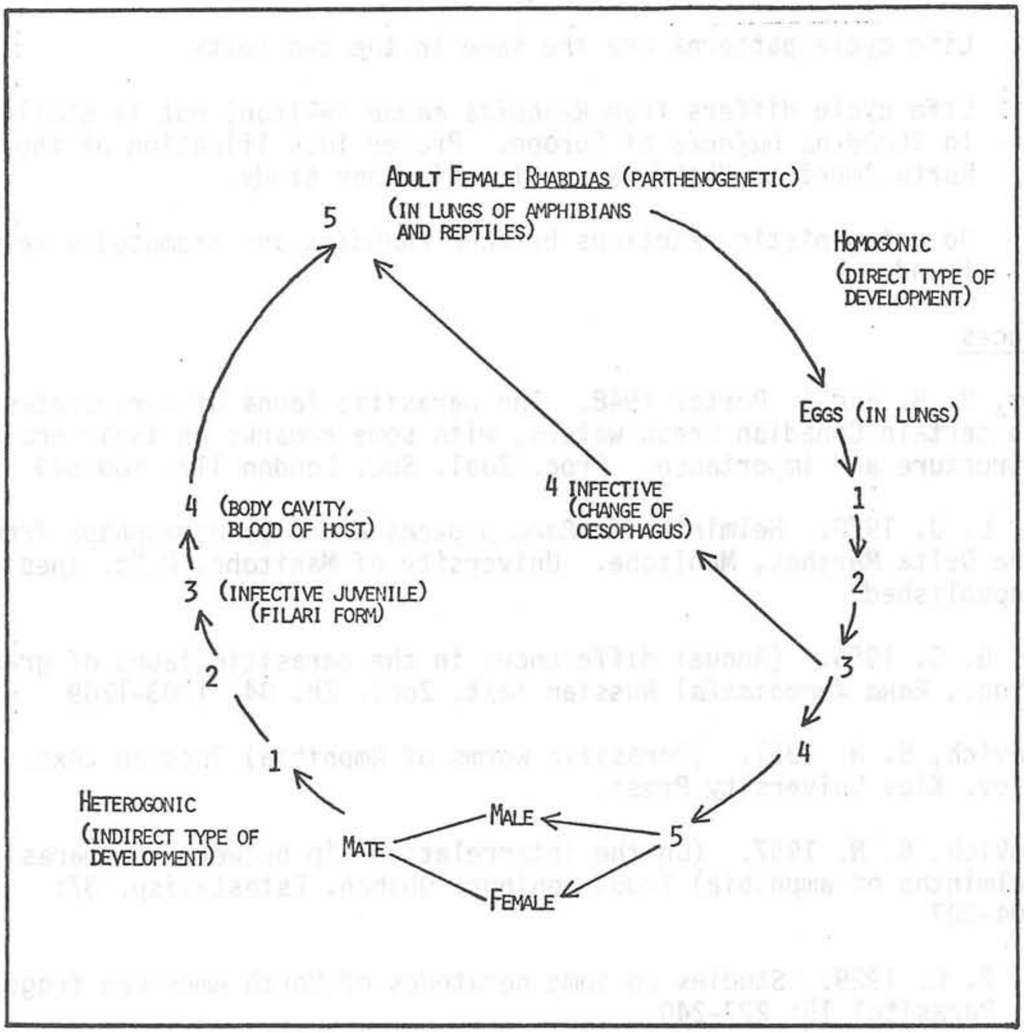

Figure 1. Life cycle of *Rhabdias*.

Conclusions

1. Size differences in *Rhabdias* from frogs and toads may be related to host differences.

2. Life cycle patterns are the same in the two hosts.

3. Life cycle differs from *Rhabdias ranae* (Walton) but is similar to *Rhabdias bufonis* of Europe. Proper identification of the North American *Rhabdias* requires further study.

4. No antagonistic reactions between *Rhabdias* and trematodes were found.

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Preliminary Survey of Biochemical Genetic Variation in Small Mammals at The University Field Station (Delta Marsh)

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Introduction

Work on small mammals in various parts of the world have shown that genetic heterogeneity is very common (Petras, 1967; Selander *et al.*, 1969). Consequently, a preliminary survey was made of the small mammal populations at Delta to see if suitable populations were available for more detailed studies. This work was undertaken in association with the 1971 summer Ecology course to introduce students to another aspect of the ecology of populations.

Methods

Blood samples were taken by the students from any mammals collected near the Field Station. The samples were collected by heart puncture, stored in glycol citrate (Owen, 1963) and later analyzed for any evidence of genetic polymorphism (Table 1).

Results

The electrophoric patterns found are summarized in Fig. 1. No intra-specific variation was found in any of the proteins examined.

Conclusions

While suitably sized populations are available, no variation was found in this study. However, further studies, using a wide range of proteins and larger sample sizes, would be useful.

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TABLE 1

Blood Protein Analyses

<u>Lactic dehydrogenase (LDH)</u> -- cellogel

Buffer:	0.1 M tris citrate (pH 8.6) 1 hour at 200 volts
Stain:	1.2 ml tris HCl (0.1 M and pH 8.0) 0.1 ml lactic acid (pH 7-8, 25 mg/ml) 0.1 ml NAD (10 mg/ml) 0.2 ml MTT (2 mg/ml) 0.1 ml PMS (1 mg/ml)

<u>Malic dehydrogenase (MDH)</u> -- cellogel

Buffer:	0.1 M tris citrate (pH 8.6) 1 hour at 200 volts
Stain:	1.2 ml tris HCl (0.1 M, pH 8.0) 0.1 ml malic acid (25 mg/ml) 0.1 ml NAD (10 mg/ml) 0.2 ml MTT (2 mg/ml) 0.1 ml PMS (2 mg/ml)

<u>6PGD</u> -- cellogel

Buffer:	0.02 M KH_2PO_4 (pH 7.0) 1 hour at 200 volts
Stain:	1.25 ml tris HCl (0.1 M, 8.6 + 0.004 MEDTA) 0.1 ml NADP (10 mg/ml) 0.15 ml 6PGA (25 mg/ml) 0.1 ml $MgCl_2$ (0.5 M) 0.2 ml MTT (2 mg/ml) 0.1 ml PMS (2 mg/ml)

TABLE 1 (continued)

G6PD -- cellogel

Buffer: Ratazzi-Borate (pH 7.8, 15 mM tris, 5 mM NaEDTA, 3.5 mM boric acid)
1 hour at 400 volts

Stain: 1.25 ml tris HCl (0.1 M, 8.6 + 0.004 MEDTA)
0.1 ml NADP (10 mg/ml)
0.15 ml G-6-P (25 mg/ml)
0.1 ml $MgCl_2$ (0.5 M)
0.2 ml MTT (2 mg/ml)
0.1 ml PMS (2 mg/ml)

Hemoglobin -- starch 12%

Buffer: 6.935 gm/l citric acid
19.38 gm/l tris
1x10^{6} merthiolate
0.1 M L.OH (8.4 gm/2 l)
0.38 M boric acid (46.97 gm/2 l -- electrolyte)

Bridge Buffer: electrolyte

Gel Buffer: 24.3 ml tris citrate + 4.5 ml electrolyte to 270 ml with D.W.

Stain: 0.2 gm benzidine
0.5 ml glacial acetic
100 ml distilled H_2O
Heat to dissolve

Add 2 ml 3% H_2O_2 before using

Running Time: 18 hours at 200 volts

Esterases -- starch 12%

Bridge Buffer: 0.3 M boric acid
0.03 M NaOH
pH to 8.0 with NaOH

Gel Buffer: 0.02 M borate (pH 8.6 with 1N NaOH)

Stain: 200λ 1% β-naphthyl acetate in acetone
1 ml 0.1 M tris HCl (pH 8.0)
10 mg blue RR salt

Running Time: 16-18 hours at 200 volts

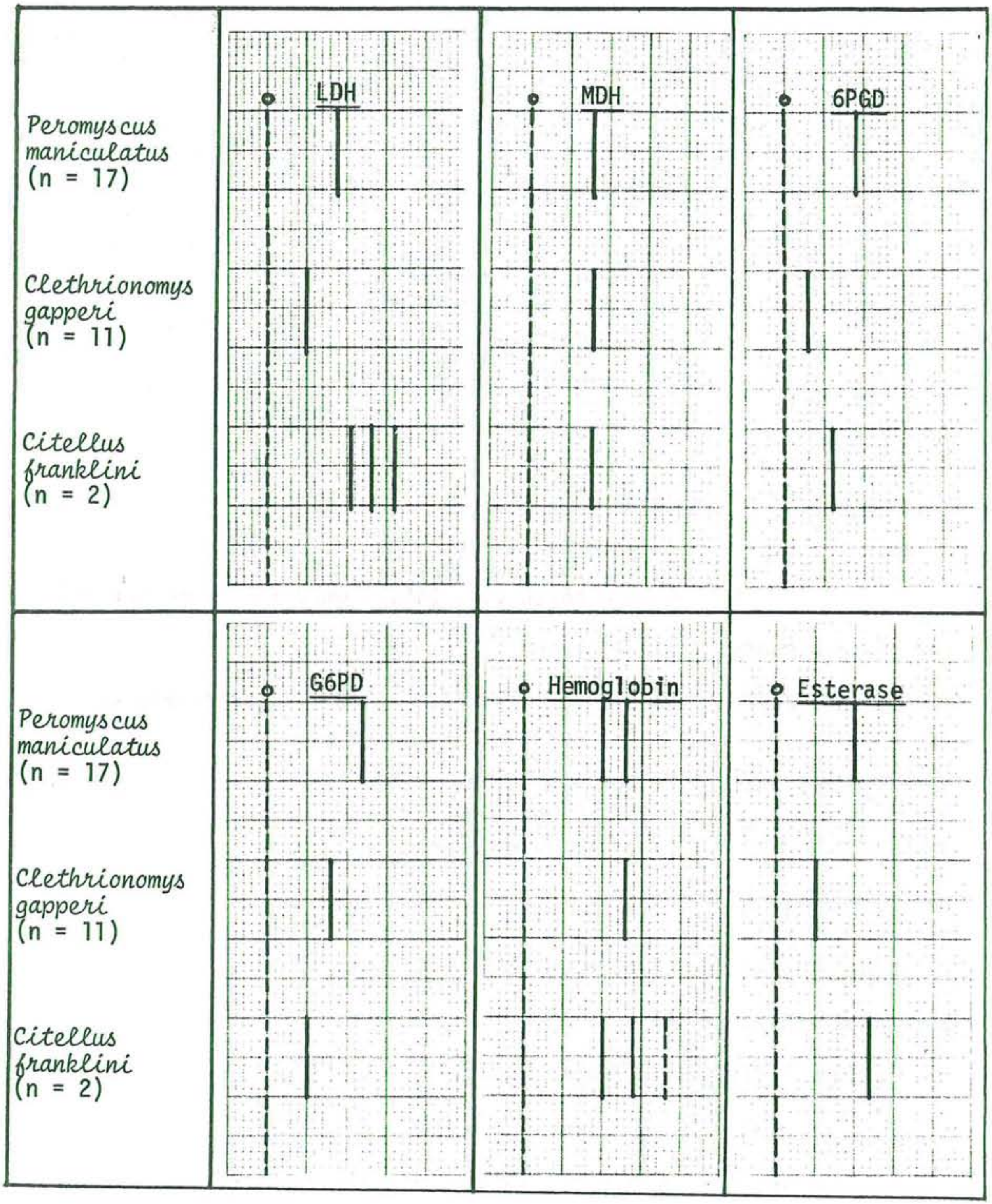

Figure 1. Diagramatic representation of electrophoretic patterns found for each protein examined.

Auditory Recognition of Voice in the Canada Goose, *Branta canadensis*

P. J. Cowan

Department of Zoology

Introduction

In the first half of this century, various workers, including Lorenz (1937), observed recently hatched goslings and ducklings following closely behind their parents, *e.g.*, when initially leaving the nest, when swimming and when walking around the breeding grounds. These observations initiated the experimental study of the following response by scientists who, owing to their theoretical orientation, were largely interested in species-specific properties which might cause the following response. They have found the following response of newly hatched naive ducklings and goslings is caused by a variety of properties, such as, size, brightness and colouration, especially when coupled with movement, but that the following response of ducklings and goslings which have had prior experience with a property is caused solely by that property. The properties investigated are all on a species-specific level; the construct defined by these studies, "imprinting", is considered as the process leading to species recognition. Although field observations can be readily explained on the basis of imprinting, other, more-recent observations of geese cannot.

Collias and Jahn (1959) observed that Canada goose goslings which accidentally stray into foreign broods usually leave these broods and resume approaching and following their own parents, instead of following other parents. Collias and Jahn suggested that goslings recognised their own parents' voices (both sets of parents call when broods become accidentally mixed). On the wintering grounds geese of the year occur in family parties, these parties being grouped in large flocks. Observations, sometimes with colour-banded birds, show that young geese remain with their own parents even though many opportunities must occur for brood mixing.

Similarly, this summer at Churchill, Manitoba I followed many multi-family flocks of Canada geese, different families walking side-by-side. The goslings continually followed their presumed parents. On the basis of imprinting work, one would expect goslings to follow any adult Canada goose. These observations suggest that goslings can distinguish between their own parents and other adult Canada geese.

Objectives and Methods

My research is concerned with testing whether such individual recognition of parents occurs in the Canada goose. Individual recognition by young has been demonstrated in various gulls, terns and auks. For example, Evans (1970) has demonstrated that young black-billed and ring-billed gull chicks recognise their own parents.

If individual recognition occurs, different Canada goose individuals will possess different properties. The properties of Canada geese themselves that we can record at present do not appear to differ between individuals.

When leading a brood, geese and ducks often utter low-pitch calls. To investigate whether these calls show any variation, I spent several weeks this summer recording such calls from five female Canada geese which were nesting at Island Park, Portage la Prairie. I recorded an average of 50 of these calls from each female. The females gave the low-pitch calls over unhatched eggs, during pipping, after hatching and when leading the brood.

Various properties of sounds, here goose calls, can be independently measured using the sound spectrograph machine which produces a graphic display of a call, from which frequencies, amplitude and duration of call components can be measured. The sound spectrograph (I used a Kay Electric Missisyer) is one of several instruments, such as the oscilloscope, pen oscillograph and the electroacoustic spectrometer, which may be used for measuring sound waves. The sound spectrograph was developed in the early 1940's at the Bell Telephone Laboratories, the purpose of the machine being to visually display the human voice in aiding communication by the deaf. Since then, the sound spectrograph in the zoological laboratory has become the major tool for sound analysis. The spectrograph has its faults. When the components of vocalisations are complex, the properties of the complex parts cannot be measured. Also, the measurements lack a high degree of precision. The sound spectrograph may instead be used for assigning classificatory and comparative concepts depending on the differing shapes of the visual display. If the notes have different shapes, then some properties of the notes are different.

Results

Fig. 1 shows tracings of spectrograms (visual display as recorded on a spectrograph) of low-pitch calls from three different female geese. Tracings differ from actual spectrograms in that tracings are uniformly black while marks on the spectrograms vary through shades of grey.

Each female gave two types of call: grunts, as shown in Fig. 1, and trills. The grunts differ little, mainly in the number of grunts per sequence within the repertoire of a single female. As one can see, the shape of notes for each female differs. Fig. 2 shows trills from two different females. Again, one can see that the notes have a different

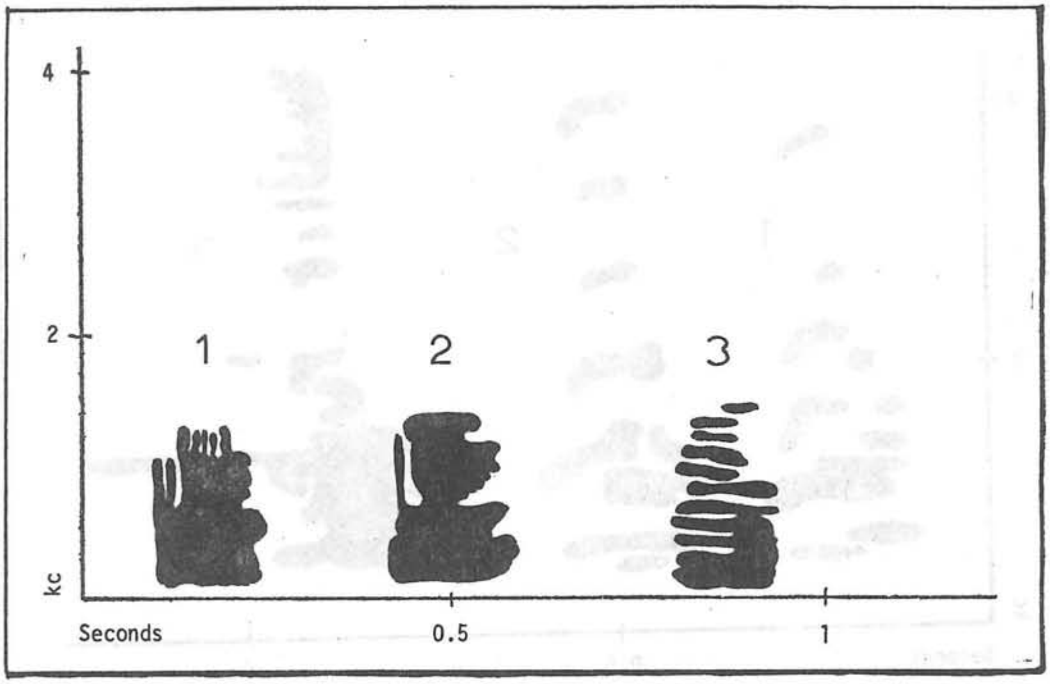

Figure 1. Single low pitch calls from three female Canada geese.

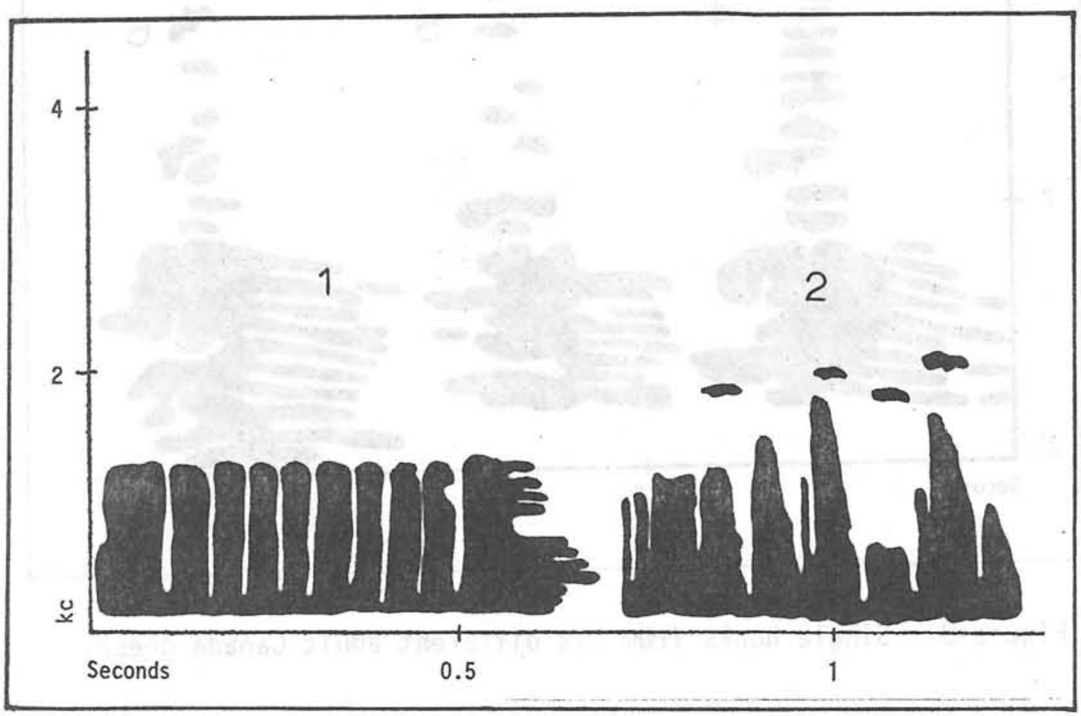

Figure 2. Single trills from two different female Canada geese.

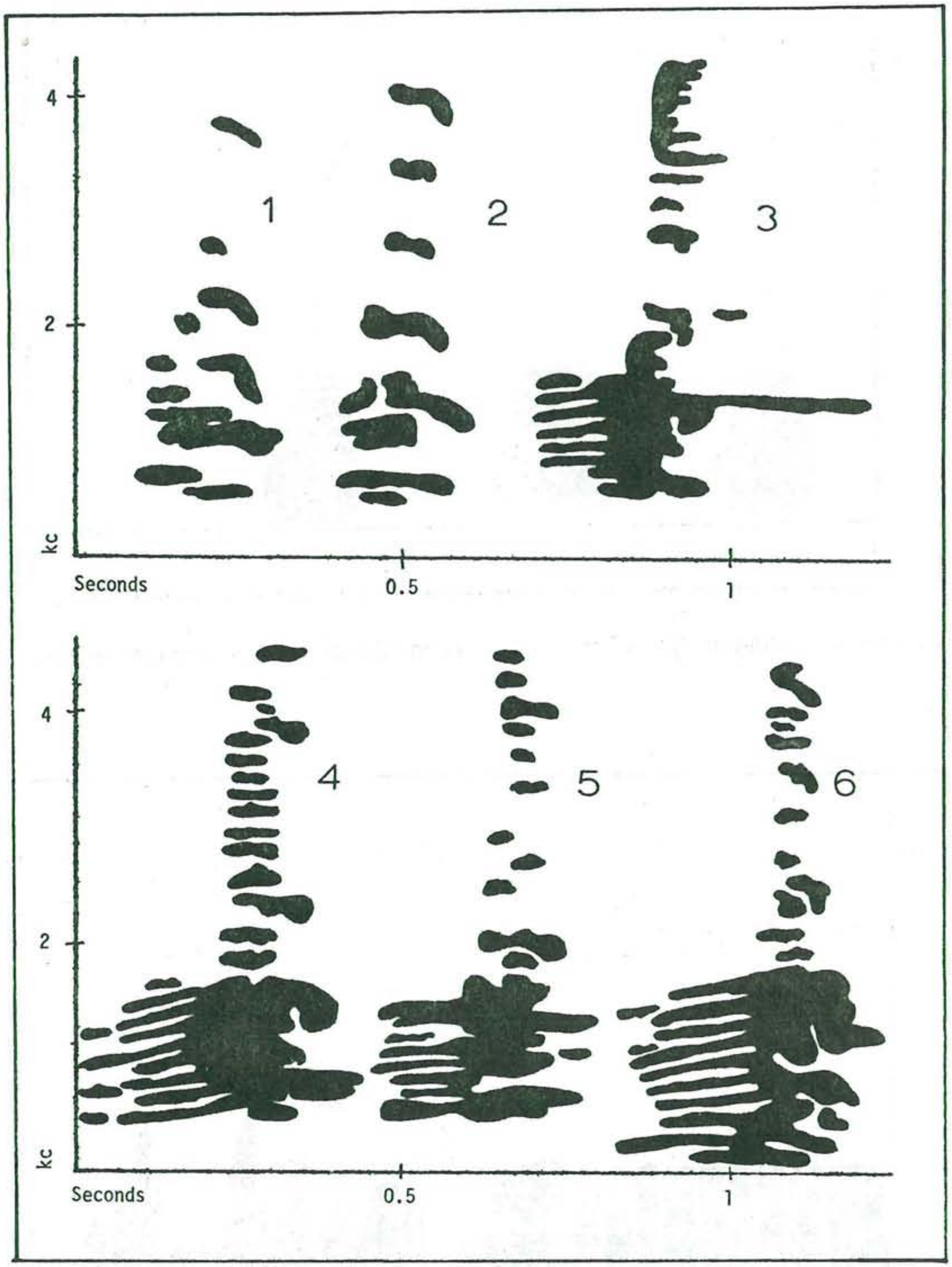

Figure 3. Single honks from six different adult Canada geese.

pattern between females.

The honking call of Canada geese is quite different from the low-pitch call. The honk is apparently given in territorial advertisement, as a long distance call to the mate, as part of the greeting ceremony, as an alarm call and in flight. During June and July at Churchill, I recorded some long series of honking calls from 15 different adult Canada geese, each of which was leading a different brood of goslings. As I approached, a family party would run away, one of the parents would fly off leaving just a single parent leading the brood. This remaining parent would frequently honk while being followed by its brood. Fig. 3 shows tracings of spectrograms from six of these parents. The honks of an individual differed little, if at all, between calls. As one can see from Fig. 3, they differed considerably between parents.

The Canada geese at Churchill are members of the subspecies *interior*. For comparison, I recorded some honks from cackling geese, the smallest subspecies of the Canada goose, at the Delta Waterfowl Research Station. These honks were quite distinct from those of the Churchill birds.

Future Work

Next spring I will be experimentally testing to see if calls of different adult geese have different effects on goslings which have had pre- and post-hatch experience with just one of the calls. The experiment is designed to test for individual recognition, to isolate the individual properties concerned and to test if previous experience with a call has an effect. Duration of approach and following responses, fear responses, response latencies, general behaviour and gosling distress and contentment calls will be recorded. Another experiment in the planning stage involves testing for subspecies recognition in the Canada goose.

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Observations on the Life Cycle of *Diorchis excentricus*, a Cestode of Ruddy Ducks, and Remarks on its Status as a Valid Species

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Department of Zoology

Abstract

Three species of Ostracoda, *Cypris pubera*, *Cyclocypris serena* and *Cypridopsis vidua*, were found to act as intermediate hosts in the life cycle of *Diorchis excentricus*, a common cestode parasite of ruddy ducks. Development of the cysticercoid was completed in 14 days, and the cysticercoids were infective to an experimentally raised ruddy duckling.

Biological evidence obtained from the life cycle clarified the taxonomic position of *Diorchis excentricus* with a closely related species, *D. nyrocae*. *Diorchis excentricus* is retained as a valid species on account of the different shape of the eggs, which were described for the first time, and on account of the absence of sucker armature in both the cysticercoid and adult specimens of *D. excentricus*.

Functional Analysis of the Home Range and Territorial Behavior of the Northern Shoveler, *Anas clypeata*, in Relation to Spacing Mechanisms

N. Seymour

Department of Zoology

Objective

A population of northern shovelers was studied at Delta, Manitoba to determine if behavioral mechanisms contributed to the spacing of the breeding pairs.

Methods

Eighteen males and three females were trapped on the study area and marked with nasal markers which enabled subsequent identification of those individuals. The males proved to be both mated territorial drakes and unmated drakes.

The marked birds and other unmarked birds were observed from a 20-foot high observation tower erected on the study area. Observations were also made from an automobile.

A tape recorder was used to describe pursuit flights and other rapidly occurring behavior. Seasonal changes in the habitat were recorded on film.

The data were gathered so as to allow for a behavioral analysis relative to three major periods of the reproductive cycle: pre-laying, laying and incubation.

Results

Much of the descriptive data involving the behavior of the birds have been analyzed, and a number of conclusions about the detailed behavior of the birds while on their territories have been drawn.

Home range of the territorial pairs differed, depending on the period of the reproductive cycle. The pairs ranged most widely during the pre-laying period, particularly before a nest site was located. The movement of the pairs was most restricted during the laying and early incubation periods. The male began to wander further from the territory as the incubation period progressed. This continued until the pair bond dissolved. The female utilized the territory, whenever off the nest, during all of the three periods. No females with broods were observed. No nests on the study area were successfully incubated to hatching.

Territory size could not be considered rigid. There were no obvious geographic boundaries to which territorial drakes related. Aggressive interactions between neighbours apparently determined the boundary between abutting territories. These boundaries did not change until late in the incubation period when the pair bond apparently was weakest. Drakes did not defend their territories successfully then and were observed only infrequently on their territories.

In approximately 45% of aerial pursuits the defending drake pursued from a central point on the territory for less than 15 seconds. This pursuit corresponds to approximately 200 yards. The other 55% of pursuits involved longer flights with intruders circling the territory before being successfully chased away. One might argue that the short straight flights reflect the size of the territory.

Other aggressive behavior, such as threat behavior by the territorial drake, was successful in preventing intruders from landing on the territory. Territorial drakes gave an aggressive two-note call that was sufficient to make intruding pairs leave the area on many occasions.

Aerial pursuit flights were analysed as to duration, intensity, faithfulness of territorial drake to the territory and birds involved in the flight. Flight duration was scored into three categories. As mentioned previously, 45% were less than 15 seconds. Approximately 43% were 15-60 seconds, and approximately 11% were greater than one minute. Flights were primarily high intensity flights with pursuing drakes attempting to or succeeding in grasping the intruder by the back or tail feathers. Territorial drakes returned to the central area of the territory after 93.7% of flights. This indicates that the drake is defending an area or his mate or both. Defending drakes pursued pairs in 60.6% of the flights with the defending drake directing his attention to the female of the pair in most cases. Mated or unmated drakes were chased in 39.4% of the flights.

The pursuit flight is considered to be successful in preventing other pairs from establishing nest sites in existing defended areas. The 93.7% figure, previously noted, further indicates that the intruder left the area in each encounter.

Pursuit flight activity over the flooded east meadow was used as an indicator of how many birds were in the area and when the daily and seasonal activity peaks occurred. Two peaks of activity occurred in the 12 weeks that the birds were showing territorial behavior. The first peak coincided with the beginning of nesting. Territories were initiated and the frequency of pursuit flights increased at this time. There was an average of eight pairs of shovelers along both ditches. Seven weeks later there was another peak in activity coinciding with severe skunk depredation of nests and an influx of pairs from elsewhere. Flight frequency was high until new territories were established. There was an average of 12-14 territorial pairs along both ditches as a result of the influx of pairs into the area.

The drake shoveler defends both the female and a site. An experiment revealed that defense of the female is more important than defense of the site. The drake relates to the female and defends her wherever she is, whether on the site or not. However, in the absence of the female, the drake defends the area most frequented by his mate. This defended area is generally associated with the nest. The drake often establishes a major loafing area within 100 feet of the nest and spends the majority of the laying and early incubation periods close to the loafing area.

The territory is deserted when the nest is destroyed. The pair may move a distance along the ditch or desert the ditch area entirely. Late nesting pairs always left the area when nests were lost. Deserted territories were often occupied by other pairs within three days of desertion. There is some evidence of pairs not breeding but waiting to establish along the ditch.

Unmated drakes actively courted mated females and engaged in both courtship and pursuit flights with mated females. A group of 15-20 unmated drakes was responsible for one-third of the flight activity seen in the ditch area. Unmated drakes may harass pairs to the point where the pair will leave an area entirely. Unmated drakes do definitely test the pair bond and may stimulate pairs to begin establishing a territory.

Aerial transects of the marsh were flown each week and data from these flights indicate that 50% of the total shoveler count occurred at the edge of the marsh on prairie and agricultural land that was laced with roadside ditches, small sloughs and temporary sheet water ponds. A much lower percentage of sightings occurred in the marsh proper. These findings were supplemented by results of road transects over much of the accessible portions of the marsh. Deep, open ditches are preferred habitat for establishment of territories. The most dense population of shovelers observed on the marsh was along the intensively observed Delta ditch.

APPENDIX I

Publications Resulting from Work at The University Field Station (Delta Marsh)

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APPENDIX III

UNIVERSITY FIELD STATION (DELTA MARSH)

RESEARCH 1971

Introduction

As the sixth season of research is embarked upon it is gratifying to reflect on the wide range of studies that have been undertaken at the Field Station. In the botanical area these have included population and productivity studies of such widely divergent groups as the algae and *Phragmites*; various aspects of the ecology of *Phragmites, Scirpus, Scolochloa* and *Typha*; studies on the forested ridge; nitrogen fixation in marsh soils, and a paleoecological investigation of the history of the marsh. Projects on the fauna have included studies on the parasites of Chironomids and amphibians; ecological investigations on the Shiners (*Notropis*) in Lake Manitoba and benthic fauna in the marsh; population studies of Sticklebacks (*Culaea*) and White-tailed deer (*Odocoileus*); metabolic organization in the muskrat (*Ondatra*) and behavioural studies of the Yellow warbler (*Dendroica*) and the Forsters tern (*Sterna*). The geologists have contributed to our knowledge of hydrology and the Pleistocene deposits of the Portage Plain, and archaeologists excavated a Beach Ridge site.

The overall objective of the research programme is focused upon obtaining a greater understanding of the dynamics of marsh ecosystems.

ZOOLOGY

Dr. E. Kucera (Post Doctoral Fellow, University Field Station) J. M. Shay

The space use and utilization of available food by White-tailed deer (*Odocoileus virginianus*)

This investigation is in its second year. Preliminary work has clearly shown the importance of certain types of vegetation as food sources or shelter, and the key role of snow during the winter in limiting deer movements and access to food. This year's research is oriented towards a quantitative expression of data. Winter is regarded as the most important period. The programme is divided into three related aspects:

1. Population: Size and composition will be estimated by ground and aerial observations and a marking programme. A check station will be set up during the deer hunting season.

2. Movements and space use: Standard measurements of snow characteristics will be made to determine the depth and hardness which limit deer movements and food availability, and the relationship between wind chill and deer activity recorded. Track and pellet counts will be made regularly on an established grid of transects together with regular and random observations of animals in the field. Attention will be paid to the use of cropland by deer.

3. Food habits: Estimates of amount of herbage available and used by deer will be made monthly, based on oven-dried weight of material clipped on sample quadrats accessible and inaccessible to deer. Analysis of rumen samples will verify the results of field observations. Sampling is scheduled for periods when food habits are likely (or found) to be changing.

Based on results of the study, an attempt will be made to estimate the carrying capacity of Delta Marsh and indicate some appropriate measures for management of deer population in this habitat.

This study is supported by the Department of Mines, Resources and Environmental Management.

M. Quaye (Ph.D. candidate, Department of Zoology) H. E. Welch

Life cycles and comparative morphology of *Rhabdias ranae* (Nematoda) in *Rana pipiens* and of *Rhabdias sp.* in *Bufo hemiophrys*, with notes on interspecific relationships of helminths co-existing in the lungs of these amphibians

A general survey of helminths in both *Rana pipiens* and *Bufo hemiophrys* during the summers of 1968 and 1969 at the University Field Station by L. Hlynka revealed two types of *Rhabdias spp.* (Nematoda) in the lungs of these amphibians. *Rhabdias ranae* was reported from *Rana pipiens* and *Rhabdias bufonis* from *Bufo hemiophrys*. As these nematode species can only be separated by size difference and as Walton (1929, 1936) believed *R. bufonis* absent from North America and Fantham and Porter (1948) reported its occurrence in Quebec, further studies are needed to establish the identity of the nematodes.

The purpose of this study is: (i) to confirm the occurrence of *Rhabdias ranae* in *Rana pipiens* and to establish the identity of the *Rhabdias* found in *Bufo hemiophrys*; (ii) to confirm the life cycle of *Rhabdias ranae* in *Rana pipiens* and to work out that of the *Rhabdias* species in *Bufo hemiophrys*; and (iii) to investigate the interspecific relationships in helminths co-existing in the lungs of *Rana pipiens* and *Bufo hemiophrys*.

This study is supported by the National Research Council.

R. A. Janusz (Summer Assistant)   J. M. Shay

Mercury levels in invertebrates and seasonal variation in benthic, littoral and trophogenic flora and fauna in the southern end of Lake Manitoba.

The purpose of the study is to provide information concerning the effect on Lake Manitoba of spring floodwaters released through the Assiniboine River Floodway.

Sampling stations will be established in the Assiniboine River Floodway, Lake Manitoba, Cram Creek, and the Assiniboine River. These will be sampled every two weeks, and collections preserved, sorted, and identified to determine seasonal variation. Bulk samples of certain abundant invertebrates will be taken every month; sorted, identified, and frozen for mercury level determination. In addition, samples will be taken on one occasion only for determination of mercury levels in water and data obtained on water chemistry, water levels, and sediment composition.

This study is supported by the Department of Mines, Natural Resources and Environmental Management and the University Field Station (Delta Marsh).

BOTANY

A. J. Macaulay (Ph.D. candidate, Department of Botany)   J. M. Shay

Ecology of *Scirpus acutus* and *Scirpus validus*

Hardstem and softstem bulrush (*Scirpus acutus* and *S. validus*) are prominent emergent species of lakes and marshes in southern Manitoba and play an important role in the communities in which they are present. Because of their characteristic position on the margin of open water, they serve as a windbreak for other emergent vegetation, and also stablize and build up shorelines. They are an important source of food and cover for waterfowl and muskrats.

Where they are sympatric, morphological distinction of the two species becomes difficult, and for this reason, their taxonomic status as species has been disputed. Detailed information on the ecology of these two species is lacking; the purpose of this study, therefore, is to define their ecological requirements in an attempt to:

1. Determine if there is ecological justification for distinguishing them as separate species (within the geographical range of this study), and

2. Obtain more precise information on their roles in the communities in which they are present.

Data are being gathered from stands of both species throughout southern Manitoba (49th to 55th parallels) on various abiotic factors including: water chemistry (pH, conductivity, calcium, magnesium and sulfate concentrations); water temperatures; annual water level regimes; and substrate texture and organic content. Attempts are being made to correlate these environmental parameters with morphological variation of the two species.

Certain areas of critical importance where the two species are sympatric and appear to hybridize (Delta Marsh) will receive additional attention. The morphological types found in such a location appear to form a mosaic of variability; this variability is being analyzed and compared with the variability of populations in areas where the two species are not sympatric.

Additional data is being gathered on the general biology of both species including growth rates, germination conditions, phenology, ability to colonize newly exposed areas (such as borrow pits and dugouts), and their role in sedimentation and "filling in" of aquatic communities.

This study is supported by grants from Ducks Unlimited, Department of Mines, Resources and Environmental Management, a C.I.L. Wildlife Fellowship and the University of Manitoba (Aquatic Biology Research Unit).

E. E. Mowbray (Ph.D. candidate, Department of Botany) J. M. Shay

The effects of fire on *Phragmites communis* dominated communities at Delta

In Manitoba, *Phragmites* stands die back in the fall leaving combustible litter that accumulates from year to year. Burning seems to be a possible method for managing *Phragmites*, i.e. opening up dense stands, but at present nothing is known of its effect.

In this study a controlled burning programme will be carried out for 3 years to determine the effects of fire on *Phragmites* and the associated flora and fauna. Control sites and sites to be burned will be selected and data collected relating to density, height, percentage flowering, productivity, litter accumulation, water content, soil composition and animal populations. The succession and composition of vegetation and productivity after burning will be studied in detail and compared with that of the controls. The use of the sites by deer and other herbivores will be determined by exclosures and trapping programmes. If burning proves to be a favourable means of managing *Phragmites*, guidelines will be forthcoming as to the most suitable conditions and intervals for burning.

Research plans for 1971 include: (1) review of pertinent literature, (2) selection of areas that can be burned safely, (3) collection of data (density, height, growth rate and productivity, light penetration and other parameters) on the controls and the areas to be burned, (4) formulation of schedule for burning the selected areas, conditions permitting and (5) burn at least one area if conditions permit.

This study is supported by the Department of Mines, Resources and Environmental Management.

J. Pearn (M.Sc. candidate, Department of Botany) J. Reid

An ecological survey of the soil and water fungi of the Delta Marsh.

Fungi, bacteria and actinomycetes fill a significant ecological niche and are of great practical importance in plant nutrition. As major decomposers of litter, they are responsible for the recycling of nutrients in any given situation thus permitting the same nutrient materials to be used many times by different species. In addition, many fungi are responsible for various types of plant diseases which may have drastic effects on the patterns of successions encountered in any given period of time.

To date, mycological investigations in the Delta Marsh have been limited in extent, and it is proposed that a detailed study be initiated to determine the influence of different site types on the species of fungi, the changes in their populations, and, eventually the role these organisms may play in ecology of the marsh.

Selected sites will be examined at regular intervals, with primary attention being paid to the aquatic Phycomycetes, Asomycetes, and Hyphomycetes in our aquatic habitats and the Phycomycetes, Ascomycetes, Hyphomycetes and Basidiomycetes of the emergent marsh sites.

In addition, a general survey sill be carried out to determine the fungus flora of the above-ground plant parts of the major marsh species.

This study is supported by the National Research Council.

F. S. Phillips (Ph.D. candidate, Department of Botany) J. M. Shay

The relationship between evaporation in *Phragmites* and water table fluctuations in the Delta Marshes.

The objective of this project is to determine the consumptive use of water by *Phragmites communis* and the effect of this use on the shallow ground water tables in the marsh. Hydrostatic lysimeters will be used to measure the evapotranspiration of *Phragmites*.

The seasonal growth patterns will be followed by taking weekly height and leaf area measurements. Stomatal densities will be determined by a plastic opening and closing will be determined by an intensive study of leaf impressions taken throughout a complete day and the percentage of stomata open at any particular time will be assessed.

An evaporation pan and a recording atmometer will be used to determine the evaporative power of the air and will thus serve as a check on the evapotranspiration data from the lysimeters. The environmental parameters of incoming solar radiation, net radiation, temperature, humidity and wind speed will be monitored by continuous recording, so that changes in the rate of evapotranspiration can be related to simultaneous changes in the available energy and local weather conditions.

Finally, the hydrologic changes in the marsh, which initiated this study, namely diurnal water table fluctuations will be monitored by means of float operated water table recorders on observation wells.

This study is supported by grants from the University of Manitoba the Agassiz Water Center.