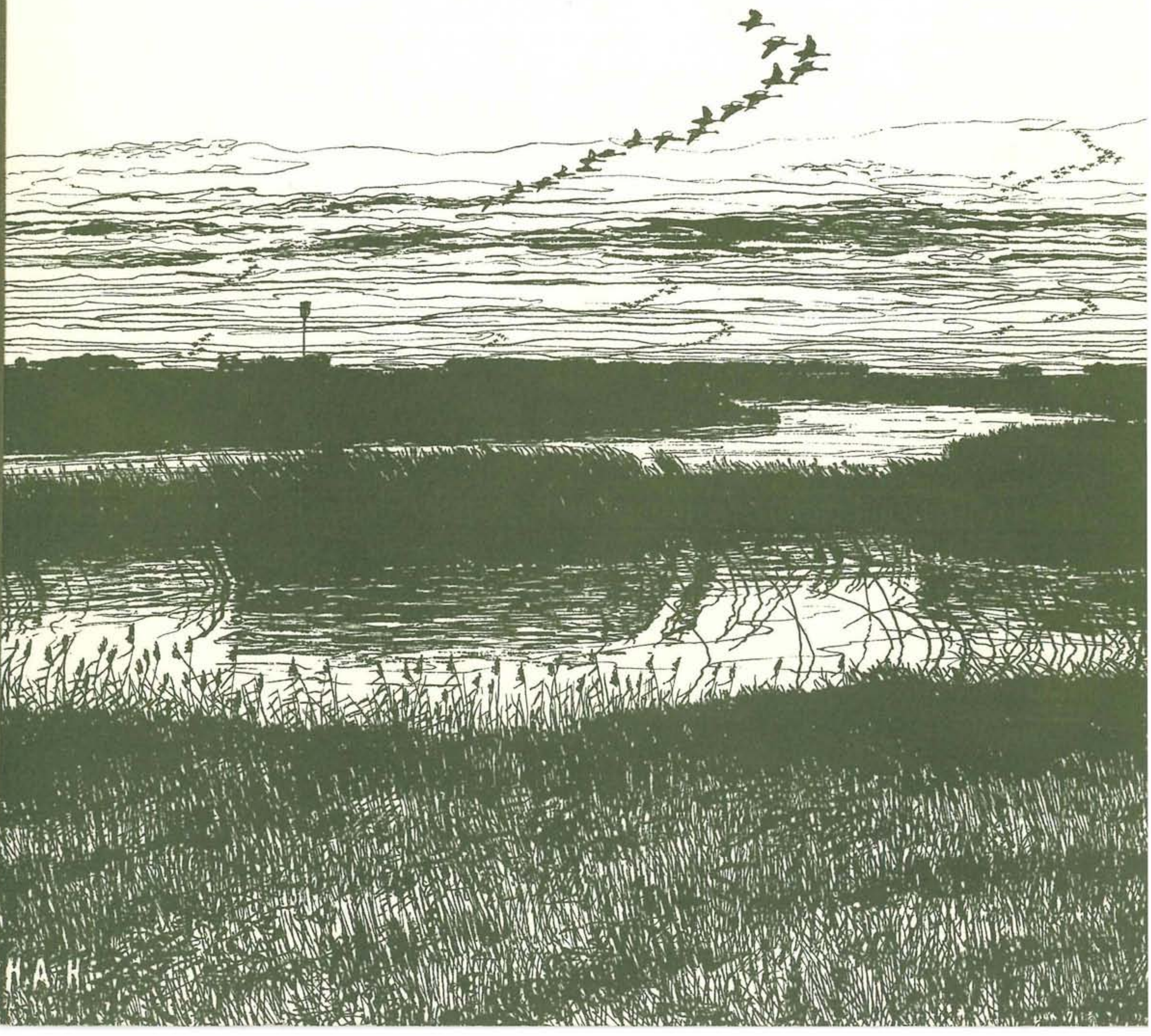
The University of Manitoba Field Station Delta Marsh

1975 Annual Report Number 10



THE UNIVERSITY OF MANITOBA FIELD STATION

(DELTA MARSH)

T E N T H   A N N U A L   R E P O R T

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Edited by

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February 1976

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

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Director's Report for 1975

Introduction

Over the years there has been a steady increase in use of the Station. In 1969, for example, we reported 265 resident weeks of occupation; in 1975 this had risen to 555 with a daily average of 15 from April until mid-September, while use continued throughout the year for short courses and ongoing research. Participants included faculty, graduate students, those taking regular University and Summer Session courses, Continuing Education programs and High School ecology field trips. One of the advantages of the Field Station is that it brings together people with a diversity of backgrounds and interests.

Staff

Dr. J. M. Shay (Director)
Dr. M. Aleksiuk (Zoology)
Dr. T. Booth (B.T.U.)
Dr. J. Gee (Zoology)
Dr. R. E. Longton (Botany)
Dr. D. Punter (Botany)
Dr. S. Sealy (Zoology)
Dr. J. M. Stewart (Botany)
Dr. H. E. Welch (Zoology)

Graduate Students

D. Busby (Zoology)
P. Goossen (Zoology)
D. Hood (Zoology)
N. Hooper (Botany)
R. MacArthur (Zoology)
R. MacCharles (Zoology)
G. Mutch (Zoology)
E. Pip (Botany)
M. Rayner (Botany)

Summer Assistants

C. Day (Zoology)
L. Girling (Botany)
M. Jungbauer (Zoology)
J. Pearson (Zoology)
R. Scarth (S.T.E.P.)
D. Soprovich (Zoology)
R. Wade (Botany)
W. Wade (Botany)

Support Staff

B. Wallis (Administrator)
I. Garnham (Cook, April, May June, Sept.)
R. Hooper (Domestic Asst.)
S. Kennedy (Domestic Asst.)
D. Klippenstein (Domestic Asst.)
E. Longstreet (Cook July)
G. Mulder (Cook Aug., Sept.)
N. Mulder (Manager)
N. Rodd (Maintenance Asst.)

Research

Fourteen research projects were in progress during 1975. In their second or final year were the studies of muskrat thermodynamics; striped skunk winter ecology; post-breeding dispersal of ring-billed gulls; epiphytes on aquatic macrophytes; *Chenopodium* ecology and grazer-aquatic plant interrelationships. New projects included studies of the breeding biology, and feeding ecology of yellow warblers; interaction of the endocrine system and parasite fauna of the red-winged blackbird; copepod parasites of saugers and walleyes; the ecology of the bullhead, and temporal succession in beach fungi. Two long term studies: ecology and productivity in *Phragmites* and protozoan and helminth parasites of frogs and toads were continued, these are outlined in the University Field Station Annual Report No. 9, 1974. Summaries and progress reports for the projects, except those on fungi and *Phragmites*, are included later in this Report.

Our warm congratulations to three graduate students who have successfully completed their studies. The Ph.D. thesis of Floyd S. Phillips is entitled "The Relationship between Evapotranspiration by *Phragmites communis* Trin. and Water Table Fluctuations in Delta Marsh, Manitoba". Glen Girman was awarded an M.Sc., his thesis being on "The Effects of a Number of Herbicides upon Photosynthesis and Heterotrophy of Naturally occurring Algal and Bacteral Communities in Delta Marsh, Manitoba" and Susan Eddy received an M.Sc. for her thesis on "Population of the Leopard Frog *Rana pipiens pipiens* Schreber at Delta Marsh, Manitoba.

Teaching

Four two-week half courses were held in the Summer Session with an average attendance of 9 students (range 6 - 10).

Introductory Ecology	(1.228, 22.229)	Dr. T. Booth
Ecology of Animal Populations	(22.342)	Dr. J. Gee
Taxonomy of Vascular Plants	(1.225)	Dr. R. E. Longton and Dr. D. Punter
Ornithology	(22.468)	Dr. S. Sealy

More adequate publicity is still required for the Summer courses.

Dr. J. Gee organized four three-day intensive sessions for students in the fall Ecology of Animal Populations course (22.342). He was assisted by Gordon Berezay, Mike Collins and Bob Ferguson in the dawn to dusk activities which form an essential part of the overall course. In September I held one week of the Landscape Ecology course (31.705) at the Station and the Plant Ecology course (1.338) directed by Dr. J. M. Stewart visited the Station for a weekend.

Dr. Michael Bruser Memorial Bursary

The first award of this $250.00 bursary was made to Walter Klenner. We again wish to thank Mrs. Bruser for creating this bursary.

Summer Seminars

The Summer Seminar Program was organized by Nina Hooper and Dan Busby and we thank the following speakers for their interesting and informative presentations:

Dr. T. Booth	Department of Botany
Dr. S. C. Jay	Department of Entomology
Dr. R. Jones	Department of Renewable Resources
Mr. D. Busby	Department of Zoology
Mr. G. Mutch	Department of Zoology
Mr. N. Mulder	University Field Station
Mr. B. Wallis	University Field Station

The 8th Annual Field Station Seminar was held on January 25th. Seventeen papers were presented and followed by a useful question period. We appreciate the interest of the audience which despite snowstorms numbered more than 60 and included members of the Department of Renewable Resources; Environment Canada; the University of Winnipeg; Brandon University and members of the public.

Continuing Education

Five weekend courses were organized by Community Studies of the Extension Division:-

Jan.	3-5	Human Survival in Winter	Dr. R. Riewe & Mr. R. Pirt
Feb.	14-16	Mammals in Winter	Dr. R. Wrigley & Mr. G. W. Malaher
March	7-9	Survival Skills	Mr. R. Hamlin & Mr. R. Lay
Nov.	7-9	The Story of the Marsh	Dr. J. M. Shay
Dec.	5-7	Mammals in Winter	Dr. R. Riewe

Unfortunately both the April program on "Waterfowl Migration" and the May one on "Spring Birds" had to be cancelled due to the support staff strike and the October program on astronomy for lack of participants.

An average of 20 attended the weekends and the enthusiasm of participants was gratifying. Activities in the programs were diversified, but whether examining small mammals at close quarters, seeing how plants prepare for winter, sleeping on the lake in an igloo or map reading in the snowbound marsh, the weekend programs were educational and enjoyable. Our thanks to all the instructors.

The trustees of the National and Provincial Parks Association met at the Station from February 28 - March 2nd and organized a small weekend study session in June. The Department of Landscape Architecture held a workshop at the Station from April 22nd - 25th with all their graduate students and faculty in attendance.

The Honorable Harvey Bostrum, Minister of Renewable Resources and some of his staff paid a brief visit to the Station on July 22nd. Members of the Manitoba Archaeological Society led by Dr. C. T. Shay participated in a day of field studies on July 26th and a number of delegates from the American Ornithologists' Union toured the Station on August 22nd.

High School Visits

In anticipation of the continuation of the High School ecology program Rachael Scarth assisted me in organizing two-day workshop sessions at the Station for high school teachers in preparation for visits of their classes to the Station. Two of these were held and met with an enthusiastic response from the teachers; a third had to be cancelled because of impossible road conditions. This unfortunately was also the fate of several planned school visits because rain and dyke-building prevented road access.

Nonetheless 400 students and their teachers benefited from the program. We are grateful to S.T.E.P. for providing a salary and to Rachael for doing an excellent job.

General

The enlarged teaching lab in Agassiz was well used throughout the season but conditions in some research labs were very cramped, despite the full and effective use of the North lab. Mallard Lodge was painted outside and 3 of the bedrooms redecorated to retain as nearly as possible the original decor.

The trees planted around the buildings in the fall of 1974 overwintered successfully. Our grateful thanks to the Department of Landscape Architecture for their planning and execution of this design project under the direction of Professors Rattray and Allsopp and the assistance of Mr. G. Stewart of Campus Planning.

For the University Campus Open House, graduate students and assistants prepared a fine, scenic display of the marsh environment complete with sound effects and a color slide show. It was placed in the "link" of the science complex and attracted considerable attention.

We organized an Field Station Open House for June 22nd, with tours, demonstrations and exhibits on each of the research projects. Leaflets announcing the event were distributed throughout the neighbourhood to residents and cottagers. Unfortunately the day was rained out by a torrential downpour! An October presentation at the Station, of short talks on our research program by faculty and graduate students illustrated by excellent slides was well received.

It is becoming increasingly apparent that the Field Station can play an important role in biological research and education. Situated in the midst of a great marsh, readily accessible from Winnipeg and other centres in southern Manitoba and equipped with research, teaching and living accommodation we have the potential to serve a variety of needs. Unfortunately we cannot effectively satisfy the growing number of requests for programmes with our present scientific staff. We now rely on our own faculty and others but too often their other responsibilities preclude full participation.

In the area of general education we receive a variety of requests for field biology programs. These come from junior schools, high schools, teachers, youth groups and the public. Our High School ecology program is dependent upon both a S.T.E.P. grant - an ephemeral source of funding - and finding a suitably experienced environmental educator.

A full time resident biologist accumulating an intimate knowledge of the marsh and its environs could help meet these demands, assist as a demonstrator in University Courses and lead weekend programs throughout the year. In addition the biologist could gather basic information on the marsh environment and carry out routine research.

We should expand our program of ongoing research and environmental observations. For example we need to monitor snow and ice conditions, water temperatures and levels in the lake and marsh, to census fish, mammals, bird and insect populations on a year-round basis and collect phenological and other data. Clearly a resident biologist could contribute to a variety of needs. We hope to seek support from a number of agencies for this position.

Acknowledgements

I should like to thank all the staff and students who have helped in many ways to make this a fruitful year. Our appreciation is extended to our neighbours, the Portage Country Club and Delta Waterfowl Research Station, for their cooperation in allowing graduate students access to their property for research purposes. We also gratefully acknowledge the continued support and interest of the Provincial Department of Renewable Resources.

Jennifer M. Shay.

Feeding Ecology of Yellow Warblers, Delta Marsh, Manitoba - A Preliminary Report

D. G. Busby

Department of Zoology

Introduction

An important aspect of the niche requirements of birds pertains to food availability and usage since a major portion of their activities center around feeding of the individual and the young. Since about 60% of all birds are partly or largely dependent on insects as a source of food (Van Tyne and Berger 1959) Morse (1971) views the insectivorous bird as a special adaptive strategy in the evolutionary radiation of bird species. He further suggests that because birds and insects are the only two groups of flying animals (excepting bats), intricate and fundamental ecological interrelationships have evolved between them.

The adaptive significance of insectivorous birds is less than obvious when one considers that wintering Goldcrests (*Regulus regulus*) in England spend virtually 100% of daylight time foraging and require about one average sized insect every 2.5 seconds to maintain a positive energy balance (Gibb 1954). However since birds exhibit great diversity and abundance despite the restrictions of food-chain energetics, this indicates even more clearly the importance of bird-insect relationships (Morse 1971).

Bird-insect relationships are particularily conspicuous in the linear forested ridge separating Lake Manitoba from the Delta Marsh. Here, several insectivorous bird species occur in relatively great densities. Among these are Least Flycatchers (*Empidonax minimus*), Gray Catbirds (*Dumetella carolinensis*), Northern Orioles (*Icterus galbula*), Eastern Kingbirds (*Tyrannus tyrannus*), Western Kingbirds (*Tyrannus verticalis*) and House Wrens (*Troglodytes aedon*). However the most abundant species is the Yellow Warbler (*Dendroica petechia*), achieving densities of at least 100 breeding pairs per mile of beach ridge (Goossen, pers. com.).

One factor which probably contributes to the success of Yellow Warblers at Delta is the availability of food. This situation lends support to Lack's (1954, 1966) hypothesis that food abundance and population density are positively correlated.

Several aspects of the feeding ecology of Yellow Warblers have been studied (see Morse 1973) however no study has correlated available food supply with the food habits and foraging behavior, a point of fundamental importance in understanding the niche requirements of a species. Such information for other insectivorous species is also generally lacking (but see Root 1967).

The purpose of this study is to examine the feeding ecology of Yellow Warblers in the vicinity of the University Field Station, Delta Marsh. In particular, the following aspects will be considered: (1) The abundance, succession, distribution and availability of arthropods in Yellow Warbler foraging habitat throughout the summer; (2) Assessment of the organisms upon which Yellow Warblers prey throughout their breeding season; (3) Foraging behaviors of Yellow Warblers throughout their breeding season; (4) The influence of some environmental changes on their foraging habits; (5) Correlation of abundance of prey with the changing food requirements of the birds (e.g. egg production; raising of young, etc.); (6) The significance of intersexual competition; and (7) Assessment of the role of Yellow Warblers in this marsh ecosystem.

Methods and Materials

Arthropod sampling

The arthropod fauna of the beach ridge was sampled from June 1 to August 20, 1975. The procedure was to sweep an insect sweep net through typical Yellow Warbler foraging habitat a total of 40 (forty) times. The contents of the net were killed with ether and then separated, identified to family, counted and dried and weighed. This procedure was repeated three times (once in each of early morning, early afternoon and early evening) every fifth day of the sampling period.

Additional arthropod information was obtained by suspending sticky fly-paper in trees at two selected sites along the beach ridge. The following procedure was used every fifth day of the sample period. Fly-paper was suspended in the trees via a pulley system at each site for a period of one hour. The paper was then examined to determine the abundance and taxonomic classification of the arthropods on the paper. This procedure was repeated with fresh fly-paper five (5) times at evenly spaced intervals on each sample day. Occasional alteration of sweep net and fly-paper schedules was necessitated by adverse weather conditions.

The total amount of arthropods per sample was quantified by obtaining dry weight and total numbers of each group. Individual taxa were weighed separately to obtain average weights for certain groups at specific times of the season.

Food habits

The food habits were determined by examining the contents of 60 stomachs of specimens collected by mist-netting or shooting at strategic times throughout the breeding season. The stomachs were dissected out and placed in 70% alcohol within five minutes to minimize post mortem digestion of the prey. Stomach contents were later analysed under a dissecting microscope. Numbers of prey fragments (e.g. Dipteran wings, Coleopteran elytra) were extrapolated to arrive at the number of organisms represented in the stomach. Frequently intact prey could be identified.

Foraging behavior

Foraging behavior was studied by walking randomly through the beach ridge at selected times throughout the season and observing foraging Yellow Warblers through 12 x 50 binoculors. Information collected included sex of bird, species of tree or shrub in which the bird was foraging, section of tree where bird was foraging, height of tree, height of foraging, length of foraging time in each section, type of foraging (glean, hover, hawk). When the bird moved away from a section the plane of movement (horizontal, vertical, tangential), type of movement (hop, step, flight), and distance of movement were noted. All details were spoken into a portable tape recorder and were worded such that when the tapes were played back specific time intervals of certain behaviors could be timed with a stop-watch. The height of trees and height of foraging were determined with an inclinometer and 100 meter tape measure.

Environmental influences

Environmental influences will be assessed by comparing detailed notes of warbler behavior taken from blinds and by random walks through the woods with changes in arthropod abundance, weather and plant phenology.

Abundance of prey vs. energy requirements

Three aspects of the breeding biology of birds are relatively highly energy demanding. These are egg production by the female, feeding the newly hatched chicks and food procurement by the fledged young. By comparing the dates of these events with the food abundance some insight into the timing of breeding may be gained.

Intersexual competition

By comparing overlap in foraging behavior and prey contents of stomachs the degree of intersexual competition may be assessed. A high degree of overlap suggests high competition whereas divergence in foraging behavior and/or food habits suggests a reduction in competition.

Results

Arthropod Sampling

Results of the sweep net sampling are illustrated in Figure 1 which shows the total dry weight and the percent composition of each group of arthropods per sample. Chironomids dominated the samples throughout the summer. Their first major irruption occurred in early June. Major hatches are represented by peaks in the histogram. In early June, caterpillars ("inchworms" or "loopers") of the geometrid moths appeared. Their abundance increased steadily until late June when their numbers decreased. Spiders and mites were evident throughout the summer but particularily so in late July and most of August. These arthropods were dried and weighed as a group regularly throughout the summer to obtain average weights for the group.

The remaining arthropods consisted of insects from 14 orders and 98 families. Table 1 shows the orders of insects and the temporal appearance of families not previously found in the sweep net samples.

Food habits

The assessment of stomach contents is still in progress. Only generalizations can be made at this time. It appears that Yellow Warblers are eating prey items approximately in proportion to their abundance. When sweep net samples showed relatively equal abundance of several groups of arthropods the stomachs generally contained a variety of arthropods. At times when one or two groups of arthropods were extremely abundant (e.g. chironomids; "inchworms") these groups dominated the stomach contents.

More than 90% of the prey items were insects and chironomids appear to be the main prey during most of the breeding season.

Foraging

Analysis of foraging behavior observations is not yet complete and the results are tentative.

The males appear to forage higher and over a greater vertical distance than do the females (Fig. 2). The average foraging height is 2.7m and 6.3m for females and males respectively. Figure 3a shows the division of trees for the purpose of analysing foraging positions. Figure 3b indicates that males spend more time foraging in the higher and outer sections of the trees whereas the females spend more time foraging in the lower and inner sections of the trees.

Yellow Warblers are primarily gleaners (Table 2); that is they pick prey from the leaves and branches of the vegetation. Occasional

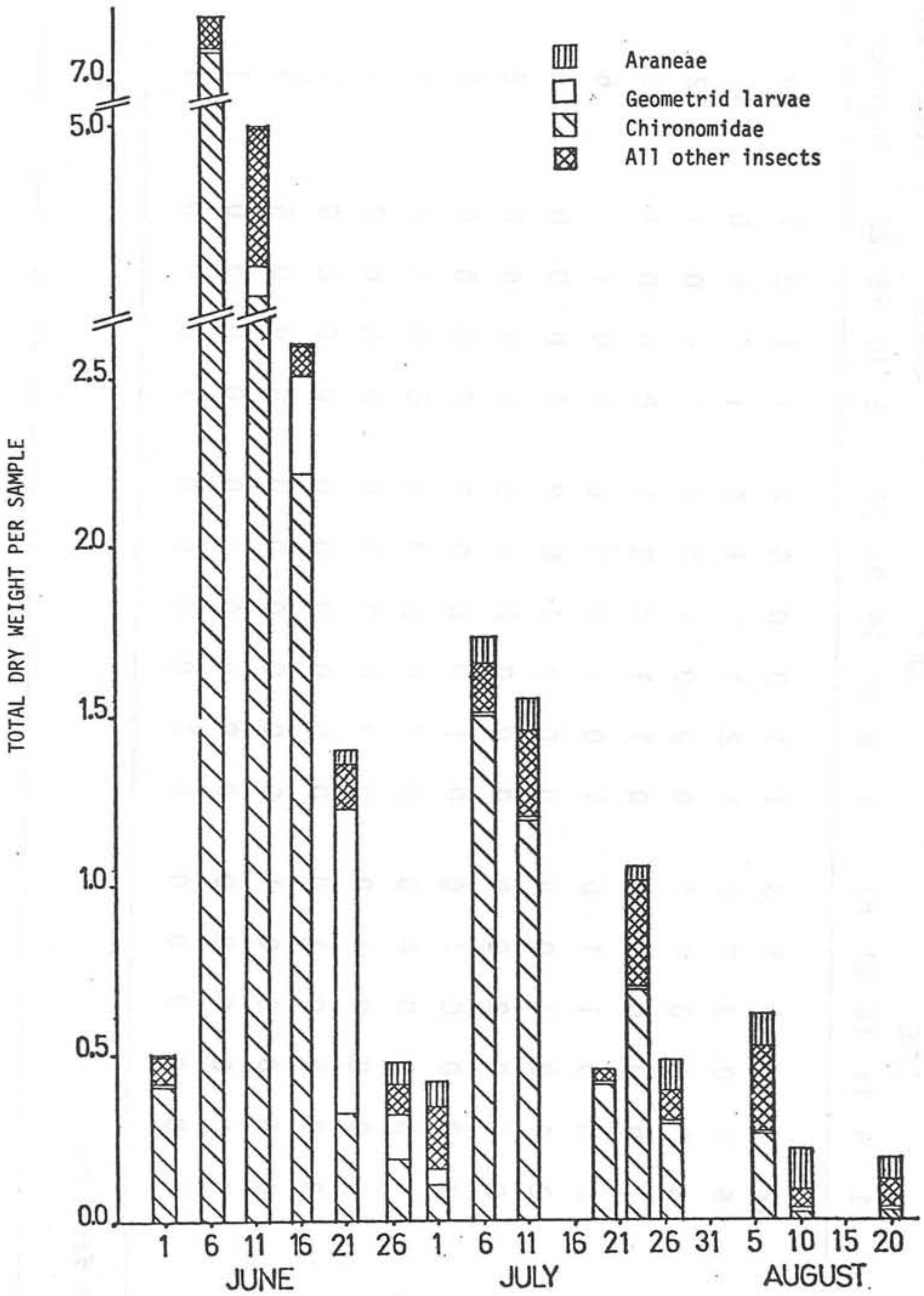

FIGURE 1. Total dry weight and percent composition per sweep net sample.

TABLE 1. Orders of insects showing temporal appearance of families not previously found in sweep net samples.

Order	JUNE 1	6	11	16	21	27	JULY 1	6	11	19	23	27	AUGUST 6	10	15	20	Total families in order
	Number of insect families occurring for first time																
Diptera	12	3	3	6	5	3	1	1	0	0	0	2	1	1	0	1	39
Coleoptera	6	0	0	3	0	2	1	2	1	0	1	0	1	0	0	0	17
Hymenoptera	6	1	0	0	1	1	0	0	0	1	0	0	1	0	0	1	12
Lepidoptera	1	0	0	0	0	0	0	1	1	3	0	1	0	0	0	1	8
Hemiptera	2	0	0	1	1	0	1	0	0	0	0	0	0	0	1		6
Homoptera	2	0	0	1	0	0	0	0	0	1	0	2	0	0	0	0	6
Neuroptera	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2
Trichoptera	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	2
Thysanoptera	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Plecoptera	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Odonata	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Orthoptera	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Psocoptera	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Mecoptera	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
Total insect families																	98

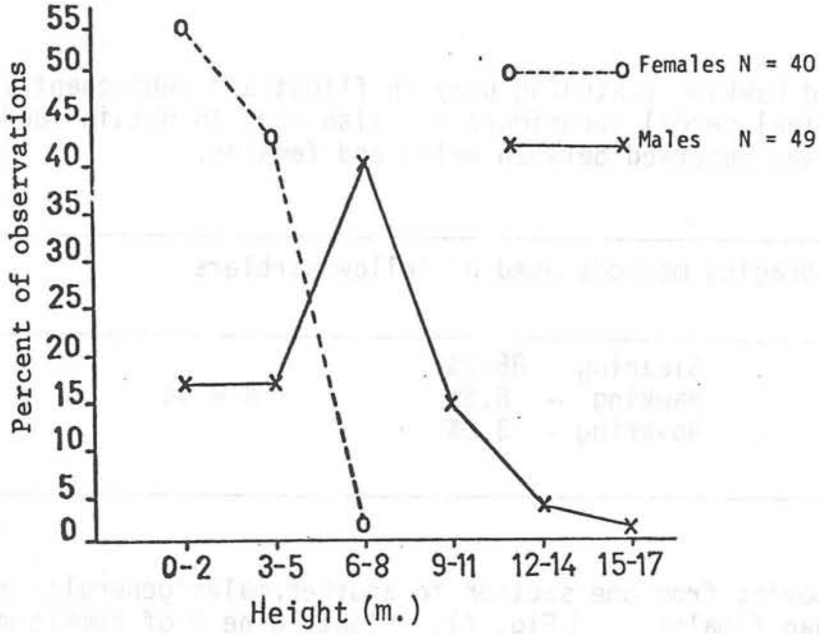

FIGURE 2. Foraging height of female and male Yellow Warblers

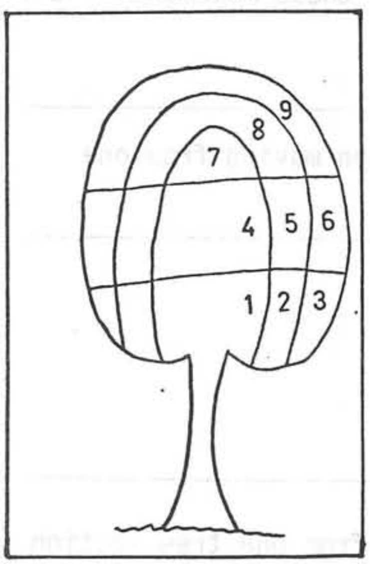

FIGURE 3a. Division of tree used in analysing foraging positions of Yellow Warblers.

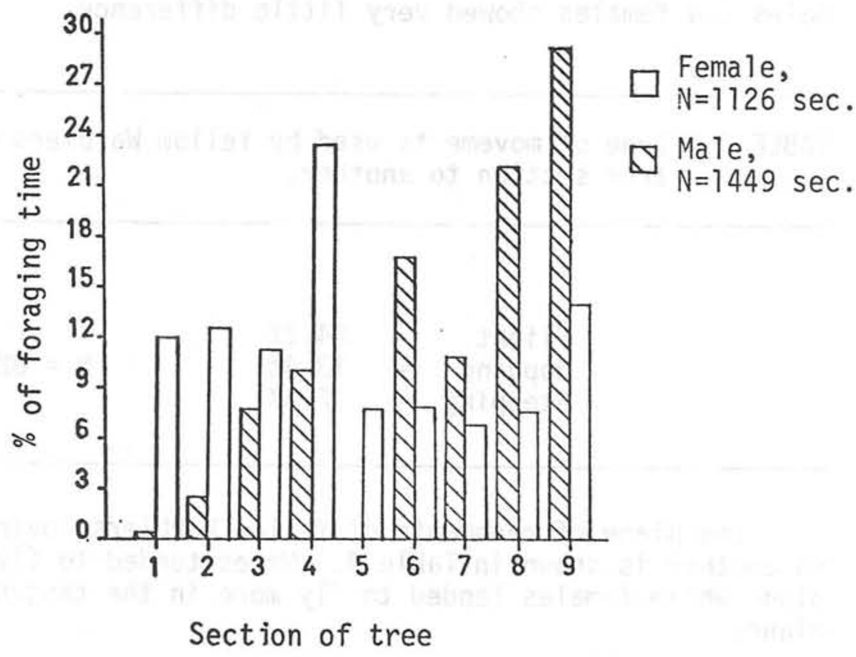

FIGURE 3b. Percent of foraging time of males and females in each section of tree.

hovering and hawking (catching prey in flight and subsequently returning to the original perch) techniques are also used to obtain food. Little difference was observed between males and females.

TABLE 2. Foraging methods used by Yellow Warblers

Gleaning	88.3%	N = 94
Hawking	8.5%	
Hovering	3.2%	

When moving from one section to another, males generally moved a greater distance than females (Fig. 4). Eighty-nine % of female movements were less than 4 meters; 55% of males movements were equal to or greater than 4 meters.

Three types of movements were utilized by Yellow Warblers, flight, hopping and stepping. Table 3 shows the proportion of these movements used. Males and females showed very little difference

TABLE 3. Type of movements used by Yellow Warblers when moving from one tree section to another.

Flight	84.2%	N = 82
Hopping	13.4%	
Stepping	2.4%	

The plane of movements of Yellow Warblers moving from one tree section to another is shown in Table 4. Males tended to fly more in the horizontal plane while females tended to fly more in the tangential and horizontal plane.

TABLE 4. Plane of movements of Yellow Warblers when moving from one tree section to another

	Female	Male
Horizontal	41.4%	62.2%
Tangential	39.0%	24.4%
Vertical	19.2%	13.3%

Environmental influences

In general, on days when arthropod abundance was low, incubating females spent more time away from the nest and moved farther from the nest to obtain food. It also appeared that the females moved more rapidly during these foraging periods. Males appear to feed the female more often when food is less abundant.

The effects of weather and plant phenology changes have not yet been assessed.

Abundance of prey vs energy requirements

Figure 5 shows the arthropod abundance throughout the summer and the high energy demanding events (from Goossen, pers. com.). The peak of prey abundance correlates with egg production by females. Minor peaks correlate with the period of feeding of young at the nest and newly fledged young.

Intersexual competition

Males and females appear to feed in different sections of the trees, at different heights and to some extent in different manners. These factors probably help to reduce intersexual competition.

Discussion

Arthropod sampling suggests that a super abundance of prey exists through most of the breeding season of Yellow Warblers along the beach ridge. Since these birds appear to eat prey in proportion to its availability and abundance rather than picking specific prey items, they can be considered generalized insectivorous birds. This fact may partially account for their extremely high productivity on the Delta area as they are able to take advantage of major irruptions of any of the arthropods.

They are also relatively generalized in foraging behaviors. Several foraging methods and movements are used and most parts of the trees are

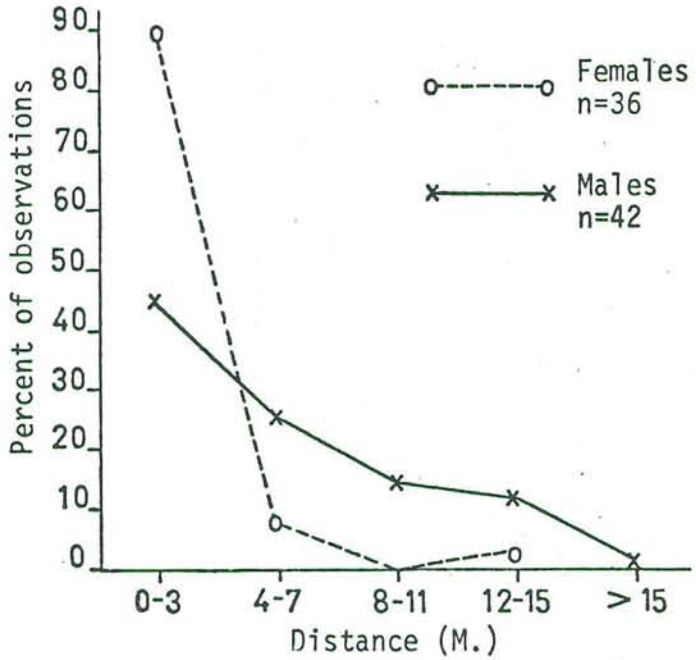

FIGURE 4. Distance moved by foraging males and females when moving from one tree section to another.

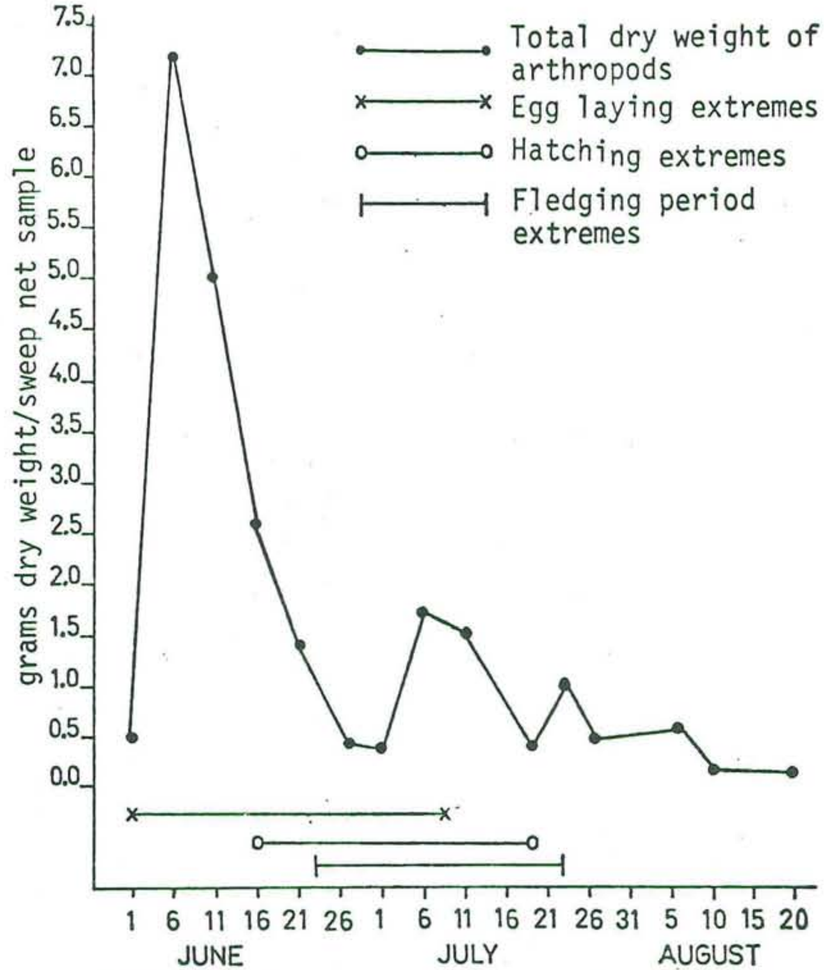

FIGURE 5. Seasonal abundance of arthropod prey with high energy demanding events of the Yellow Warbler breeding season.

utilized at least to some extent. All tree and shrub species are used for foraging and both females and males may be found foraging from ground level to the tops of the tallest trees.

Despite their generalized capabilities, Yellow Warblers are usually confined to foraging within their own territory and in certain manners. They are mainly gleaners of the mid-levels of the vertical stratification of the ridge, a niche occupied by no other species at Delta. Their movements are rapid and they seldom remain still for more than a few seconds.

The high energy demanding events of the breeding cycle correspond to the high insect abundance times. The period of egg laying corresponds with the largest peak of insect abundance. This fact lends support to Lack's (1954, 1966) hypothesis that egg production is timed to occur during periods of high food availability. Future field studies will examine more closely this and other phenomena of the feeding ecology of Yellow Warblers at Delta Marsh.

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Biology of Black Bullhead (*Ictalurus melas*) in Delta Marsh

Dr. J. H. Gee
Department of Zoology

Introduction

During the spring of 1974 the exceptionally high spring run-off through the Assiniboine diversion carried catfish from Assiniboine River. When the west dyke of the diversion broke in 1974 catfish were released into marsh waters as well as into the lake. Previously there were no records of catfish having been taken from these waters despite intensive and varied fishing effort.

The most abundant species of catfish after introduction was the black bullhead. These were quite conspicuous in the late summer and early autumn of 1974. "Balls" of young-of-the-year could be seen in both marsh and lake indicating that those individuals that had been introduced had spawned successfully 6 weeks after introduction and that the fry had survived the first 3 months in marsh waters. Estimates of the density of fry in the patches of vegetation along the lake shore by the removal method indicated that there were 2.1/m^2. In addition to black bullhead, I have seen channel catfish (*Ictalurus punctatus*), brown bullhead (*Ictalurus nelbulosus*) taken from Lake Manitoba and have a report of tadpole madtom (*Noturus gyrinus*) being taken from Delta Marsh by H. Smart.

Methods and Results

In 1974 hoopnets were operated in the marsh to provide information on the biology of black bullheads. From May to September about 95% of the age one and older fish were adults, being three years of age or older (Table 1.) Fish in their first and second years were relatively rare in the marsh. Fry were first captured in the hoopnets in mid July and compared to the numbers of older fish in August-September were extremely abundant (Table 1). This indicates a very successful spawning by adult fish in the marsh. Spawning occurred in late June and early July. Fecundity of females varied from 3,000 to 6,000 eggs/female. While in the marsh adult bullheads consumed perch fry, fathead minnows, and some gastropods. Fry consumed cladocera, ostracods, amphipods, and tricoptera larvae. Starting in August, the catch per unit effort in the Blind Channel and in Foresters Bay started to decline while in Cram Creek it increased. This trend continued into

September when almost no fish were captured in the Blind Channel but catches were made at the mouth of Cram Creek. This indicates that both fry and adult bullheads leave the marsh waters in Autumn and overwinter in Lake Manitoba.

TABLE I. Age distribution of black bullhead captured in Delta Marsh in 1975 by hoopnets. The two columns on the left are exclusive of young-of-the-year. Those on the right (July and August) include young-of-the-year. N = number of fish captured. Year class indicates the year of birth.

Month	Year Class	% of Population	N			
May	1974	3.0				
	1973	8.3				
	1972	63.5				
	1971-	25.2	172			
June	1974	0				
	1973	2.4				
	1972	87.4				
	1971-	10.2	342			
July 1-14	1974	0.6				
	1973	4.2				
	1972	84.6				
	1971-	10.6	317			
July				1975	59.0	
15-31	1974	1.0		1974	0.4	
	1973	3.4		1973	1.3	
	1972	87.5		1972	36.0	
	1971-	8.1	338	1971-	3.3	823
Aug. to				1975	98.2	
Sept. 7	1974	1.7		1974	0.0	
	1973	7.1		1973	0.1	
	1972	82.1		1972	1.5	
	1971-	9.1	276	1971-	0.2	14,726

These data indicate that adult black bullheads move into Delta Marsh where spawning occurs. Fry and adults remain in marsh waters during the summer and move back to lake waters in autumn.

Breeding Ecology of the Yellow Warbler at the Delta Marsh, Manitoba

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Introduction

Yellow Warblers (*Dendroica petechia*) are one of the most common summer residents along the lakeshore ridge which separates the Delta Marsh from Lake Manitoba. The purpose of this study is to ascertain the productivity of this species and factors affecting their success. Aspects relating to the natural history of this common warbler have been documented by Bent (1953), Bigglestone (1913) and Schrantz (1943) while McGeen (1972) has examined Cowbird-Yellow Warbler relationships. More information is needed on its mating system and breeding strategy in response to varying factors such as population density and food supply.

Methods

Observations were made from the time of their arrival in May until their departure in September. An intensive nest search was carried out during the breeding season to locate as many nests as possible along the lakeshore ridge. Nests were checked daily and notes were made on their outcome. Eggs were marked and nestlings were banded whenever possible. Attempts were made to color-band adult pairs at specific nest sites. An intensive banding effort began on July 6 until the end of the fall migration.
1453 Yellow Warblers were banded during the period from May 17 to September 9.

Results

Since the research has not been completed and the analysis is only a preliminary one, the results in this paper should be viewed as tentative.

Arrival and nest initiation

The first male was sighted on May 12 at Oxbow woods and May 13 on the study area. Resident males arrived on May 16 while resident females began arriving on May 23. Resident males began singing immediately upon arrival and soon were establishing territorial boundaries. Although one chase between 2 males was noted on May 19, intra-specific aggression became significant on May 24, coinciding with the arrival of the females. The first sign of nest building activity was noted on May 26.

Clutch size

Clutch initiation began on June 1. Figure 1 illustrates the first egg dates for 118 Yellow Warbler nests as well as egg deposition dates for 26 Cowbird eggs. The average clutch size for 66 unparasitized nests was found to be 4.44. Clutch size decreased as the season progressed as seen in Table 1. The trend in clutch size over the breeding season and during each 8 day interval is also illustrated in the same Table. There was a general increase of four-egg clutches over the season while clutches of five eggs decrease as the season progressed.

TABLE 1. Clutch size during the 1975 breeding season

	June 5-12	June 13-20	June 21-28	June 29-July 7
Number of eggs laid	172	79	16	26
Number of nests	37	18	4	7
Number of eggs per nest	4.65	4.39	4.00	3.71
Number of 3 egg clutches	0(0%)	1(5.6%)	0(0%)	2(28.6%)
Number of 4 egg clutches	13(35.1%)	9(50.0%)	4(100%)	5(71.4%)
Number of 5 egg clutches	24(64.9%)	8(44.4%)	0(0%)	0(0%)

Incubation and nestling period

The female alone incubates the eggs while the male defends the territory and feeds the female. The mean incubation period for 23 nests was found to be 11.2 days. Of the 23 nests, 19 had an incubation period of 11 days while 4 had a 12 day incubation period. The nestling period was about 2 days shorter than the incubation period. The mean nestling period for 20 nests was found to be 9.7 days. These results are similar to Schrantz (1943) who found that in Iowa the Yellow Warbler had an average incubation period of 11.0 days and an average nestling period of 9.5 days.

Breeding success

A total of 127 completed nests were found. Five of these did not receive any eggs or were destroyed soon after completion. Another dozen nests were considered incomplete. Of the 127 nests, 33(26%) were parasitized by the Brown-headed Cowbird (*Molothrus ater*). Breeding success of both the Yellow Warbler and Cowbird are described in Tables 2 and 3 respectively. Yellow Warblers were more successful in unparasitized nests since Cowbird nestlings

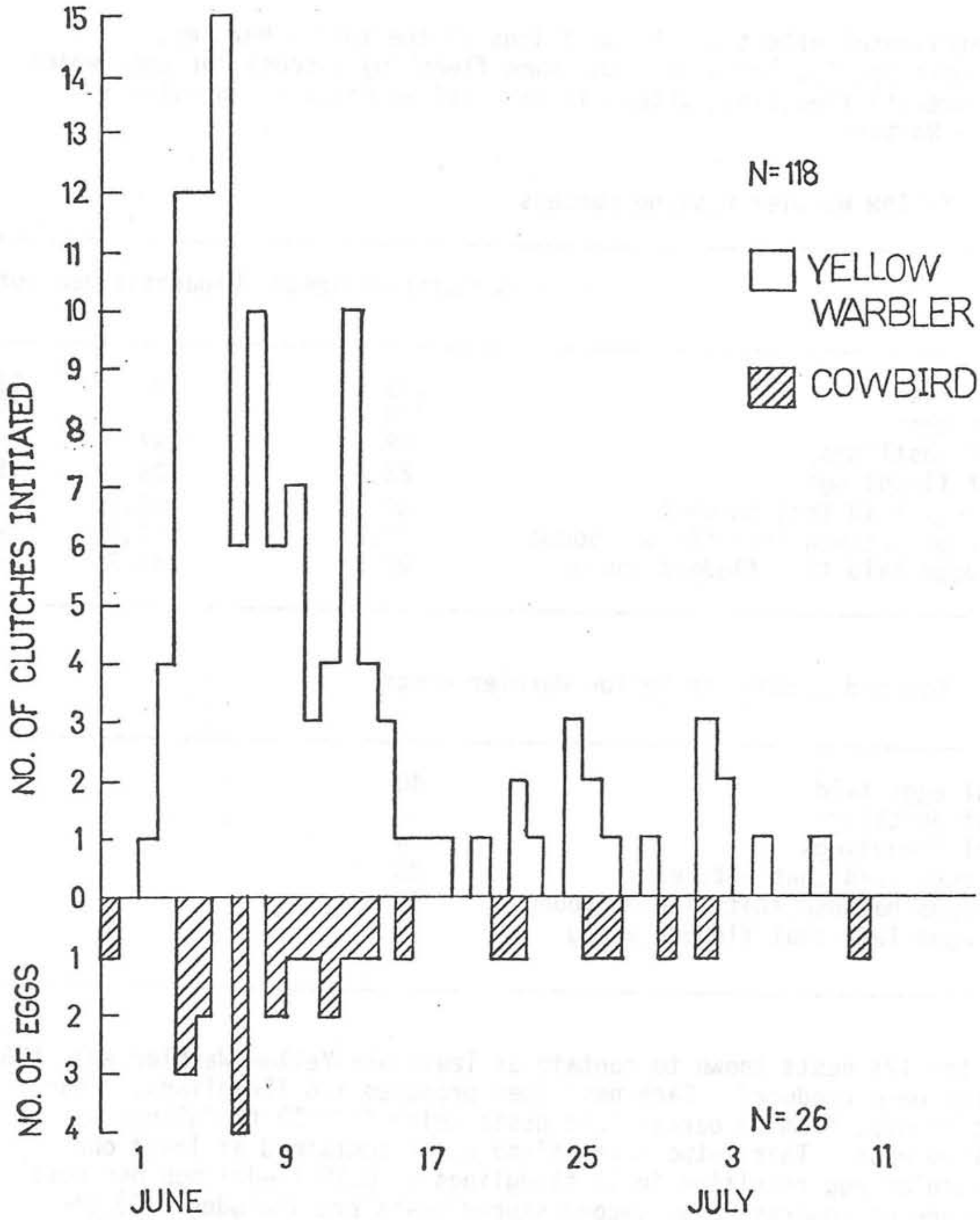

FIGURE 1. Yellow Warbler clutch initiation and Cowbird egg deposition dates for the 1975 breeding season.

have a detrimental effect on the nestlings of the Yellow Warbler. Although both species had almost the same fledgling success for eggs which hatched, overall fledgling success in parasitized nests was greater for the Yellow Warbler.

TABLE 2. Yellow Warbler nesting success

	Parasitized Nests	Unparasitized	Total
Number of nests	33	94	127
Number of eggs	114	375	489
Number of nestlings	48	237	285
Number of fledglings	23	175	198
Percent eggs laid that hatched	42.1	63.2	-
Percent eggs hatched that fledged young	47.9	73.8	-
Percent eggs laid that fledged young	20.2	46.7	-

TABLE 3. Cowbird success in Yellow Warbler nests

Number of eggs laid	40
Number of nestlings	10
Number of fledglings	4
Percent eggs laid that hatched	25
Percent eggs hatched that fledged young	40
Percent eggs laid that fledged young	10

Of the 121 nests known to contain at least one Yellow Warbler egg, 1968 fledglings were produced. Each nest then produced 1.6 fledglings. Four Cowbirds fledged from 33 parasitized nests which is 0.13 fledglings per parasitized nest. Thirty-two parasitized nests contained at least one Yellow Warbler egg resulting in 12 fledglings or 0.38 fledglings per nest. If the young of unparasitized second storey nests are included (11) the number of fledglings per parasitized nest is 0.72. Finally, of the 89 unparasitized nests containing at least one Yellow Warbler egg, 175 fledglings were produced or 2.0 fledglings per nest.

Fall departure

The Yellow Warbler is the first warbler species to return to the wintering grounds in Central America, appearing as early as August (Chapman, 1907). Since Yellow Warbler densities were high at Delta, it was impossible to determine when residents had left the area and when northern migrants had arrived. Maximum number of unbanded Yellow Warblers, mostly juveniles, were recorded during the period from July 31 to August 8. The peak day was August 4 when a total of 125 Yellow Warblers was banded. Information as to the length of residency may be obtained from color-banded birds. The last color-banded bird was a male seen on September 3. It had been captured on June 8 and can therefore be considered as a resident. The last Yellow Warbler was seen by Michael Collins on September 16, east of the Assiniboine Diversion on the lakeshore ridge.

Discussion

The major factors influencing Yellow Warbler success at the Delta Marsh include the food supply, predation and cowbird parasitism. Food appears to be in super abundance and may explain the concentration of several insectivorous passerine species which inhabit the ridge. The nature of the food supply and its effect on the Yellow Warbler is still under investigation (Busby, pers. com.).

Although data on predation has not been presented, approximately 40% of the egg and nestling losses may be attributed to this factor. Nice (1957) suggests that passerines which build open type nests have an egg or young mortality of 55%. Potential predators at the Delta Marsh include the Common Grackle, Brown-headed Cowbird, short-tailed and long-tailed weasels, skunk, and red squirrel.

Cowbird parasitism was relatively low (26%) as compared to Hicks's (1934) 42% for 146 Yellow Warbler nests. There is a 64% loss in fledglings produced in parasitized nests as compared to unparasitized nests. Although other factors than the Cowbird may account for this difference, brood parasitism has a negative effect on Yellow Warbler productivity.

It is not known to what extent inter-specific competition affects the reproductive success of Yellow Warblers however the habitat is ideal since the lakeshore ridge produces a natural edge effect, a habitat requirement for the Yellow Warbler.

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A Study of the Seasonal Variation of the Parasites and some Endocrine Parameters of the Red-winged Blackbird *Agelaius phoeniceus* L.

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Introduction

A few studies of the parasites of the Red-winged blackbird have been undertaken but only one of these (Spory 1965) reported both external and internal parasites. All were carried out in United States except one report of the examination of four nestlings in Ontario (Bourns 1966). Previous studies on the parasites of the Red-winged blackbird were done by Wallace & Olsen (1963) in Colorado, Spory (1965) in Ohio, McLaughlin (1968) in New Jersey, Stanley and Rabalais (1971) in Ohio, and Cooper & Crites (1974) in Maryland.

The objectives of this study were: (i) to discover which parasites infect the Red-wing Blackbird at Delta Marsh during breeding season, (ii) to determine if seasonal trends exist, (iii) to compare relative abundance of parasites, (iv) to make preliminary observations on some concurrent seasonal hormone fluctuations, and (v) to identify nest arthropods in an attempt to identify intermediate hosts of protozoan blood parasites.

Methods

Seven sample periods were chosen between the time that Red-winged blackbirds arrived in the north and returned to the south. Ten males and ten females made up each sample and young birds were taken when they became available. The times corresponded to those of major hormone differences detectable by the behaviour patterns displayed by the birds. Birds were observed in the field for the particular characteristic behaviour before being sampled. Sample periods were: (1) arrival in the marsh (post-migration), (2) defence of territories and nest building, (3) egg laying, (4) raising of young (in nests), (5) feeding of fledged young, (6) moulting in August, and (7) pre-migration.

In addition a winter sample from Arkansas is planned to compare the infection rate in the Red-wing's two habitats.

Birds were shot with a 410 shotgun and immediately upon retrieval a sample of blood was obtained by syringe from the heart. The specimen was placed in a plastic bag with ether fumes and transported to the lab. Ectoparasites were recovered first by ruffling the feathers over a sheet of white paper. This freed the larger mites, lice, fleas and flies, and allowed them to be transferred by a fine paint brush (size 000) to ethanol for storage. Primary feathers and some neck skin were removed for digestion in KOH to free feather mites by the method of Hilton (1970). Blood smears were taken for each bird, and a number of organ smears were also made to detect blood parasites in the last sample.

Birds were dissected as soon after death as possible. Each organ was placed in a petri dish of 0.85% NaCl (saline) and opened separately. Parasites were removed, fixed, and stored in 70% ethanol for staining, mounting and identification.

A sample of serum and the pituitary gland from each bird was frozen for sex hormone and prolactin assay respectively. Thyroid glands were fixed for histological assay of thyroxine. Gonads were fixed and later measured and dried for weight determination as a second measure of sex hormone level. Spleens were dried and weighed to give information about blood parasites in the last two samples.

Insects were removed from five Red-winged blackbirds' nests by Tulgren funnel and identified to family before shipment to the Biosystematics Research Institute, Ottawa, for further identification and confirmation.

Results

Table 1 shows dates, numbers and ages of all blackbirds collected. Young of the year were very difficult to obtain after fledging so their numbers are both inconsistent and low in all but Sample 4 (the nesting sample). All birds were difficult to obtain for the last sample due in part to their behavioural changes prior to migration. The required number of females was not obtained.

TABLE 1: Collection Data

		Adults				Age of Nestlings	
Sample No.	Date	No. of mature male	No. of mature female	No. of immature	% parasites	Number <5 days	Number >5 days
1	April 30-May 18	10	10	1	90%	0	0
2	May 19-May 22	10	10	0	100	0	0
3	June 3-June 7	10	10	0	100	0	0
4	June 17-June 21	10	10	0	100	14	11
5	July 1-July 12	10	10	1	100	0	0
6	Aug. 18-Sept. 4	10	10	2	90	0	0
7	Sept. 28-Oct. 5	11	6	1	56	0	0
	Total	71	66	5		% para: 7.1%	100%

Total Number birds 167
Total incidence of infection 85%

Table 2 lists all parasites currently identified, their location in the host, and their incidence in 167 birds.

When the birds arrived at the Delta Marsh, 90% of them were parasitized but none had intestinal trematodes. In Sample 2 and in the remaining samples of the summer, 100% of the birds harboured parasites. The level dropped drastically in the pre-migration sample to 56%. The total percentage of parasitism for the entire sample was 85.

TABLE 2: Parasites found location in the host and incidence

Group	Location	Name	Incidence
Trematoda	intestine	*Plagiorchis noblei*	62.2%
		unidentified	7.1%
	gall bladder	*Conspicuum* sp.	0.5%
	kidney	unidentified	4.1%
Acanthocephala	intestine	*Mediorhynchus* sp.	-
Cestoda	intestine	*Anonchotaenia* sp.	13.1%
Nematoda	blood	microfilaria (s.o. Filariina)	0.5%
	body cavity	larvae	0.5%
	proventriculus	*Tetrameres* sp.	0.5%
		Microtetrameres sp.	0.5%
		fam. Acuariidae	0.5%
Protozoa	red blood cells	*Parahaemoproteus* sp. *Plasmodium* sp.	16.6%
Fleas	body & nests	fam. Ceratophyllidae	4.1%
Lice	body & feathers	unidentified	48.5%
Mites	body & feathers	unidentified	37.1%

The most abundant parasite was the intestinal trematode *Plagiorchis noblei* Park whose seasonal distribution Figure 1 closely follows the seasonal pattern of all parasites from Samples 3 through 7 (Fig. 1). Cestodes were at peak abundance early in the summer but absent in later samples. Blood parasites showed a small peak in June but a more dramatic peak may have occurred in September. Both lice and mites were in their greatest abundance in the earliest samples and relatively rare in the later ones. (Fig. 2)

To date the only endocrine parameter measured is gonad dry weight. Figure 3 shows the seasonal change in gonad dry weights.

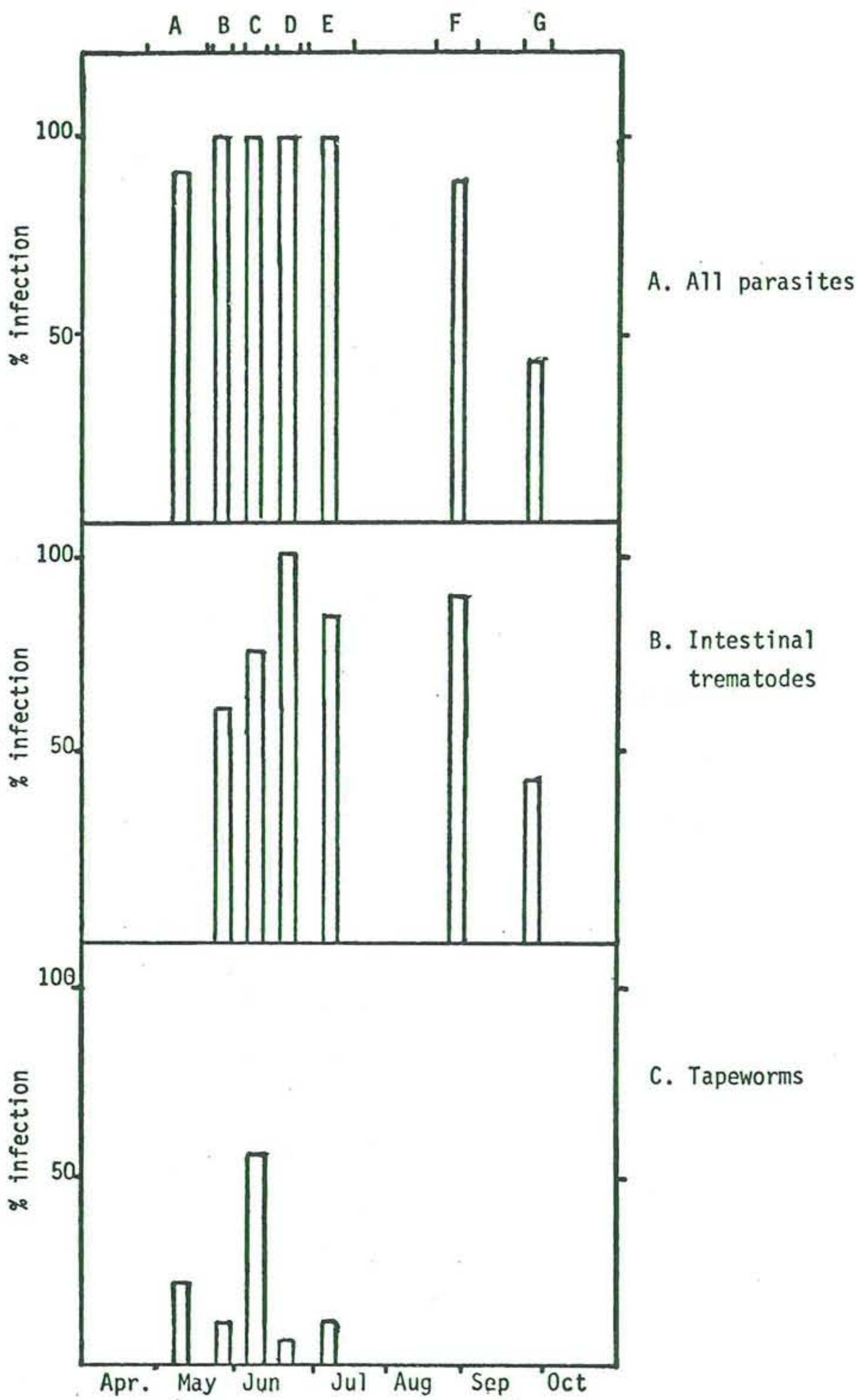

FIGURE 1. Seasonal distribution of all parasites, intestinal trematodes, and tapeworms

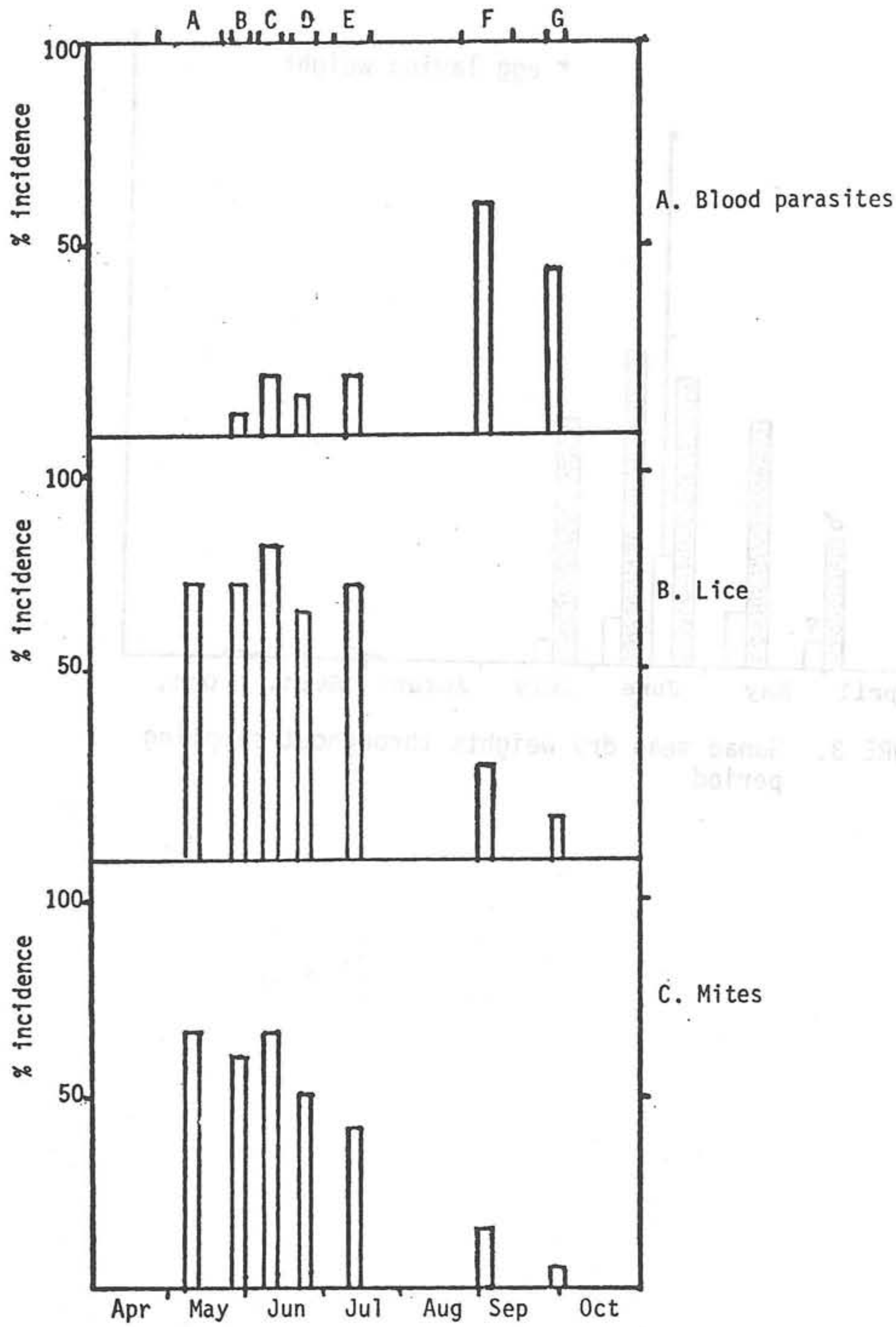

FIGURE 2. Seasonal distribution of blood parasites, lice and mites

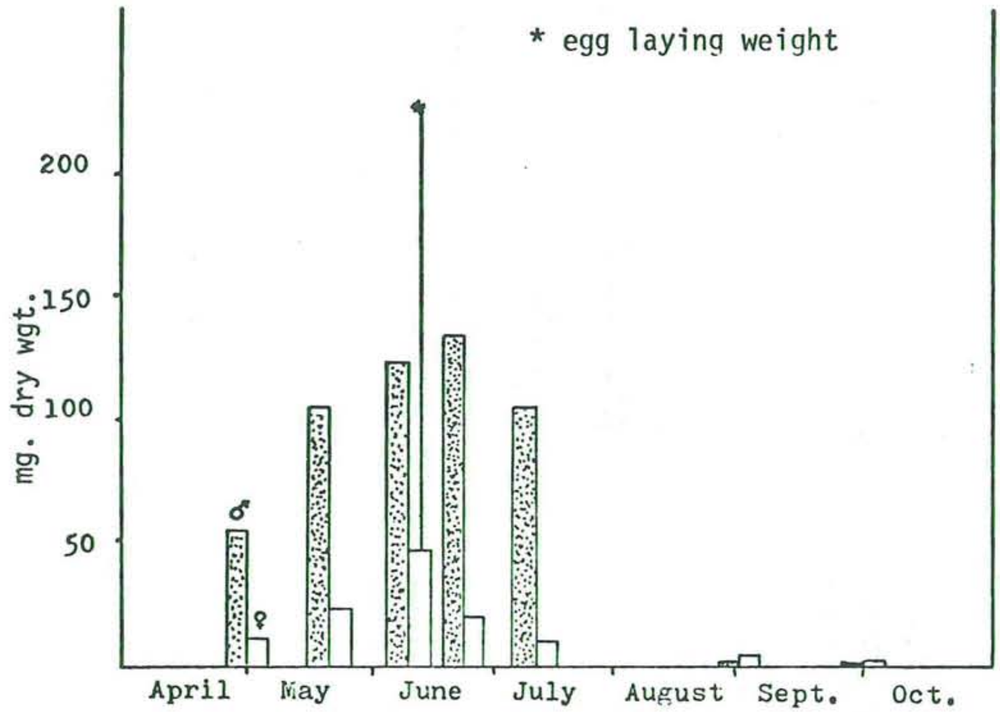

FIGURE 3. Gonad mean dry weights throughout sampling period

Results of insect identifications have not yet been confirmed but the following ordinal and family determinations have been made

Order	Number of families
Diptera	14
Coleoptera	8
Homoptera	3
Hemiptera	2
Lepidoptera	4
Thysanoptera	2
Hymenoptera	3
Diptera (larvae)	1
Coleoptera (larvae)	1

In addition, 8 families of the class Acarina were represented. The mean number of arthropods per nest was 605 $\pm$ 96. The dipterans were the most abundant.

Discussion

All of the parasites so far identified have been reported elsewhere. Most previous studies are restricted to helminths (Wallace & Olsen 1963, Stanley & Rabalais 1971, and Cooper & Crites 1974) or blood parasites (McLaughlin 1968), and only one (Spory 1965) reports both internal and external parasites though this report is concerned mainly with the Acarina.

The percentage of birds found parasitized in the present study is greater than in any other report. This is partly due to the collection of both ecto- and endoparasites. As we can see in Figures 1 and 2 ectoparasites were most abundant when the birds arrived and shortly thereafter, while internal parasites were infrequent. The total parasite infection rate reflects the ectoparasite population at this time in the summer. Later the intestinal trematodes account for most parasites. The total curve reflects this most abundant parasite.

Other possible reasons for the increase in parasites in the breeding season may include: (i) differences in habitat and food supply available in the two seasons, (ii) intermediate host presence or absence from one location, and (iii) changes in the host susceptibility to parasites due to physiological changes occurring during the breeding season.

The dry weight of the gonads reflects the relative amount of sex hormone circulating in the blood. Peak levels occurred in Samples 3 and 4. In Sample 4 the highest intestinal trematode incidence was also observed though no similar trend occurs in the total parasite curve. If the sex hormone level was affecting any particular parasite, this could only be proven by concurrent hormone treatment and experimental infection with the parasite.

Nest insects include the dipteran family Ceratopogonidae which is known to include intermediate hosts for the blood protozoan parasite *Parahaemoproteus* (=*Haemoproteus*). As this blood parasite was found in the adult Red-winged blackbirds this may indicate that the parasite was acquired at nesting.

Summary

Seven samples of a total of 167 Red-winged blackbirds were collected during the 1975 breeding season yielding two species of cestodes, four of trematodes, four of nematodes, one acanthocephalan, one flea, three of lice, four (or more) of mites, one dipteran, and possibly two species of protozoan blood parasite. Total incidence of parasitism was 85% and the lowest incidence of 56% occurred immediately before migration south. Peak sex hormone levels were reached at Samples 3 and 4. Insects present in the nests included Ceratopogonidae some of which may be intermediate hosts for one species of blood parasite found in this host.

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Annual Primary Production of Epiphytic Algae in Crescent Pond, Delta Marsh, Manitoba

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Department of Botany

Introduction

The term epiphytic algae, refers to that group of algae colonizing the submerged portions of aquatic vegetation. In ecosystems such as Delta Marsh, with extensive areas of both emergent and submerged vegetation, the potential for a significant contribution to the overall primary production of the aquatic system by the epiphytic algal community exists. Information on this community is limited and production estimates are scarce. This scarcity reflects in part the technical difficulties associated with assessing epiphytic algal production. In 1973 a project was initiated with the aim of examining various aspects of the epiphytic algal community, including production rates. The primary production of epiphytic algae in a marsh pond has been estimated for the period June 1974 to June 1975 on the basis of artificial substrate colonization. It is this portion of the research project which is reported.

Sample site

Crescent Pond is located 1.6 km. west of the University of Manitoba Delta Marsh Field Station. The pond has a maximum surface area of 8.6 hectares and a maximum spring depth of 135 cms. It has no permanent surface connection with any other body of water. The pond water is alkaline and the seasonal pH ranges from 8.0 to 8.5.

Crescent Pond has an extensive littoral zone. The dominant emergent macrophyte is *Typha latifolia*, with narrow distinct zones of *Scirpus acutus* and *Phragmites communis*. The dominant submerged macrophyte is *Potamogeton pectinatus*, which occurs in abundance to a depth of 90 cms. To increase sampling efficiency, the *Typha* and *Potamogeton* sites were subdivided into low density and high density stands, yielding a total of 4 zones of emergent vegetation and 2 of submerged vegetation (Fig. 1).

Readings of light intensity directly above the water surface were made at various sites with a Weston Illumination Meter (Table 1).

TABLE 1. Relative light intensities 2 cms above water surface at various macrophyte sites, Crescent Pond, Delta Marsh

Site	Relative intensity
Open water	100%
Scirpus acutus	50%
Typha latifolia (low density)	80%
Typha latifolia (high density)	5%
Phragmites communis	2%

Methods

Experimental design

The experimental design is outlined in Table 2. In the emergent zone, a subsample or two-stage sample design with the condition of primary units of equal size was used. Primary units were transects 1/2 meter wide extending from the front edge to the back edge of the emergent zone in each stratum described above. Two primary units were established as permanent quadrats in each stratum on a random basis. Secondary units were defined as the number of 3 cm^2 areas available for colonization in each primary unit. Artificial substrates consisting of cellulose-acetate strips (60 x 5 cm), attached to a wooden frame with strips extending the length of the water column, were placed in a series perpendicular to the water's edge beside each primary unit. In the sampling procedure outlined below, the artificial substrate is equated with the submerged macrophyte surface area, more precisely, the secondary units. A simple random design was used for the *Potamogeton* sites. Locations of the artificial substrates were determined on a random basis.

Determination of submerged macrophyte surface area

The surface areas of *Typha*, *Phragmites* and *Scirpus* were measured directly in each sample period at the permanently established primary unit quadrats. Depth was recorded and the percent new area exposed in each sample interval was calculated to allow correction of primary production estimates.

The submerged area of *Potamogeton pectinatus* was determined on the basis of a surface area to dry weight conversion factor. The conversion factor calculated on July 19 was 0.673 cm^2 surface area/mg. dry weight (125°C for 12 hours) and on August 20 was 1.162 cm^2/mg. dry weight. To determine total submerged areas at each sample period, 3 randomly chosen 225 cm^2 quadrats were sampled in each of the two submerged strata and all submerged vegetation within each quadrat was removed. Material was washed, dried and weighed. Surface areas were determined by use of the appropriate conversion factor.

TABLE 2. Experimental design for estimation of epiphytic algal production; Crescent Pond, Delta Marsh

Site	Sample design	Colonizable surface area (cm^2/m^2 littoral zone)	No. of m^2 colonized by macrophyte in pond	N	n	M	m
Potamogeton I (high density)	simple random	8789-51022 cm^2/m^2	26854	A 78.7 x 10^6 642.4 x 10^6 3 cm^2 units	A 12		
Potamogeton II (low density)	simple random	1018-16969 cm^2/m^2	33628	A 11.4 x 10^6- 190.2 x 10^6 3 cm^2 units	A 12		
Scirpus	subsampling with primary units of equal size	12843-18525 cm^2/m^2	484	B 242 (½ x 4m quadrats)	B 2	4281 -6175 $3cm^2$ units	6
Phragmites	subsampling with primary units equal size	2229-4826 cm^2/m^2	308	B 154 (½ x 4m quadrats)	B 2	742-3217 $3cm^2$ units	6
Typha I (high density)	subsampling with primary units of equal size	9204-10,794 cm^2/m^2	6192	B 1548 (½ x 8m quadrats)	B 2	12272 -14392 $3cm^2$ units	6
Typha II (low density)	subsampling with primary units of equal size	804-2149 cm^2/m^2	2736	B 684 (½ x 8m quadrats)	B 2	1075 -2865 $3cm^2$ units	6

NA = total number of units
nA = number from NA sampled
NB = total number primary units
nB = number primary units sampled
M = total number of subunits per primary units
m = number of subunits sampled per primary units

Production estimate

Production estimates were made at 2 - 4 week intervals from June - October 1974 and May - June 1975. The May - June samples represented algal colonization on submerged surfaces of the previous year's *Typha* and *Scirpus* after ice cover. After June, old stems fell to the sediment as decay progressed. No *Potamogeton* from the previous year was evident in the spring and *Phragmites* was ignored because of the negligible area submerged at this time.

The sample method for determining $^{14}CO_2$ uptake followed that outlined in a previous report (Hooper 1974), including corrections for new surface area available for colonization. In addition, at each sample period, samples of the artificial substrate were collected, scraped, filtered and stored in a desiccator for combustion in Perkin - Elmer Model 240 Elemental Analyzer.

Results

Initial analysis of data showed a variance to mean relationship indicative of a non-normal distribution. The relationship is described by Taylor's Power Law (Taylor 1961). Following appropriate data transformation (square root), a co-efficient of variation ($s/\bar{x}$) was determined for all sample values and averaged. The average co-efficient of variation applicable to all productivity values to be discussed is 31%.

Sample day productivity values for each site are given in Figures 2 - 5 on the basis of 100% daily solar radiation and on a common substrate area of 1 m^2. This allows direct comparison of sites and sample days. All substrates had maximum production rates in September and October. Fairly high production rates were observed at the *Typha* and *Scirpus* sites immediately after ice-melt. Seasonal results for all sites are summarized in Table 3. Production is expressed on the basis of unit surface area, unit of macrophyte area and total pond area. In 1974 the production per m^2 surface area was highest at the low-density *Typha* site, followed by the *Scirpus* site, the high-density *Typha* site, the *Potamogeton* sites and the *Phragmites* site, which was much lower than the preceeding sites. The most significant contributions to annual production were made by epiphytes attached to *Typha* in high density stands and to *Potamogeton*. The importance of these substrates is due to extensive areas of these species available for colonization by algae in Crescent Pond.

Results of organic C analysis are given in Figure 6. The seasonal trend of C and N follows the observed primary production rates. The average C/N ratio calculated was 9.3 with no obvious seasonal trends or substrate differences observed. Replacement times, calculated as the organic C/daily production value, give an estimate of the time necessary to replace the standing crop. (Table 4). In all sites except *Phragmites* the highest turnover times were observed in September and October. Very low productivity and standing crop at the *Phragmites* site result in ratios much more sensitive to minor fluctuation and so must be interpretated with caution.

TABLE 3. Primary production of epiphytic algae attached to macrophytes in Crescent Pond, June 1974 - June 1975.

Site	Production/m^2 surface area (mg C/m^2)	Production/m^2 macrophyte zone (mg. C/m^2)	Overall pond production (g.)
Scirpus	32,306	43,490	21,049
Typha (high density)	23,047	22,944	142,105
Typha (low density)	28,421	5,679	15,845
Phragmites	2,353	642	273
Potamogeton (low density)	7,854	11,785	396,138
Potamogeton (high density)	8,643	48,552	1,303,761
Total			1,880,988
Average per m^2 total pond area			26.8

TABLE 4. Replacement times for epiphytic algae based on monthly means.

Macrophyte site	Month	Replacement time (days)
Typha (high density)	July	8.0
	August	13.0
	September	8.8
	October	16.3
Typha (low density)	July	6.6
	August	7.0
	September	14.5
	October	19.0
Scirpus	June	9.1
	July	13.7
	August	12.0
	September	10.6
	October	22.3
Potamogeton (high density)	July	7.9
	August	4.5
	September	35.5
Phragmites	June	16.6
	July	61.5
	August	55.6
	September	5.4

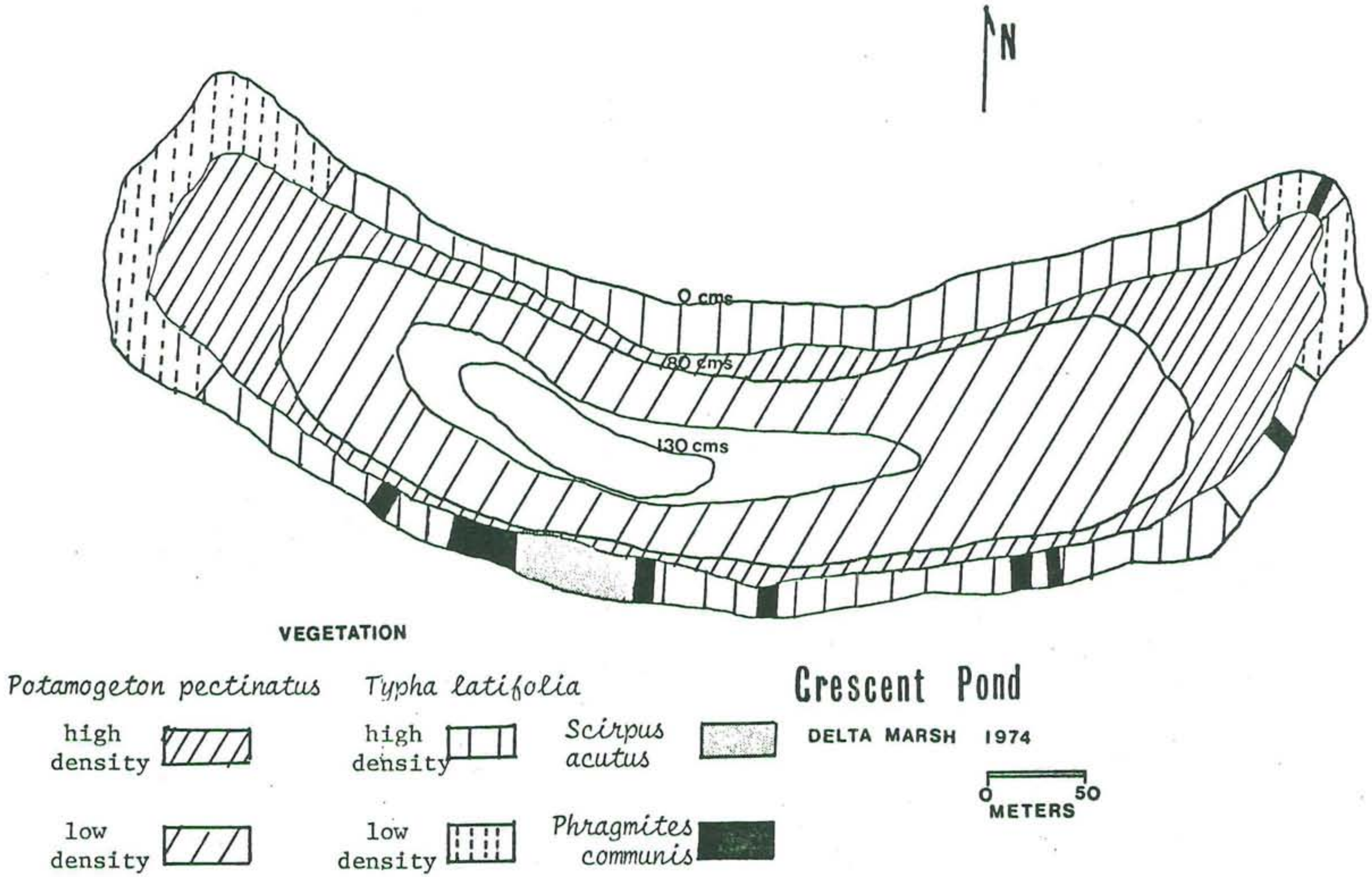

FIGURE 1. Vegetation map of Crescent Pond, Delta Marsh, Manitoba.

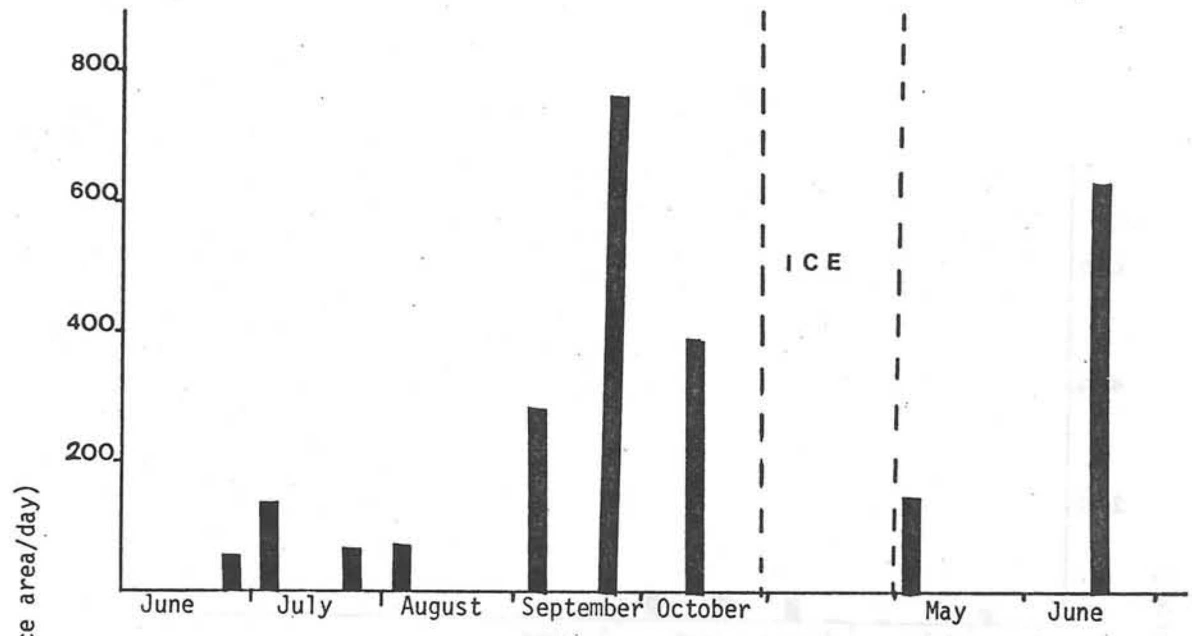

FIGURE 2. Seasonal primary productivity of epiphytic algae attached to artificial substrate at *Scirpus validus* site, Crescent Pond, June 74 - June 75.

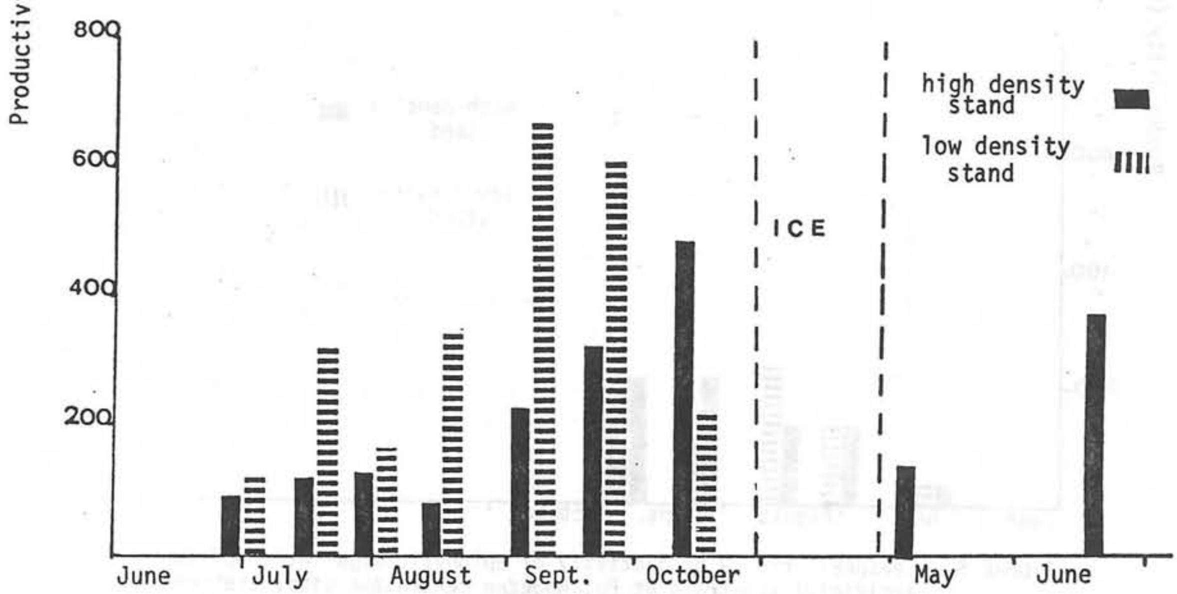

FIGURE 3. Seasonal primary productivity of epiphytic algae attached to artificial substrate at *Typha latifolia* site, Crescent Pond, June 74 - June 75.

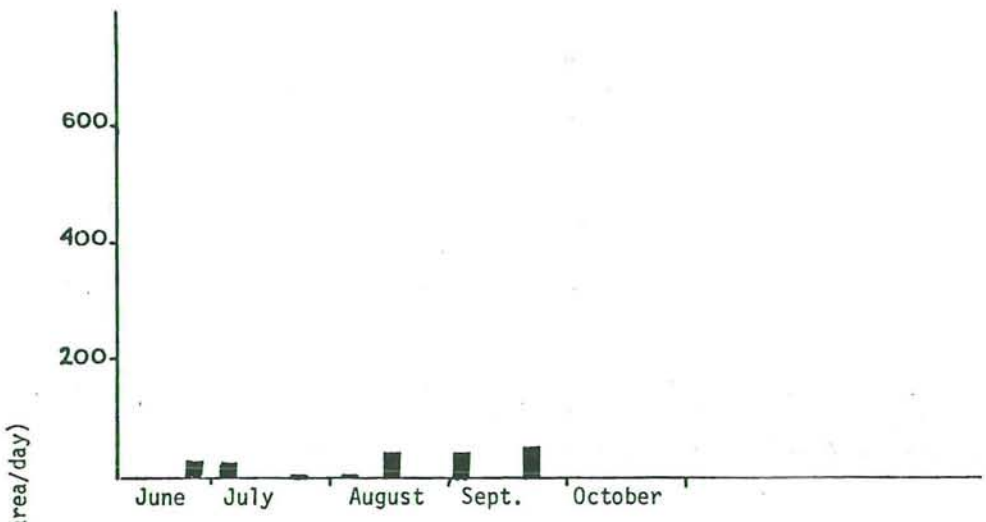

FIGURE 4. Seasonal primary productivity of epiphytic algae attached to artificial substrate at *Phragmites communis* site, Crescent Pond, June 74 - June 75.

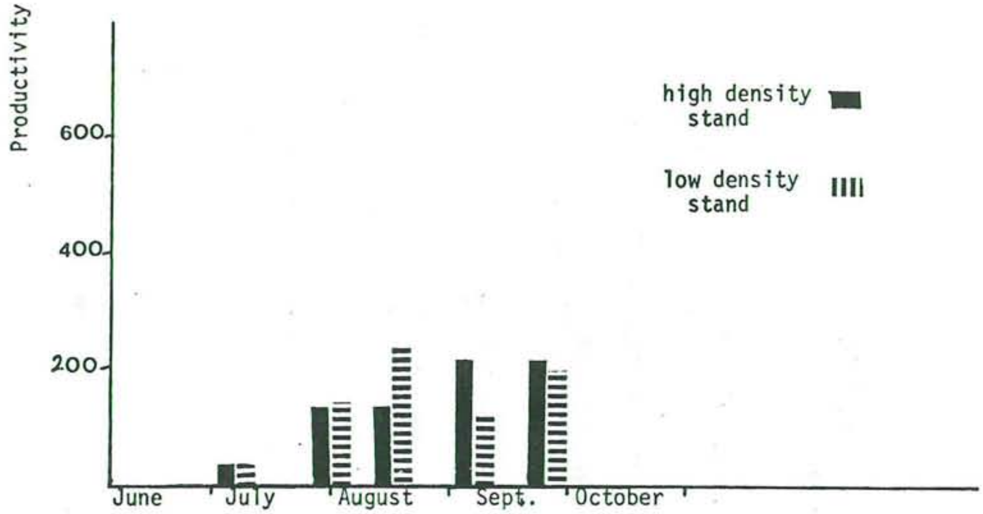

FIGURE 5. Seasonal primary productivity of epiphytic algae attached to artificial substrate at *Potamogeton pectinatus* site, Crescent Pond, June 74 - June 75.

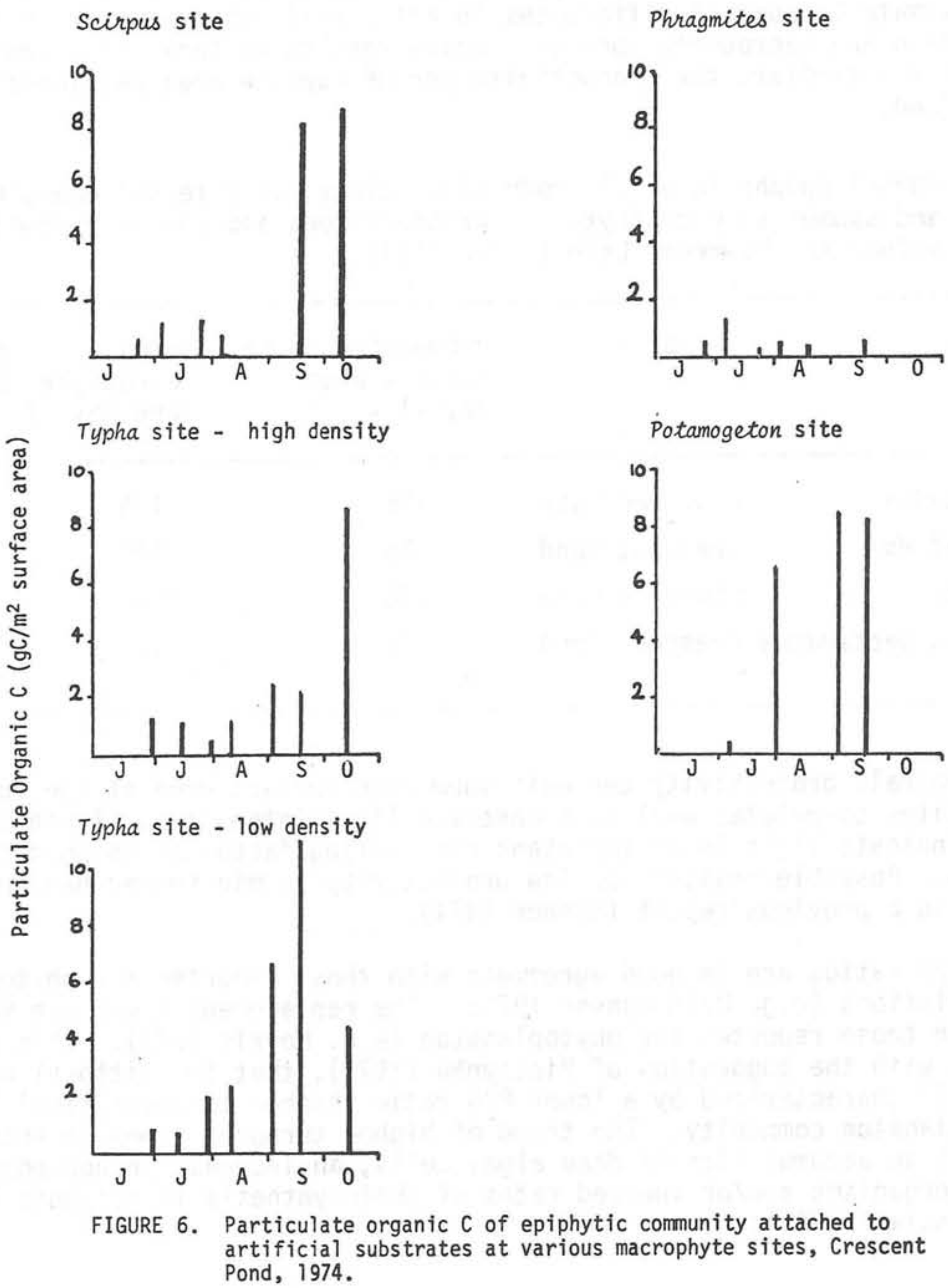

FIGURE 6. Particulate organic C of epiphytic community attached to artificial substrates at various macrophyte sites, Crescent Pond, 1974.

Discussion

Some aspects of the production estimate can be compared with estimates of epiphytic algal production of Allen (1971) (Table 5). The comparisons are approximate because of differences in artificial substrates, methodology site location and macrophyte species. While results in terms of overall pond production are similar, the productivity per m^2 surface area was lower at Crescent Pond.

TABLE 5. Annual epiphytic algal production values for selected emergent and submerged macrophytes in Crescent Pond and annual production values for Lawrence Lake (Allen 1971).

Macrophyte	Site	Production mg/m^2 surface ares day -1	mg/m^2 macrophyte zone day -1	gC/m^2 pond surface year -1
Scirpus acutus	Lawrence Lake	336	195	2.86
Scirpus validus	Crescent Pond	86	120	0.3
Najas-Chara	Lawrence Lake	258	1807	35.00
Potamogeton pectinatus	Crescent Pond	24	133	24.0

In general, productivity per unit submerged surface area at the various emergent sites correlates well with observed light intensities (Table 1). This may indicate light is an important controlling factor in epiphytic algal production. Possible reasons for low productivity in mid-summer have been discussed in a previous report (Hooper 1974).

The C/N ratios are in good agreement with those reported for phytoplanktonic populations (e.g. Holm-Hansen 1970). The replacement times are much higher than those reported for phytoplankton (e.g. Morris 1974). This is consistent with the suggestion of Pieczynka (1971), that the littoral algal community is characterized by a lower P/B ratio (higher turnover time) than the phytoplankton community. The trend of higher turnover times in autumn may reflect an accumulation of dead algal cells, an increase in non-photosynthetic organisms and/or lowered rates of photosynthesis in response to decreased solar radiation.

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Thermoregulation in the Muskrat, (*Ondatra zibethica*): A Field Approach

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Introduction

The present study is an assessment of the behavioral and physiological adaptations by which the muskrat maintains a favorable thermal equilibrium with its environment - both summer and winter. Behavioral aspects under consideration, include lodge and pushup construction, microclimate and daily activity patterns in relation to prevailing weather conditions. The physiological component of the study involves the measurement of deep body temperature under various natural and laboratory conditions as well as the metabolic responses of seasonally acclimatized animals to a wide range of air temperatures.

In 1975 the majority of the winter and summer field work consisted of monitoring daily patterns of behavior and deep body temperature in free-ranging animals. These studies were made in conjunction with the collection of microclimate data. During the past year, increased emphasis was placed on body temperature and metabolism studies of summer- and winter-acclimatized muskrats maintained under laboratory conditions.

Materials and Methods

I. Behavioral thermoregulation - Field studies

A. Microclimate

My objective here has been to evaluate the modification by muskrats of the microclimate, through the construction and occupation of shelters - both summer and winter. I have described the physical structures of the different types of shelters these animals utilize and the extent to which they change from summer to winter. Physical parameters examined include composition of the shelters and the spatial orientation of lodges and pushups with respect to one another and the surrounding emergent plant cover. A number of lodges and pushups and one burrow system have been measured and dissected to provide details concerning construction and internal configuration. In addition, the ambient temperatures (Ta's) of nest chambers, surrounding air and water were monitored at one-half hour and one hour intervals. As well as Ta, the CO_2 tensions within the nest chambers of lodges were examined on a seasonal basis.

B. Huddling response to cold stress

In order to assess aggregation responses in winter muskrats, as many animals as possible were live-trapped from a single lodge and equipped with intra-abdominal transmitters. These units which have been described elsewhere (Wang 1972), not only provided data on position, but were also used to monitor activity and deep body temperature (Tb). An attempt was also made in the winter of 1974-75 to relate fluctuations in nest Ta to the number of muskrats present, as determined by radio telemetry. An effort was also made to induce huddling in the laboratory and measure the possible metabolic efficiency of such behavior.

C. Body temperature in relation to behavior

To evaluate the contribution of spontaneous activity to Tb regulation, Tb and behavior were monitored simultaneously, with the aid of radio telemetry. Three basic methods of recording Tb and activity level were employed in the field. Firstly, a census technique was used in which as many animals as possible were located at periodic intervals throughout the day. A second method involved the continuous monitoring of activity and Tb from one animal for a duration of ½ - 4 hr. These "activity-Tb" runs provided subtle, moment-moment changes in Tb associated with short-term changes in activity level. A third technique involved the use of an automatic monitoring system. This system permitted the recording of activity and Tb from one animal at 4.5 - 5.5 min. intervals on a 24-hour basis.

II. Physiological thermoregulation - Laboratory studies

A. Oxygen consumption

In an attempt to measure possible seasonal differences in pelage insulation and basal metabolism, the oxygen consumption of seasonally acclimatized animals was measured over a wide range of Ta's (-15 - +30°C). The majority of the metabolic experiments were performed on wild muskrats within 15 days of initial capture. An open flow system incorporating a Beckman F3 Oxygen Analyzer was employed for this purpose. Metabolism measurements were made on single animals, as well as on groups of two, three and four muskrats respectively.

B. Body temperature

Body temperature measurements were made on captive animals in conjunction with the above metabolism studies. In addition, the rate of Tb cooling was examined in seasonally acclimatized animals, exposed to water temperatures ranging from +2 - +30°C.

Results and Discussion

A. Microclimate

Table I provides a summary of winter and summer lodge dimensions exclusive of data collected during the summer of 1975. Information is also available - both from direct observation and indirectly via telemetry, on the use of air spaces beneath the ice. The history of the development, use and eventual abandonment of pushup and in some cases, lodges, is also available. For instance, it was noted that as winter progressed, the internal structures of the lodges appeared to undergo a transition, involving the formation of one or more new nest chambers below the original one.

Automatic records of Ta were obtained from 5 lodges and 2 bank burrow chambers in summer. Winter Ta data are available for a total of 8 lodges and 4 pushups. Representative winter and summer samples of 24 hour recordings of Ta have been presented in an earlier report. In general, summer lodge temperatures varied between +15 and +28°C, while winter lodge Ta's varied between +0.5 and +20°C, depending upon surrounding air temperature, and the number and activity level of the animals occupying the lodge (Figs. 1 and 2 respectively).

A total of 34 measurements of CO_2 levels were made on 11 different lodges in the winter of 1974-75. The percentage composition of CO_2 in the ambient air of the nest chamber varied from less than 0.5% to 10.0%. CO_2 levels varied from 0.03% to 0.24% in 7 summer lodges sampled in 1975.

B. Huddling response to cold stress

To date, three basic lines of evidence have been obtained to support the contention that huddling occurs among muskrats in winter. First, the greater size of the winter nest chamber (Table I) may reflect a need for accommodating a larger number of animals in the winter nest. Secondly, a great deal of winter telemetry data has been gathered indicating the presence of from 2 - 6 inactive muskrats in a given lodge at a specific time. (Fig. 1) Thirdly, it has been possible to directly observe huddling in the laboratory.

C. Body temperature and activity

To date, telemetry data has been obtained from 12 free-living muskrats in summer (9 adults and 3 juveniles) and 18 muskrats in winter (adults and sub-adults). Representative samples of summer and winter patterns of Tb changes in relation to behavior have been presented in an earlier report. In summer, Tb generally increased slightly with swimming or feeding activity, and then dropped back to resting levels upon return to the lodge or burrow. It should be noted however, that the reverse pattern was sometimes observed in summer animals. The factors which determine the direction of Tb change associated with activity in summer muskrats are as yet undefined. In winter, short-term activity in water (usually less than 10 minutes) is frequently accompanied by a slight elevation in Tb. Longer periods of activity in water are generally characterized by a net decline in Tb. The amplitude of

TABLE 1. Summer and winter lodge dimensions (in inches)

		External Dimensions			Wall	No. of	Plunge	No.of	Nest Dimensions			Floor-H_2O
		Length	Width	Height	Thickness	Plunge holes	Hole dia.	Nests	Length	Width	Height	Distance
Summer Lodges (June 1- July 1,1974	Range	42- 92	32-66	15-28	5-12	1-4	4-6	1-3	6-11	6-10	4-7	1.5-8
	Mean	64.4	47.3	20.6	8.6	2.5	5	1.8	9.5	8.8	5.6	5.1
	n	11	11	11	10	11	2	11	20	20	16	14
Winter Residence Lodges (Nov.26,1974- April 13,1975)	Range	42-100	33-96	17.5-41	11-30.5	1-3	3.5-9	1-3	9-35	6-28.5	6-13.5	2-18
	Mean	64.7	57.7	27.4	18.0	2.2	6.4	1.2	19.3	14.5	8.9	9.9
	n	27	27	27	30	20	5	20	23	23	23	15
Winter Feeding Lodges (Nov.26, 1974- April 13,1975)	Range	21-44	12-37	8-17.5	3-14.5	1-2	4.5-10	1-2	9-26	7-21	5.5-18	0-10
	Mean	31.3	24.3	14	7.3	1.5	6.9	1.1	12.9	10	8.6	3.6
	n	23	23	21	24	24	12	24	25	24	25	16

Tb changes associated with spontaneous activity seldom exceed 2.0°C, either summer or winter.

One of the most interesting findings with respect to Tb dynamics, is the observation that Tb often increases dramatically just prior to an animal's exit from the lodge (Fig. 3). This observation has been made repeatedly by use of an automatic recording system. The occurrence of a similar pattern in summer animals is more infrequent, and Tb increases are generally of a lesser magnitude.

In winter animals a significant negative correlation ($r = -.63$; $P < .01$) was observed between the total time spent in the nest (on a 24 hour basis) and daily Ta, between November 5th and December 11th, 1975 (Fig.4). Also, an inverse relationship was noted between the daily frequency of foraging trips away from the lodge in winter and the mean duration of the individual trips (Fig. 5).

D. Laboratory studies of metabolism and body temperature

At the present time, no obvious differences appear to exist between summer and winter animals, with respect to oxygen consumption over the range of Ta's investigated. This is in agreement with the work of Hart (1962) and McEwan et al. (1974). Winter animals are however, far more resistant to Tb cooling during forced immersion in cold water, than are summer individuals tested under identical conditions. It should be noted that metabolism and Tb experiments are still in progress and rough analysis has been performed on only a small segment of the total data.

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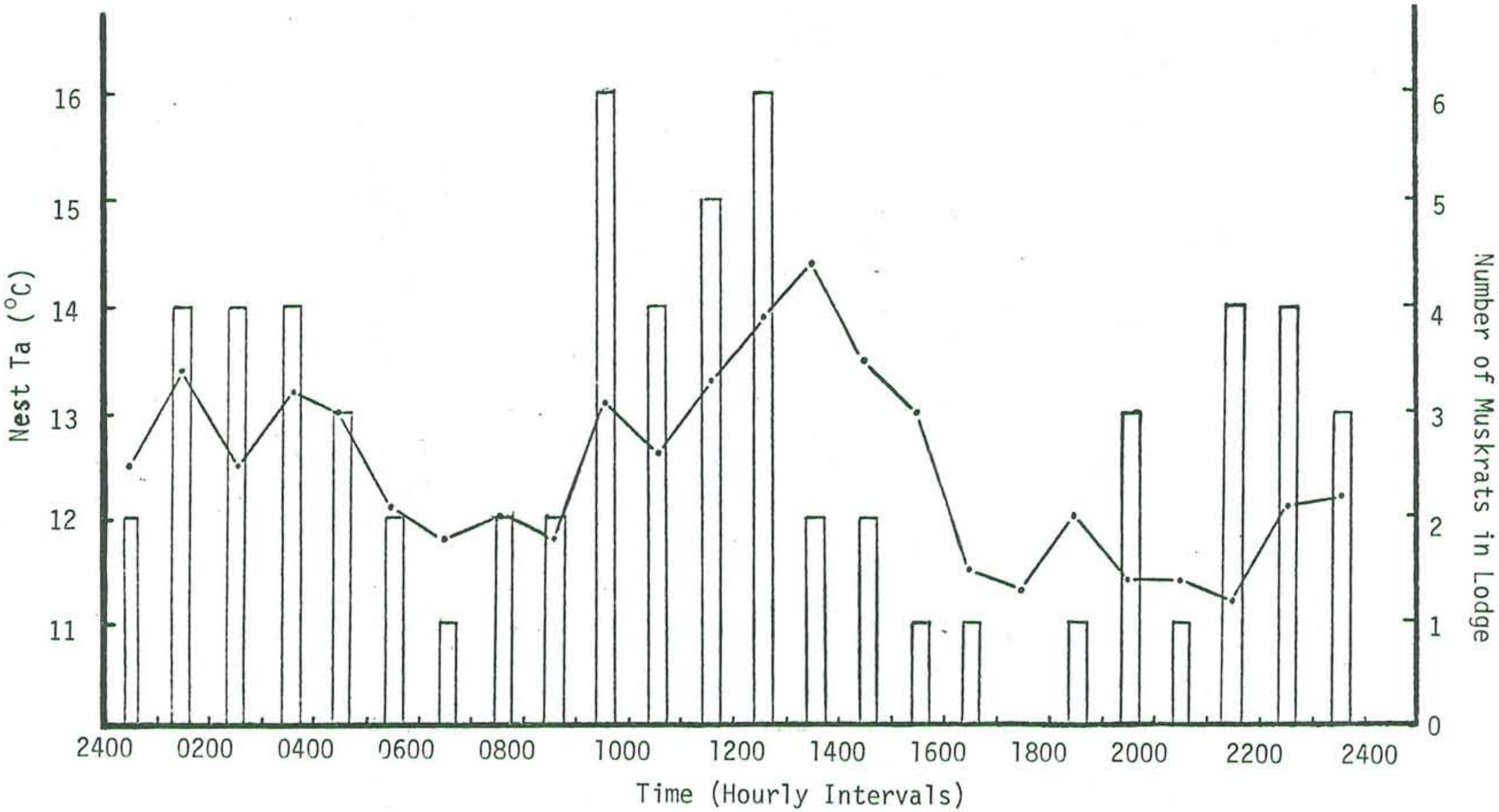

FIGURE 1. Hourly observations of number of radio-implanted muskrats in a lodge (vertical bars), and nest ambient temperature (single points) in the same lodge. Nov. 29-30, 1974.

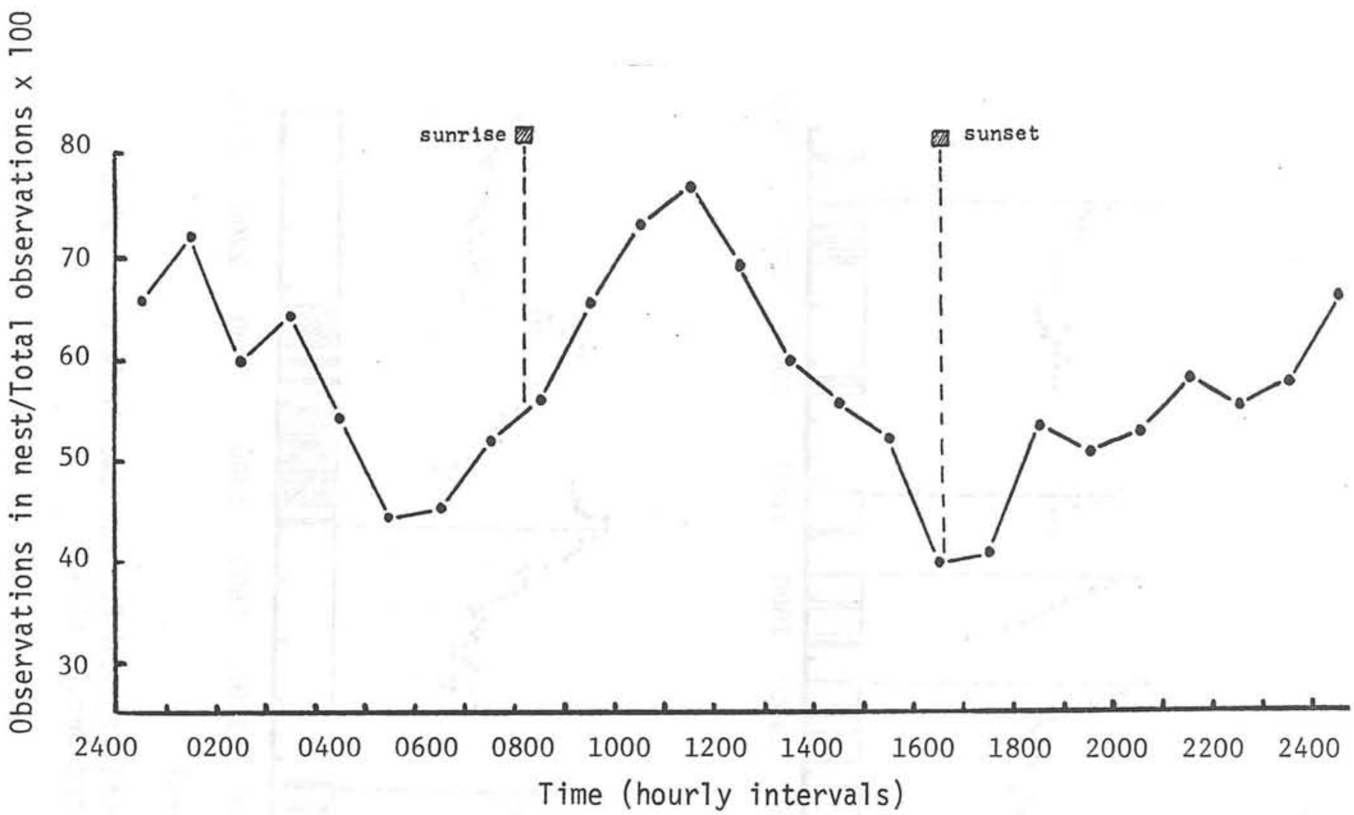

FIGURE 2A. Daily pattern of nest utilization by four muskrats in winter (Nov. 26-Dec.11; Dec. 27-Jan. 5). For each hourly interval, the percentage of total observations (made at 5 min. intervals) in which the animals were inactive in the nest have been presented (n=7, 421).

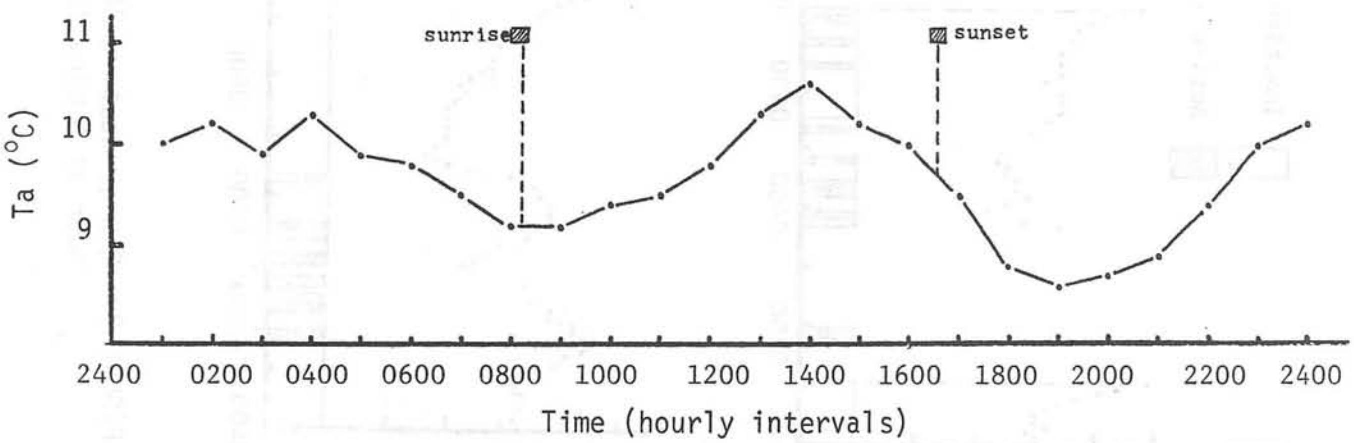

FIGURE 2B. Mean hourly ambient temperatures recorded from the nest chamber of the residence lodge inhabited by the same four muskrats (Nov. 26-Dec. 11; Dec. 27-Jan. 5 n=594).

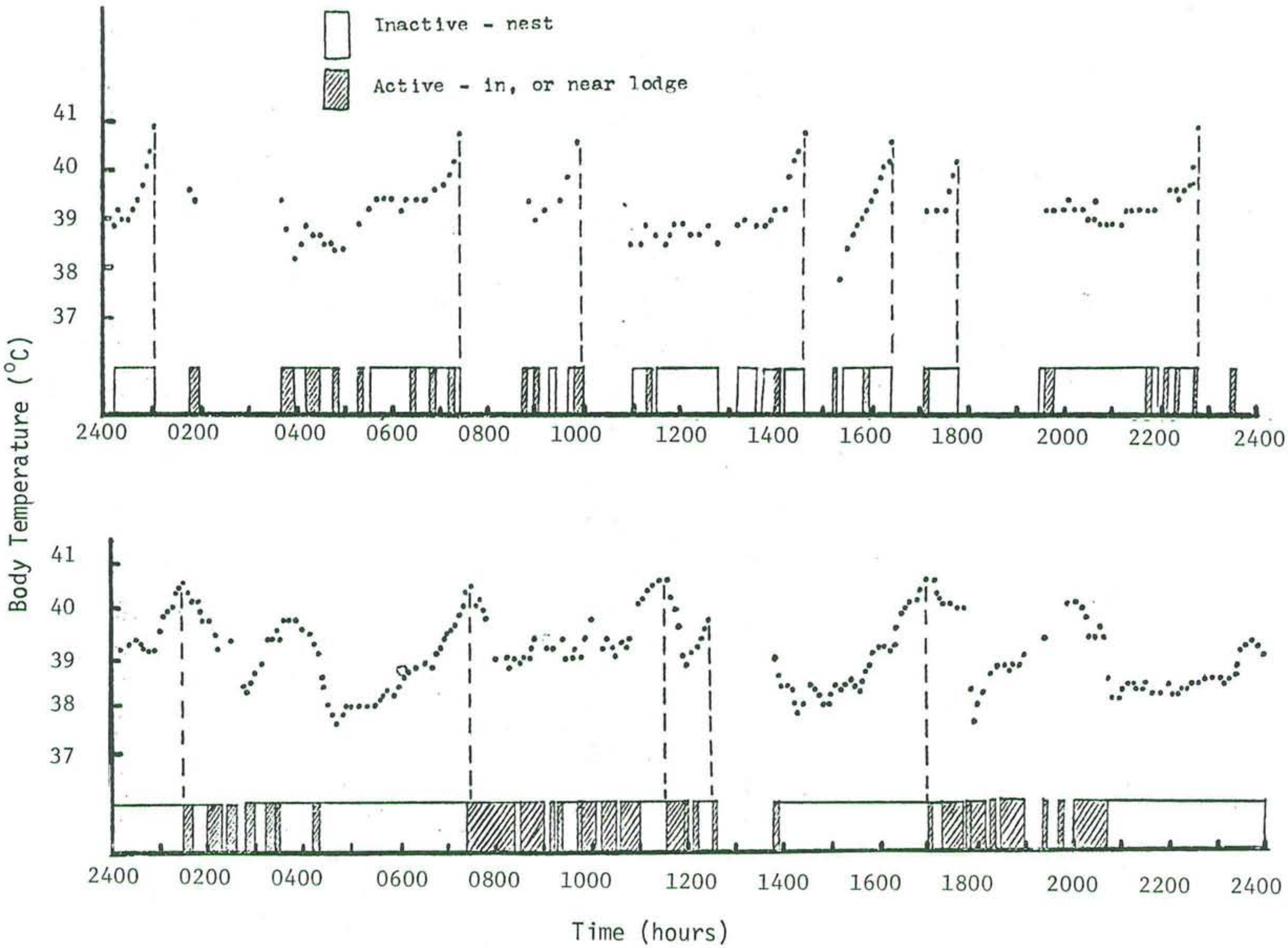

FIGURE 3. Representative 24-hr. records of activity and Tb from two different muskrats made at 5 min. intervals (Nov. 12 and Dec.2 1974)

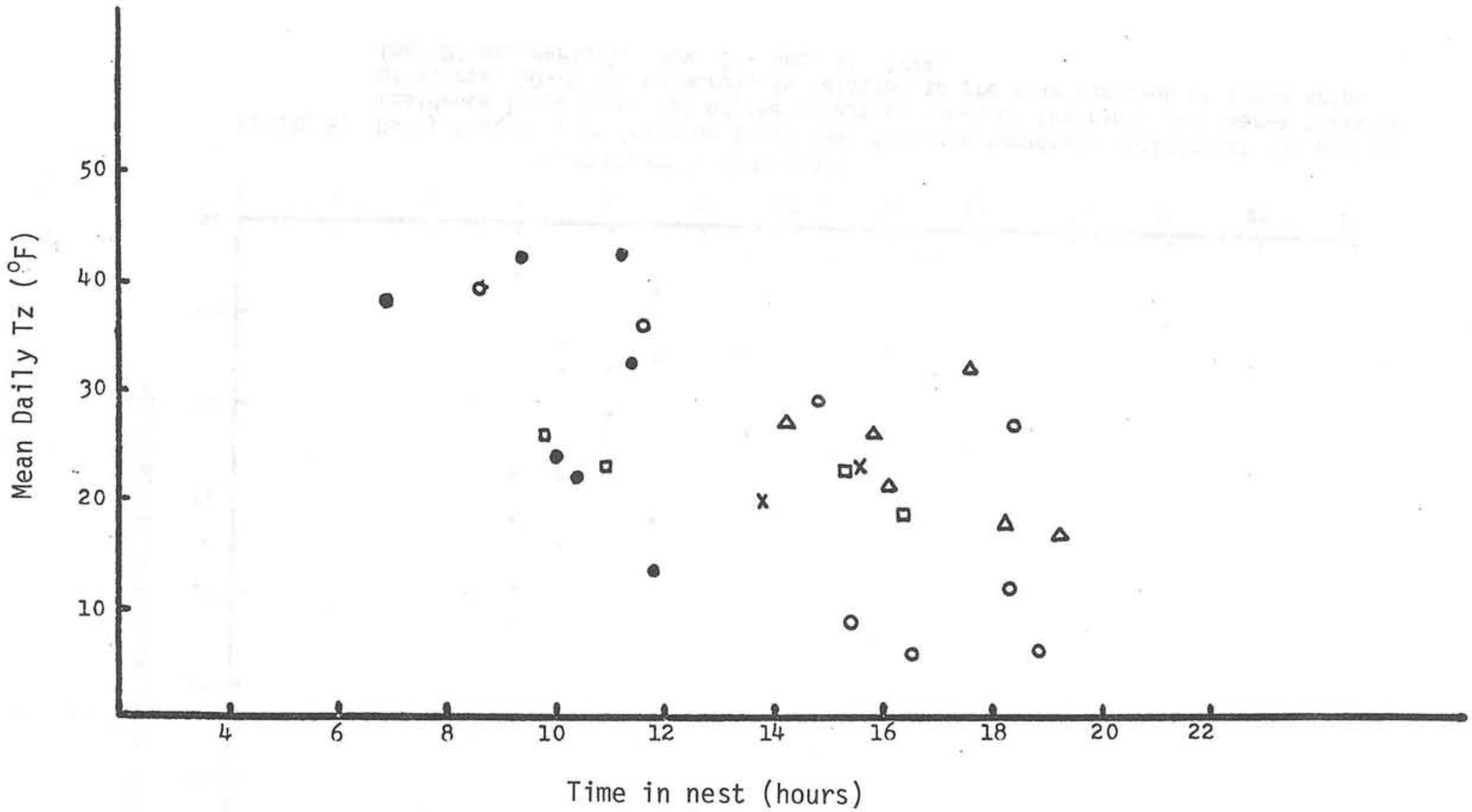

FIGURE 4. Total time spent in the nest chamber (per 24-hr. period) in relation to ambient air temperature (Nov. 5 - Dec. 11). The air temperature in this case is the mean of the daily maximum and minimum values recorded at the Delta Field Station. Each symbol depicts one of four muskrats.

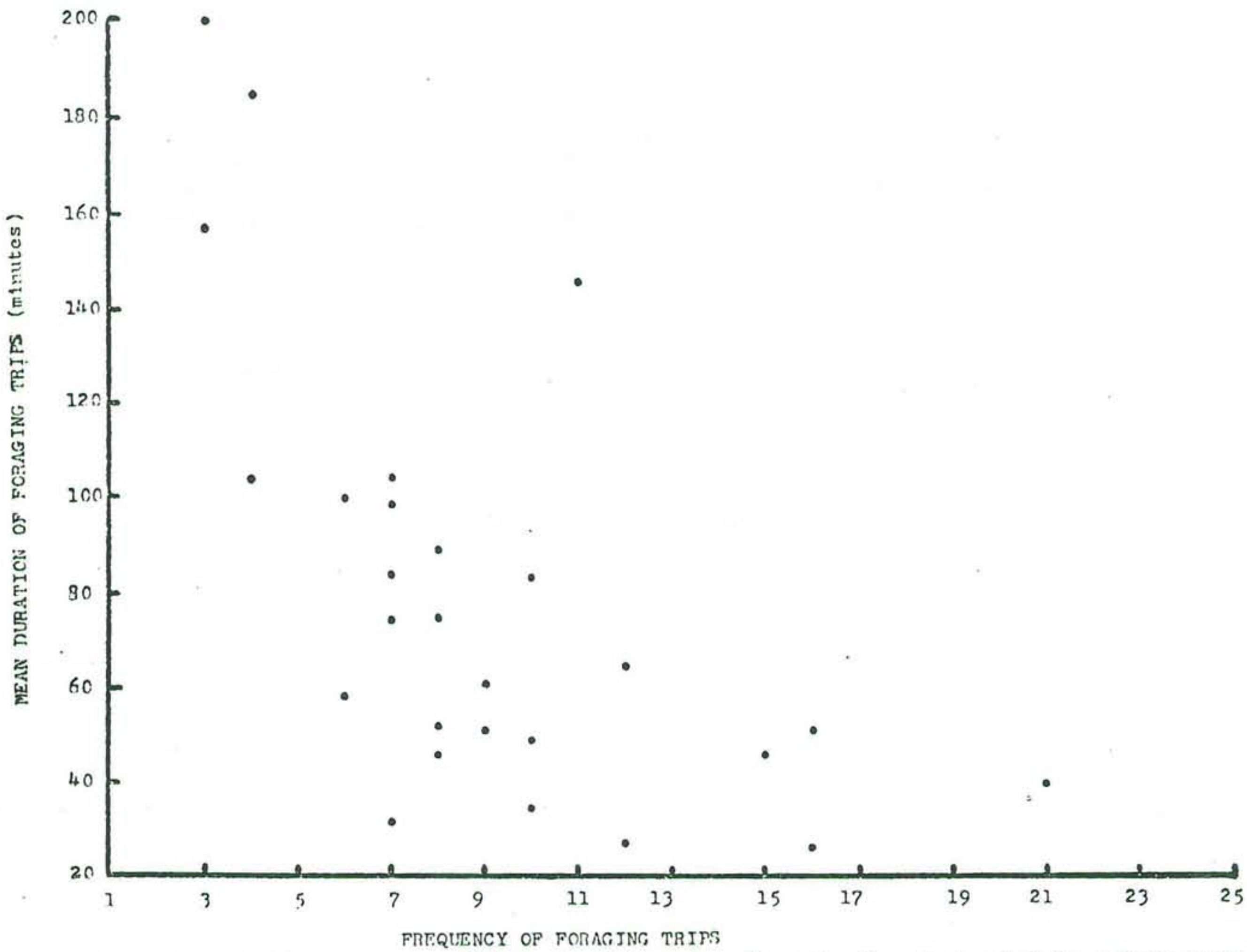

FIGURE 5. Daily frequency of foraging trips away from the immediate vicinity of the winter residence lodge (i.e. out of the reception range of the radio receiver-a distance of approx. 60-70 ft. or more), in relation to the mean duration of these trips (per 24-hr. period). Nov. 5 - Dec. 11 1974.

Post-breeding Biology and Migratory Patterns of the Ring-Billed Gull (*Larus delawarensis*) in Manitoba

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Introduction

Although the breeding biology of the Ring-billed Gull has been rather intensively studied the post-breeding biology is less well known. The Ring-billed Gull nests on insular colonies in many of the larger lakes in central and western Manitoba. The young are semi-precocial and remain at the colony for about six weeks (Vermeer, 1970). When they leave the colony they undergo an explosive dispersal (Cooke & Ross, 1970). One objective of this study was to chart the dispersal and the fall migration pattern.

The Delta Marsh provides excellent non-breeding habitat. The marsh provides many potential loafing sites and the peripheral beach and agricultural fields serve as excellent habitat for loafing and feeding. In addition Lake Manitoba provides the gulls with a secure roosting site. A second phase of the study involved an evaluation of the importance of the various sites to the gulls. Daily local movements were also noted.

Methods

Banding and color-marking of young gulls was conducted on five selected colonies in Manitoba: Rocky Lake, Kawinaw Lake, Dog Lake and at Overflow Point and Circle Islands in Lake Winnipegosis. Colonies were visited when most chicks were between two and four weeks of age. Vermeer (1970) found that mortality was highest for the two weeks following the hatch. A banding operation was conducted during that period and the disturbance resulted in increased chick mortality. Chicks and some adults (Kawinaw Lake) were captured by hand and banded with size five Canadian Wildlife Service bands. Banded birds were color-marked by applying a commercially available spray paint to the wings, breast and tail. The color used was indicative of the colony of origin. Chicks which did not possess a complete covering of juvenile contour feathers were not marked.

Ring-billed Gulls arrive at Delta in mid-April and move to the breeding colonies in early May. Gulls left the colonies and invaded Delta in late July. Flocks were counted on a daily basis. Location, time and age class composition were noted.

Two successful attempts were made to capture gulls at Delta, using a rocket net. A total of nine gulls (two adults and seven juveniles) were individually color-marked and released.

Eye color of captured and collected gulls was determined in the field by use of Munsell Soil Color charts. Photographs of the eyes were taken for comparison with the eye color of birds collected in 1974. Agfachrome 64 ASA color slide film was used throughout the two years of the study. Stomachs, wings, tails and gonads were removed from collected specimens for further analysis.

Results

The results of banding and color-marking are shown in Table 1.

TABLE 1. Numbers of Ring-billed Gulls banded and color-marked at six locations in Manitoba.

Location	Lat.-Long.	Number Juveniles	Banded Adults	Estimated Number color-marked
Kawinaw Lake	52°40'N- 99°20'W	1230	27	500
Rocky Lake	54°00'N-101°30'W	500	-	200
Dog Lake	51°00'N- 98°30'W	250	-	150
Lake Winnipegosis				
Overflow Point	53°00'N-100°20'W	182	-	150
Circle Islands	53°00'N-100°20'W	39	-	30
U.F.S.(Delta Marsh)	50°10'N- 98°20'W	8	2	10
	Totals	2209	29	1040

Band returns and color-marked sightings indicate that gulls from the Manitoba population migrate south easterly direction (Fig.1). This pattern seems to be in contradiction to the known ranges and migratory patterns of Ring-billed Gulls (Fig.2).

Ring-billed Gulls arrived at Delta before the break-up of lake ice. Numbers of gulls at Delta increased until about May 10 when most gulls left. This indicates that Delta serves as a stopover resting area for the gulls during spring migration. The departure date for the majority of gulls coincides with the final major break-up of lake ice at Delta.

In April and May of 1975 the gulls used two major areas of the Delta

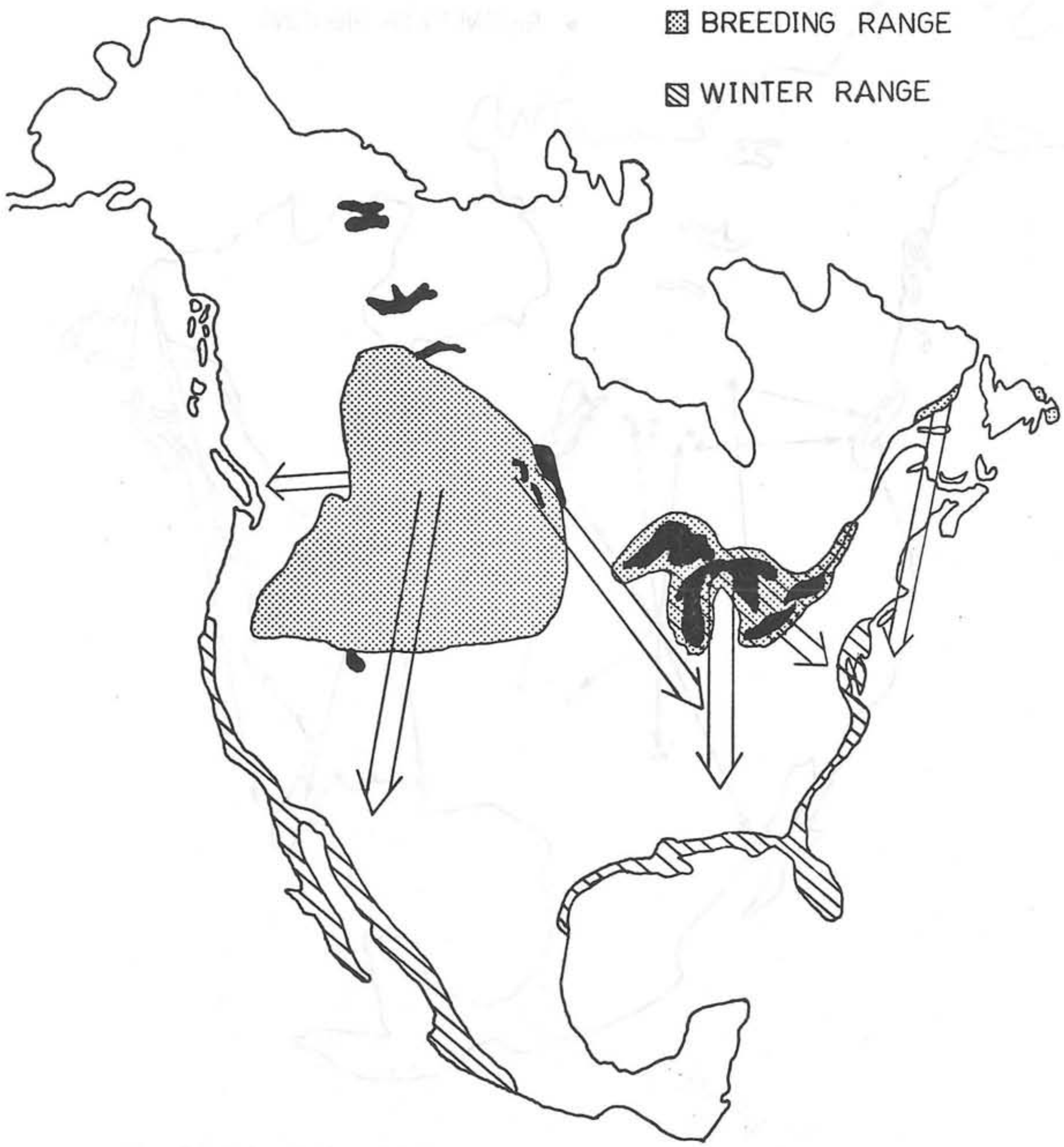

FIGURE 1. Range and migration routes of Ring-billed Gulls. Arrows indicate major migratory routes.

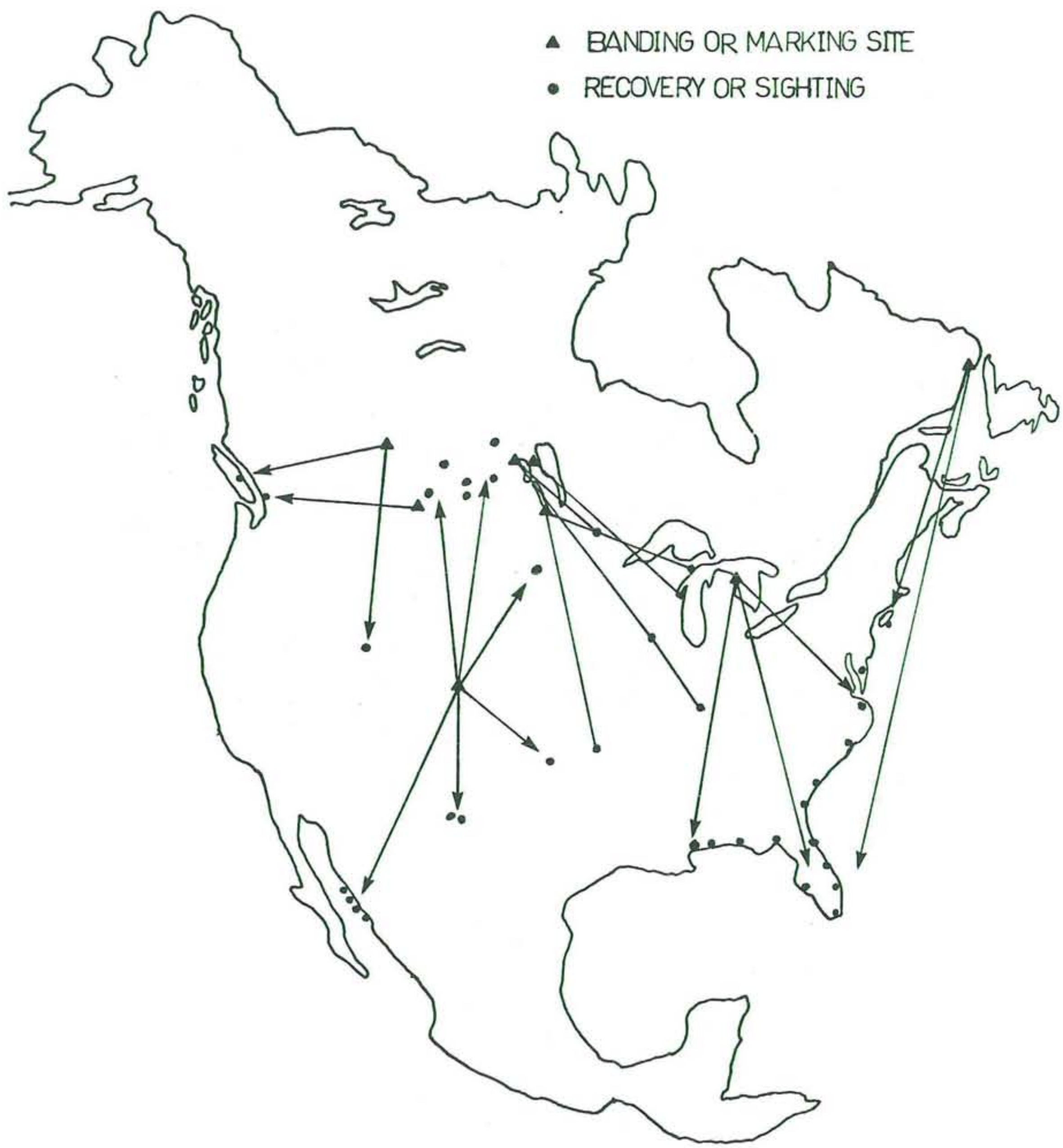

FIGURE 2. Band returns and color-mark sighting of Ring-billed Gulls in North America. (after Ryder, 1967; Southern, 1967; Evans, 1976; present study)

habitat, the edge of the offshore ice and the marsh borrow pits. Large numbers of gulls spent much of the day loafing and feeding along the ice edge and seemingly all gulls used this same area as an overnight roost. Many gulls made trips to the marsh borrow pits during the day. Food was abundant and readily available there due to large numbers of winter-killed carp which had been stranded in these pits in the May 1974 flooding of the West Marsh.

After May 10 few Ring-billed Gulls were seen at Delta. Two flocks of about 100 individuals seen feeding in tilled fields comprised almost all the gulls seen at Delta during the middle of May.

The first juvenile Ring-billed Gulls were seen at Delta on July 25. Numbers of gulls, both adult and juvenile, increased daily until mid-August. Gulls of both age classes utilized the beach and borrow pits for feeding and loafing, almost exclusively until mid-August. During this time few gulls were seen in the agricultural fields.

In late August numbers of gulls on the beach and in the marsh decreased and numbers in the fallow fields increased. Large numbers of gulls (up to 2500) were seen flying from Lake Manitoba to the fields around Westbourne, Manitoba each morning around sunrise. During the day there was significant movement within and between fields. There was very little movement back to the lake until sunset. Around sunset large flocks of gulls were seen moving back to the lake where they roosted overnight. These daily movements continued until early October when the number of gulls at Delta markedly decreased. This probably reflects the major fall migration.

Acknowledgements

I would like to thank the students and staff of the University Field Station whose assistance and friendship was greatly appreciated. Special thanks are due to Messrs. P. Ward, D. Busby, P. Goossen, D. Soprovitch, and Ms. S. Stumpf and also to my supervisor Dr. S. G. Sealy. Thanks are due also to the Manitoba Parks Branch and the Wildlife Research Branch for special assistance. Dr. R. M. Evans provided several of his own gull banding records for my use, thank you.

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Winter Dormancy in the Striped Skunk

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Introduction

Within all boreal regions organisms face the annual problem of surviving the late fall, winter and early spring period. This is the season that is least conducive to most species "normal" activities. There are, of course, numerous strategies for passing the winter period, even within a group such as the mammals. Of specific interest in the present instance are the adaptations of a group of boreal carnivores, widely known to become essentially inactive ("hibernate") for long periods during winter. Nearctic species commonly considered to display this feature are the black bear (*Ursus americanus*), grizzly bear (*U. arctos*), polar bear (*U. maritimus*), raccoon (*Procyon lotor*), badger (*Taxidea taxus*), and striped skunk (*Mephitis mephitis*). Recent research on physiological aspects of winter adaptation within these taxa has concentrated on the bears (Hock, 1960; Folk et al, 1970; Nelson et al, 1973); although some quantitative behavioral observations have been made recently on the raccoon (Cowan, 1973) and striped skunk (Sunquist, 1970; Houseknecht, 1971; Aleksiuk and Stewart, in prep.). The behavioral and physiological changes which these species undergo have been termed "carnivorean lethargy" (Hock, 1960).

The skunk feeds opportunistically on insects, small mammals, birds' eggs, fish, amphibians and carrion (Verts, 1967). An important feature of all these food items is their seasonality - in northern regions, such as the area where the present study was conducted, these food materials become almost totally unavailable between early November and April. At the same time, low ambient temperatures, snow and wind would probably increase the energy requirements of active skunks, both for thermoregulation and locomotion. These conditions would seriously worsen the unfavorable energy balance which the essentially aphagic animals must experience during this period. The species is thus expected to have evolved a strategy whereby limited energy reserves may be made to last through the entire winter. This report describes aspects of such a strategy, in terms of changes in daily and seasonal activity patterns, body temperature dynamics and fat storage.

Methods

Activity patterns

As previously described (Mutch, 1974), simulated dens were constructed within wire mesh enclosures for the purpose of maintaining a small colony of captive male skunks. Circadian activity patterns of individual animals were monitored by means of abdominally implanted clicker-type radio transmitters, between early November 1974 and mid April 1975. Between mid April 1975 and October 1975 activity pattern of captive male skunks were determined by means of visual observations on these animals. The observations were pooled for all captive individuals to give an hourly activity index (percentage of all observations in that hour when skunks were observed to be active) in each month. Monthly, and between November and mid April, weekly, diel activity indices (sum of hourly indices divided by 24) were calculated. The hourly activity indices of captive and free-ranging animals (Mutch, 1974) differed significantly (Student's t-test, $p < 0.01$) only in September (i.e., for those months when both forms of data were available).

Body temperature

The abdominal implantation of previously calibrated click-type body temperature transmitters and the method of monitoring these transmitters have previously been described (Mutch, 1974). Data collection continued for one, 24-hour period per week from early November to the end of April. The transmitters were then removed and recalibrated and appropriate correction factors applied to compensate for drift in the calibration curves. Body temperature data were collected on two adult male skunks in mid August 1975, using techniques similar to the ones earlier described.

Body fat

Total fat extraction (by dissolving the fat in serial changes of ethyl ether) was carried out on five adult males captured in October 1974 and five adult males captured in late April and early May 1975 (three of these animals had been maintained in captivity over winter.) After the removal of the fat the residue was dried to a constant weight.

Results

Changes in activity patterns

Seasonal changes in the activity patterns of captive skunks are very evident (Fig. 1). Four distinct seasonal patterns are recognizable. In summer (May, June, July, August and part of September) the animals were active on about 28 to 37% of the hourly occasions when observations were made. Between May and August, when nights were relatively short, this

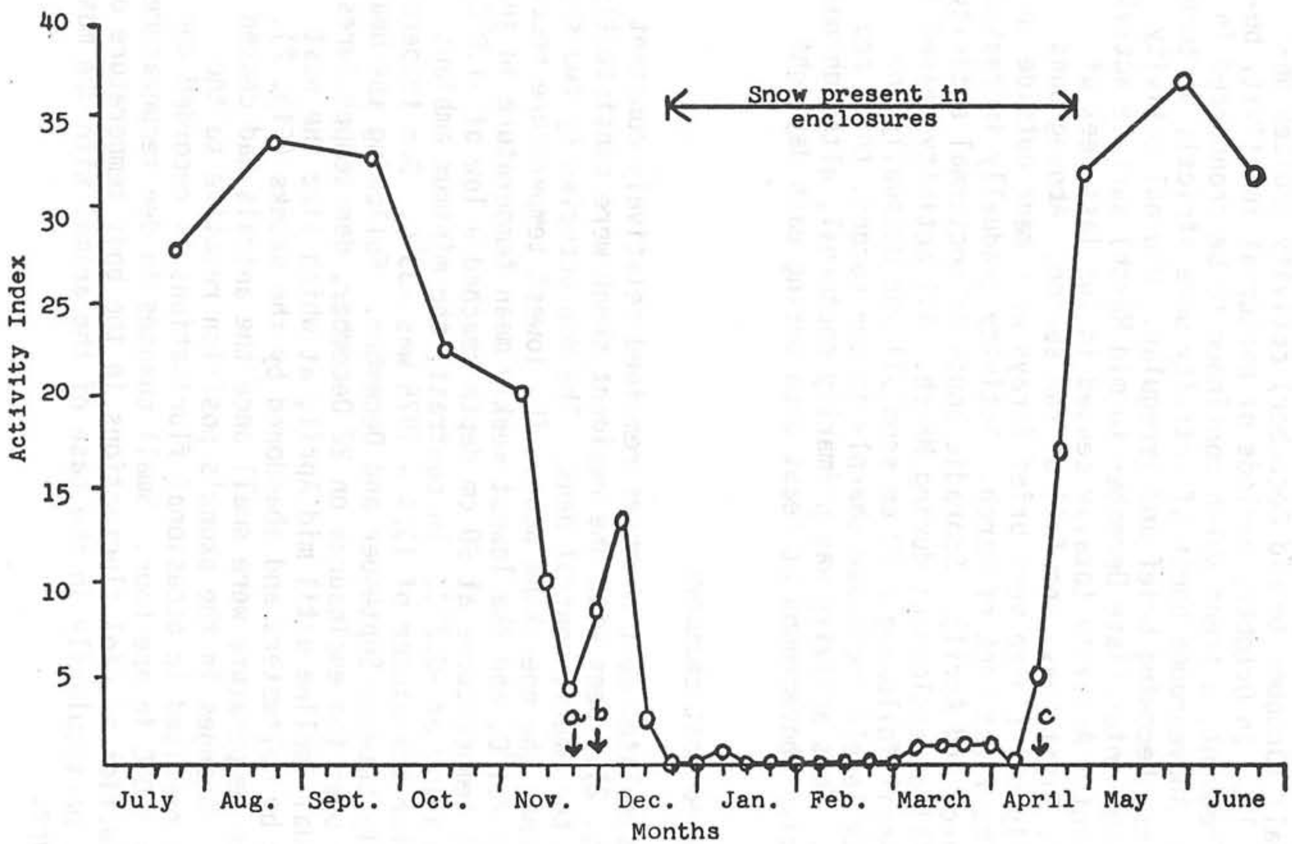

FIGURE 1: Changes in the surface activity of male skunks held in outdoor enclosures. The activity index represents the number of observations of active skunks made in each weekly or monthly period as a percentage of all observations made in that interval. Activity was monitored by radio telemetry and visually.

a = food reduced
b = food supply terminated
c = food supply returned

means that the animals were active during most of the dark period, at least to the extent that this can be determined by discontinuous observations. Skunks, both captive and free-ranging, were essentially nocturnal at this time. Activity commenced at approximately the time of sunset and continued, with the possibility of one or more short periods of inactivity, until first light. Between then and sunrise the decrease in activity indices was rapid, with only scattered surface activity during the hours of daylight, primarily before noon. During fall (October to mid December) activity indices decreased markedly (Fig. 1). In October, periods of nocturnal inactivity became longer and more frequent, a trend which continued to be pronounced in November and December. Aboveground bouts of activity were strictly nocturnal in the latter two months, becoming brief and irregular. Diurnal activity was nonexistant. During winter (late December to mid March) surface activity was virtually nonexistant. Activity totally ceased in the last week of December, following the first heavy snowfall of the season. Aboveground activity was essentially nil (three very brief forays were made outside in early January) until the first week of March. Activity gradually increased during spring (late March and April). Sporadic bouts of nocturnal activity occurred in the snow-filled enclosures during March. All activity ceased in late March and early April following a 30 cm snowfall and unusually low temperatures. Activity levels increased sharply in the second, third and fourth weeks of April. This activity was primarily nocturnal, although most of the skunks were active aboveground at least once during each daylight period.

Temperatures of simulated nest chambers

Temperatures of simulated nest chambers remained relatively constant during the winter (Fig. 2). Dens with one resident skunk were consistently about 3°C warmer than the empty, control dens. The den occupied by two skunks was about 4°C warmer than the one-skunk dens. The lowest temperature recorded in a one-skunk den was 2.1°C, and the lowest weekly mean temperature in such a den was 2.7°C. Soil temperatures at 90 cm depth reached a low of -1.0°C, and an unoccupied den a low of -0.3°C. In contrast, the minimum ambient temperature recorded for the winter of 1974 - 1975 was -35°C. Den temperatures dropped gradually between September and December. Following the heavy snowfall and drifting over the enclosures on 22 December, den temperatures underwent a very gradual decline until mid April, at which time the nest chambers were flooded by meltwaters and abandoned by the skunks (Fig. 2). Diel variations in den temperature were small once the animals had ceased aboveground activity. Changes in the skunk's position relative to the telethermometer probe resulted in occasional fluctuations in recorded den temperature of 0.5 to 1.0°C in one hour. Small changes in den temperatures were an apparent reflection of diel fluctuations in the body temperature of the skunk in the den, particularily in the case of the animal with the most labile body temperature.

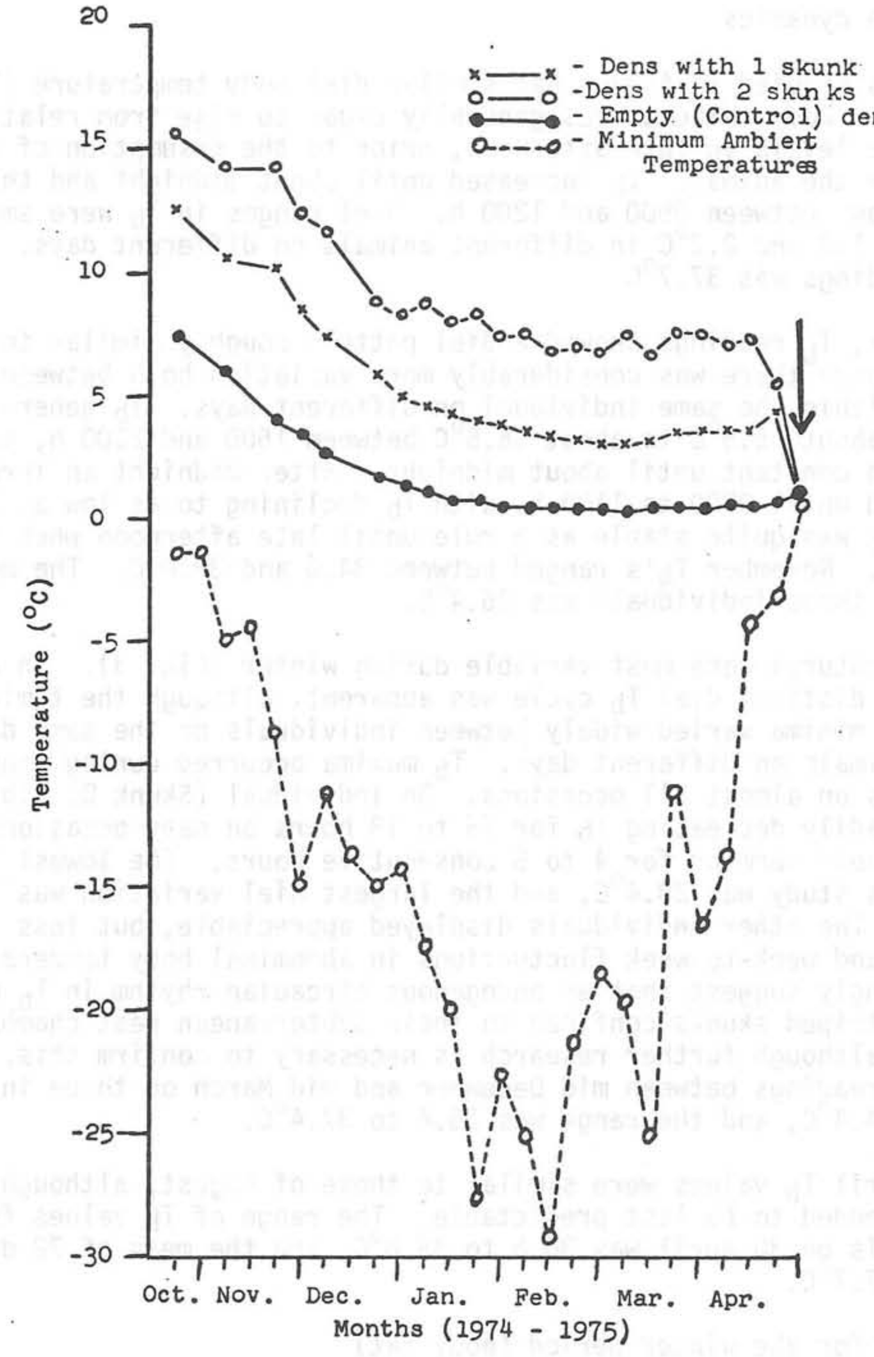

FIGURE 2: Temperatures of simulated nest chambers (control dens, dens occupied by one skunk, and den occupied by two skunks) and minimum ambient temperatures at the University Field Station, all for the period October 1974 to April 1975. Each den and soil temperature is the mean of 24 consecutive hourly readings. All ambient minima are weekly means. The arrow indicates flooding of the nest chambers.

Body temperature dynamics

Both skunks studied in August had similar diel body temperature (T_b) cycles (Fig. 3). Body temperatures generally began to rise from relatively constant daytime levels in late afternoon, prior to the resumption of outside activity by the animal. T_b increased until about midnight and then declined to a low between 0900 and 1200 h. Diel ranges in T_b were small, varying between 1.0 and 2.2°C in different animals on different days. The mean of 264 readings was 37.7°C.

In November, T_b readings showed a diel pattern roughly similar to that of August, although there was considerably more variation both between individuals and within the same individual on different days. T_b generally increased from about 35.5°C to about 36.5°C between 1500 and 2000 h, and then usually remained constant until about midnight. After midnight an irregular decline occurred until 0700 to 1100 h, with T_b declining to as low as 34.0°C on occasion. T_b was quite stable as a rule until late afternoon when the diel rise began. November T_b's ranged between 34.0 and 38.0°C. The mean of 192 readings on three individuals was 36.4°C.

Body temperatures were most variable during winter (Fig. 3). In almost all instances a distinct diel T_b cycle was apparent, although the timing of diel maxima and minima varied widely between individuals on the same day and for the same animals on different days. T_b maxima occurred during hours of outside darkness on almost all occasions. On individual (Skunk D, Fig. 3) exhibited a steadily decreasing T_b for 15 to 18 hours on many occasions, followed by a rapid warming for 4 to 6 consecutive hours. The lowest T_b recorded in this study was 28.4°C, and the largest diel variation was 7.2°C in one animal. The other individuals displayed appreciable, but less dramatic, diel and week-to-week fluctuations in abdominal body temperature. These data strongly suggest that an endogenous circadian rhythm in T_b may exist in male striped skunks confined to their subterranean nest chambers during winter, although further research is necessary to confirm this. The mean of 840 T_b readings between mid December and mid March on three individuals was 34.4°C, and the range was 28.4 to 37.4°C.

By late April T_b values were similar to those of August, although the diel patterns tended to be less predictable. The range of T_b values for three individuals on 30 April was 36.6 to 38.8°C, and the mean of 72 determinations was 37.7°C.

Energy reserves for the winter period (body fat)

Skunks undergo rapid fattening in summer and fall, and by September or October are generally very obese. Skunks are not known to store food for winter. Studies on other mammalian species which pass the winter without food indicate that depot fat reserves provide almost the entire winter energy supply (Nelson et al, 1973).

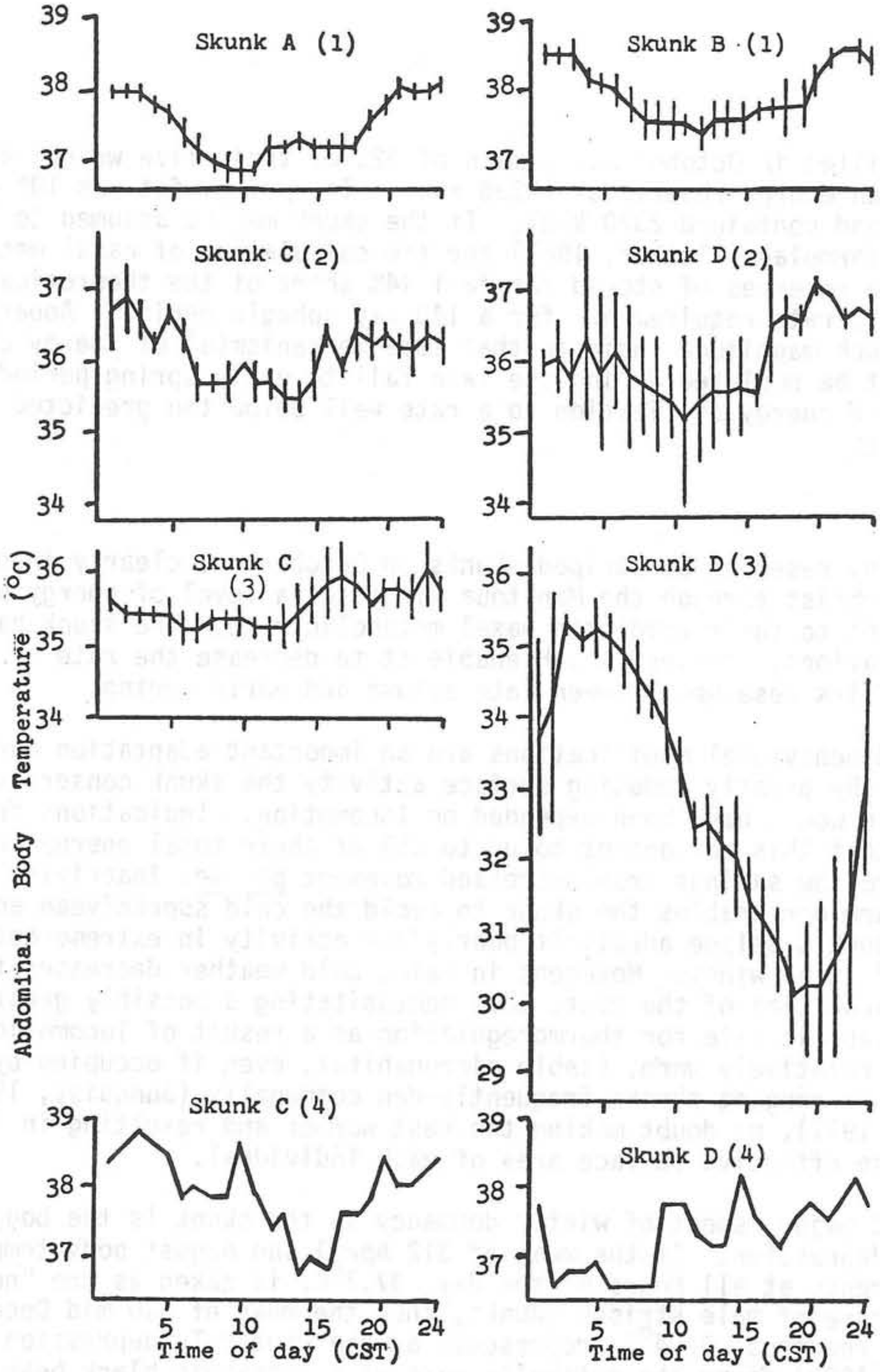

FIGURE 3: Diel abdominal body temperatures ± standard error of the mean of adult male striped skunks as determined by radio telemetry. Skunks A and B were monitored in August, and skunks C and D were monitored between November and April.

(1) August 10 - 17 (2) November 5, 19, 26
(3) February 18, 26, March 4, 11 (4) April 30

Skunks killed in October had a mean of 32% of their live weight as fat, representing an energy reserve of 12236 kcal. In spring, fat was 10% of live weight and contained 2370 kcal. If the skunk may be assumed to follow standard formulae (Kleiber, 1961) for the calculation of basal metabolic rate, then the reserves of stored fat fall 44% short of the theoretical basal metabolic rate requirements for a 140 day aphagic period. Apparent deficits of such magnitude indicate that some mechanism(s) of energy conservation must be employed during the late fall to early spring period in order to reduce energy utilization to a rate well below the predicted basal metabolic rate.

Discussion

The energy reserves of striped skunks in October are clearly inadequate for them to subsist through the Manitoba winter at a level of energy utilization equivalent to their predicted basal metabolic rate. The skunk has several adaptations, however, which enable it to decrease the rate of exploitation of its reserves between late autumn and early spring.

Profound behavioral modifications are an important adaptation during this period. By greatly reducing surface activity the skunk conserves energy that otherwise would have been expended on locomotion. Indications from other studies are that this may amount to up to 25% of their total energy budget. In addition to the savings from decreased movement *per se*, inactivity in a relatively warm den enables the skunk to avoid the cold supranivean environment. The skunk's pelage adapts it poorly for activity in extreme cold, especially if it is windy. Movement in calm, cold weather decreases the insulative capacities of the coat, thus necessitating a possibly greater increase in metabolic rate for thermoregulation as a result of locomotion. The den is a relatively warm, stable microhabitat, even if occupied by only one skunk. Free-ranging skunks frequently den communally (Sunquist, 1970; Houseknecht, 1971), no doubt making the nest warmer and resulting in decreases in the effective surface area of each individual.

A second major aspect of winter dormancy in the skunk is the body temperature depression. If the mean of 312 April and August body temperature measurements at all hours of the day, 37.7°C, is taken as the "normal" body temperature of male striped skunks, then the mean of 840 mid December to mid March readings, 34.4°C, represents a mean winter T_b depression of 3.3°C. Hock (1960) found the metabolic rate of a lethargic black bear with a probable T_b depression of 4 to 7°C was 50 to 60% of the normothermic rate. Folk *et al* (1970) described a 71 to 90% decrease in the resting heart rates of dormant black bears between September and December, with a 4°C drop in T_b. These data indicate that a small drop in T_b can be accompanied by profound decreases in the metabolic rates of lethargic bears. Skunks, which undergo similar decreases in T_b, can be expected to have significant decreases in metabolic rate.

Winter is an extremely critical period in the skunk's annual cycle of life in boreal regions. The strategy it has evolved enabling it to survive this period is quite recognizable. The first aspect of this strategy is the accumulation and storage of energy as fat during summer and fall. This is followed by a prolonged aphagic period when energy expenditure is markedly reduced by an almost total cessation of surface activity, a retreat to a relatively warm subterranean den and a depression in body temperature. This strategy is a key element ensuring the skunk's survival and success over a very large boreal region.

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Some Aspects of the Ecology and Management of *Chenopodium rubrum* in the Delta Marsh

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Introduction

Artificial manipulation of water levels is a basic practice in marsh management. The dyking, flooding and drawdown processes change the marsh environment and influence plant growth. Mud flat areas, the first to respond to water level fluctuations, are colonized by annuals, many of which are producers of waterfowl food and thus are of particular interest in marsh investigations.

Chenopodium rubrum and *Senecio congestus* are the two mud flat colonizers upon which this study focuses. Some aspects of the ecology and management of *Chenopodium rubrum* are here reported.

Methods

During the spring of 1975 sites that appeared to have the potential for *Chenopodium* growth were located and reference stakes installed for water level measurements. The progress of drawdown was monitored at approximately 10 day intervals throughout the season. Most of these sites were still flooded in late summer due to high water conditions and in general, only small natural populations of *Chenopodium* were found growing on marsh edges, in openings in *Scolochloa* meadows and in disturbed areas.

To assess seedling survival 100 25cm^2 wire quadrats were set within a *Chenopodium* population on August 5 and an initial seedling count made. Survival was determined on August 21.

Phenology and growth form of *Chenopodium* was investigated by following the performance of 20 plants from each of 8 populations. Measurements were made of plant height and horizontal diameter, leaves were counted, reproductive condition noted and degree of branching recorded on a relative scale from 0 to 5.

Concentrations of *Chenopodium* attract waterfowl, especially teal, during the fall migration, because of the desirability of the seeds as a food item. In conjunction with the Delta Waterfowl Research Station, four tracts of marsh were artificially manipulated by various sequences of burning or cutting, rotovating, flooding and draining, to set back succession and create habitat suitable for *Chenopodium*. Three of these sites were used to study the effect of seed density on *Chenopodium* production. Plots were delimited and sown with amounts of seed ranging from 0 to 500g/100m^2. The study sites were of variable size and this controlled the number of treatments that could be accommodated in each. The success of the treatments was assessed by harvesting the above ground standing crop in September when 10 1/16m^2 quadrats were clipped from each 100m^2 under investigation. All material was sorted and the number of plants and dry weight by species was determined for *Chenopodium rubrum*, *Phragmites communis*, *Typha latifolia* and *Scolochloa festucacea*. Presence or absence of other species was recorded and their total dry weight measured.

Round Pond East (RPE) was burned and rotovated in the fall of 1974. Spring standing water was pumped out by June 12, 1975. *Chenopodium* seed density treatments were applied to 5 400m^2 plots on June 16 and harvesting was conducted on September 13 and 14. The site was reflooded September 15. Round Pond West (RPW), also rotovated in the fall of 1974, was drawndown by June 20, 1975. This area was to be re-rotovated before planting, but due to wet conditions this was not completed until July 8. Seven treatments were randomly assigned to 21 100m^2 plots and seed broadcast on July 12. The harvest was made September 28 and 29 while the area was being reflooded. Akins Bay (Akins) was burned and rotovated and 4 seed treatments were applied to 10 100m^2 plots on July 24. The vegetation was harvested on September 11 while reflooding was in progress. Cook Creek West (CCW) was managed through the 1974 season. In 1975 it was allowed to drawdown naturally and was cut and then rotovated on July 11. This site was not planted. The harvest was conducted on September 22 while the area was being flooded. The two marsh edge sites on the south of Bluebill Bay (BE and BW) are used by waterbirds for resting areas. On September 4 and 9, 20 1/16m^2 quadrats were harvested from the *Chenopodium* zone of each of these loafing bars. Site locations are indicated in Figure 1. Soil samples were taken from these sites and were analyzed for pH, conductivity and organic matter.

The controlled water level study plots used during 1974 were reactivated in the spring of 1975. Additional plots were dug, fresh soil placed in each and a more effective pumping system installed. By mid-August this part of the study had to be reluctantly abandoned, for despite considerable expenditure of time and energy the effects of excessive precipitation could not be overcome. A field experiment initiated in two sites to investigate the influence on *Chenopodium* germination, of surface litter, especially algal scum, by comparison of raked with unraked portions was also abandoned because of flooding.

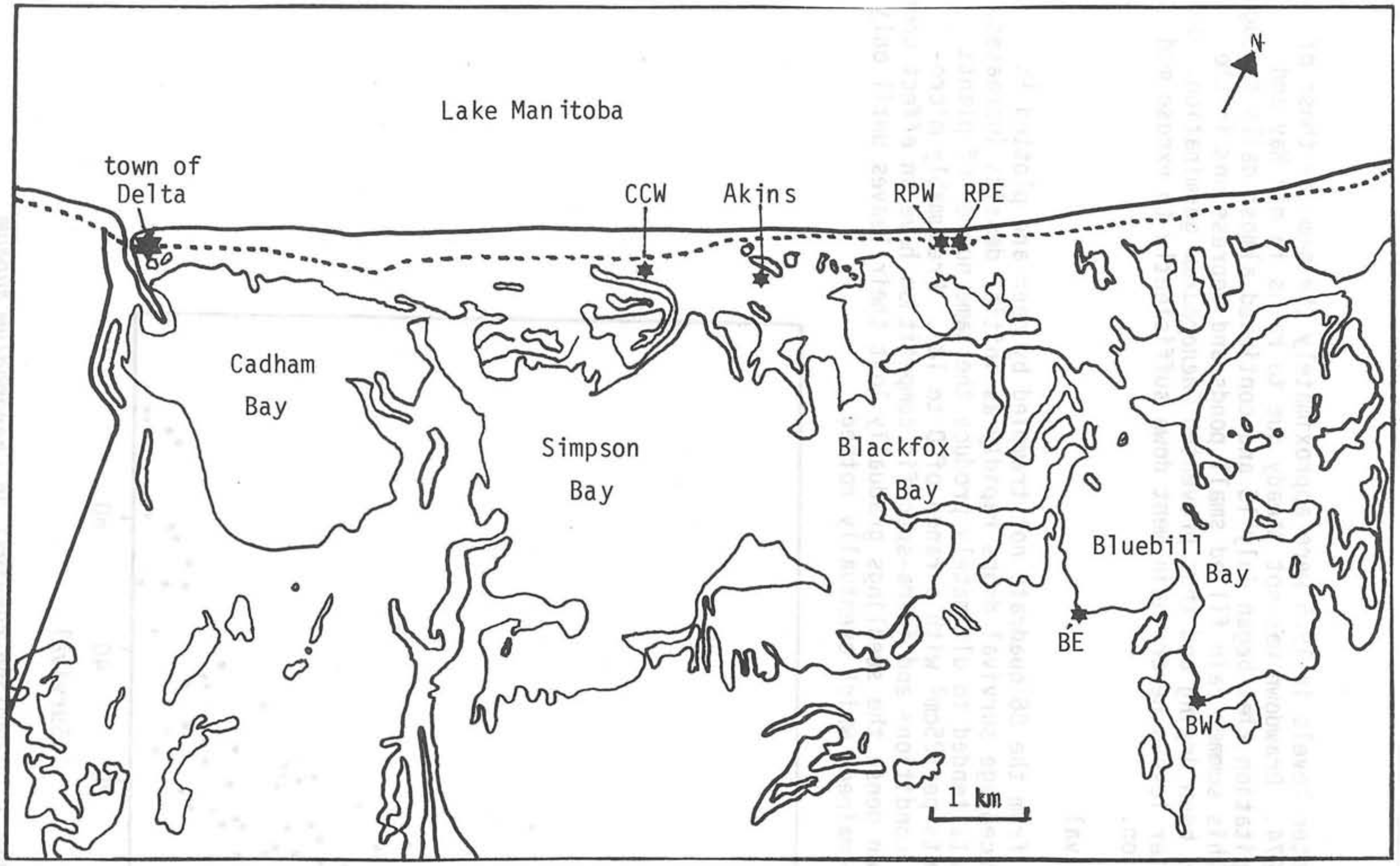

FIGURE 1. Map of part of the Delta Marsh showing location of major study sites.

Results and discussion

Water levels

Spring water levels in 1975 were approximately the same as those of the fall of 1974. Drawdown was not steady due to rains in mid May and further precipitation that began July 15 and continued almost daily throughout August. This summer rain filled small ponds and depressions in the marsh that had been drying and thus prevented *Chenopodium* germination. In most sites water levels never again went down sufficiently to expose mud for colonization.

Seedling survival

The data from the 86 quadrats not trampled by deer are plotted in Figure 2. Percentage survival drops rapidly as initial density increases. All the quadrats tended to ultimately produce the same number of plants ($\bar{x}$ = 4.63 plants per $25cm^2$ with a range of 0 to 18). Presumably micro-environmental conditions and intra-specific competition have an effect upon survival. When dense the seedlings gradually lost their leaves until only a bare stem remained, which eventually rotted.

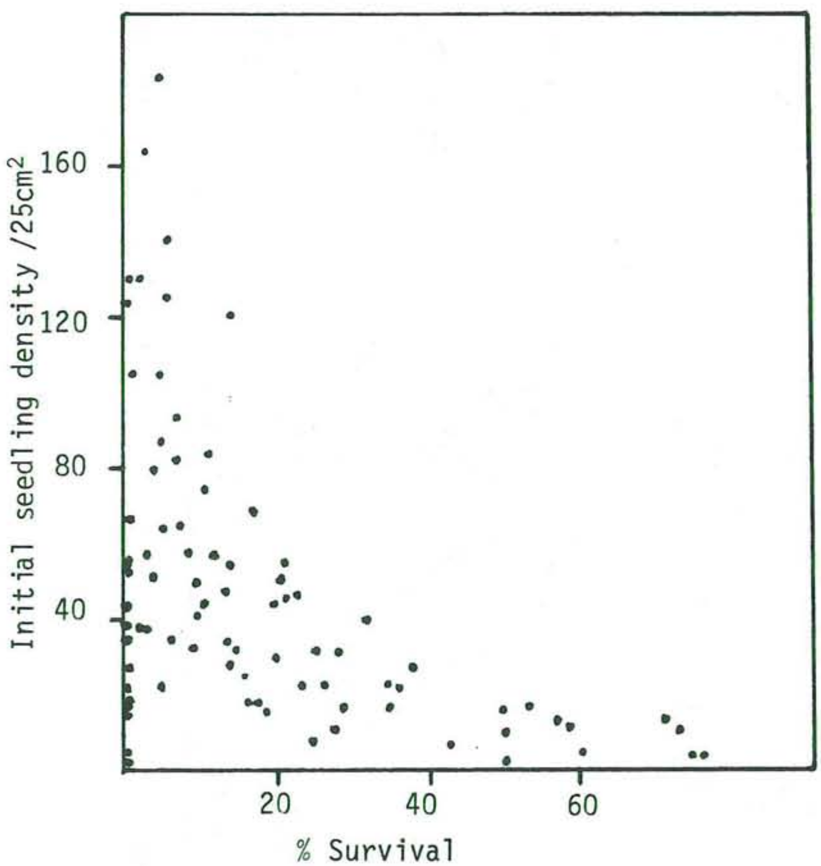

FIGURE 2. Seedling survival in *Chenopodium rubrum*

Plant performance

Many plants possess the ability to respond to environmental variation by differential expression of the genotype. This phenotypic plasticity was observed in *Chenopodium*. Figure 3, a 3-dimensional plot of plant height, horizontal diameter and branching index, suggests a phenotypic separation of populations. Populations 1 and 2, far from the others in form, are both from newly constructed dykes - high areas having good drainage. Populations 2, 3, and 6 were in close spatial proximity, but differed in time of exposure of the habitat and the subsequent moisture regime of the soil. Areas 2 and 6 were both available for colonization in mid June, but 6 was continuously waterlogged. Area 3 was exposed 3 to 4 weeks later and experienced an intermediate drainage regime. Populations 4 and 7 were 10m apart, but the individuals of group 7 were not allowed to germinate until several weeks after group 4. Populations 5 and 8 were found in very similar sites in *Scolochloa* meadows, but the soil at area 8 was continuously waterlogged after growth began.

It appears that time of germination and subsequent moisture regime are prime factors affecting the growth form of *Chenopodium* plants.

Harvest data

Only a preliminary analysis has been completed on some of the harvest data. Table 1 lists all the species found during the September harvest with their percentage occurrence. Differences in the species composition of the sites are apparent with RPE and RPW having a greater species diversity than any of the others. These two back marsh sites are within the beach ridge complex and thus invasion by a wide range of species is possible from the forest habitat.

Table 2 shows some of the differences between the sites in a little more detail. RPE produced a large number of *Chenopodium* plants per quadrat, but they were small and were only 3.7% of the total biomass. RPW nourished relatively good populations of moderate sized plants which made up a larger (37.9%) proportion of the total biomass. The differences in production between these two adjacent sites can be partly attributed to the management techniques used, RPW was re-rotovated in the summer before the seed was planted while RPE was not. This allowed the vegetation to become well established and was then aided by the fact that RPE was better drained than RPW which had standing water in depressions throughout the area.

The low productivity of CCW and Akins was a response to wet conditions - water remained on these sites through most of the growing season. At Akins *Chenopodium* was a prominent component of the vegetation while at CCW *Atriplex patula* was the dominant plant.

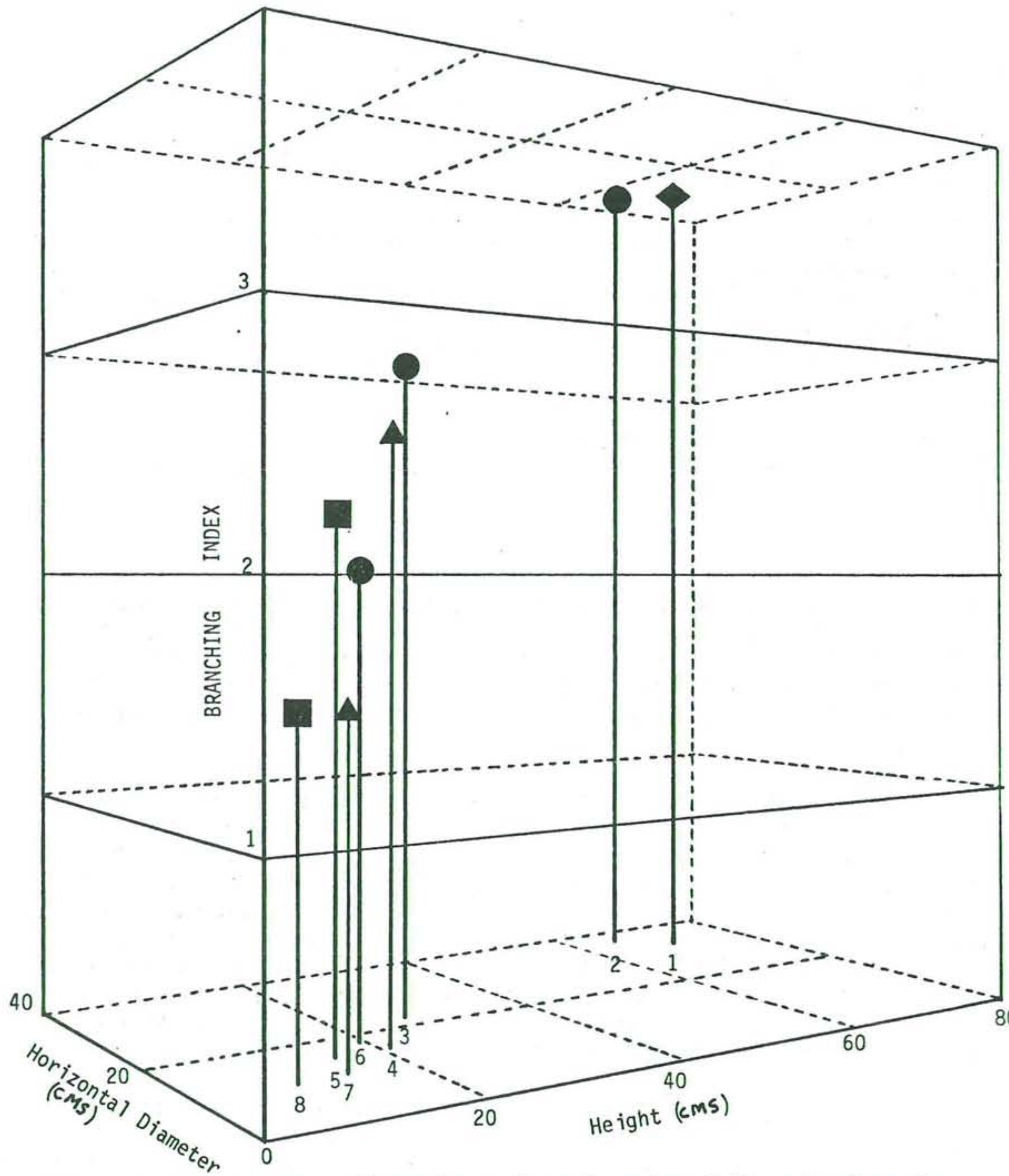

FIGURE 3. Growth form of *Chenopodium rubrum* shown in a 3-dimensional graph. Populations from adjacent areas are indicated with the same symbol.

TABLE 1. % occurrence of all species found in September 1975 harvest quadrats at 6 sites in the Delta Marsh

Species	RPE	RPW	AKINS	CCW	BE	BW
# quadrats	190	210	100	40	20	20
Agropyron repens						5
Aster brachyactis	6.3		25	25	100	65
Atriplex patula	50.5	16.6	48	77.5	65	95
Bidens cernua	22.6	22.4				
Chenopodium rubrum	61.6	78.1	50	35	90	65
Cicuta maculata			2			
Cirsium arvense	3.2	7.6	1			
Epilobium glandulosum var. *adenocaulon*	41.1	1.0				
Fragaria virginiana	5.3	3.3				
Galium trifidum	90.5	73.8				
Hordeum jubatum				22.5	30	40
Humulus lupulus						5
Impatiens biflora						5
Lycopus asper	23.2	0.4	7		5	25
Mentha arvensis	33.7	1.0				
Phragmites communis	71.6	54.2	12		20	70
Polygonum coccineum		13.8				
Ranunculus spp.	2.1	3.3	4			5
Rorripa icelandica var. *hispida*	25.8	47.6				
Rumex maritimus var. *fueginus*	2.1	7.1	3			
Scirpus acutus	5.3	2.3	1			
S. fluviatilis	77.9	63.3				
S. paludosus			10	20	20	
S. validus					10	40
Scolochloa festucacea		5.2	48	20		
Senecio congestus					25	15
Sium suave	3.7	1.4	1			
Sonchus arvensis	6.8	3.8	18	5	25	45
Stachys palustris	11.6	6.6	15			
Suaeda depressa	0.5		4	10		
Teucrium occidentale	0.4	0.4				
Typha latifolia	44.2	8.5	1		50	
Urtica dioica	5.3	1.0			15	90
Woody seedlings	2.1	7.6				
Total # of species	24	24	17	8	12	14

TABLE 2. Data for some plant species from quadrats harvested in 6 Delta Marsh sites, September 1975

MEAN VALUES/1/16m²								Weight of *Chenopodium* as a % of Total Biomass	% Empty Quadrats
	# of plants	Above ground biomass (grams)							
Species	*Chenopodium*	*Chenopodium*	*Phragmites*	*Typha*	*Scolochloa*	*Scirpus validus*	Total Biomass		
Site									
RPE	17.87	0.98	7.75	2.93	-	-	26.60	3.7	
RPW	9.62	2.57	2.32	0.04	-	-	6.47	39.7	
Akins	4.12	0.54	0.23	trace	0.35	-	3.16	17.1	22
CCW	1.2	0.12	-	-	0.21	-	3.90	3.1	10
BE	4.15	7.48	12.15	15.36	-	1.38	55.30	13.5	
BW	1.45	1.03	13.83	-	-	3.55	35.36	2.9	

The two Bluebill sites appeared very similar in the field, but the *Chenopodium* at BE was larger and more numerous than at BW. *Chenopodium* was only one of several species in the vegetation of these very lush loafing bars.

Analysis of variance completed for the planting experiment at RPW with respect to numbers and dry weight of *Chenopodium* per quadrat indicate that the variance among the treatments is not significant at the 5% level, while the variance among the plots is significant. The microtopography of the site caused so much variation in the results that the effects of the seed density treatments cannot be discerned Vehicle ruts made by the marsh tractors filled with water in the rains that began soon after planting and prevented uniform germination. It was apparent however, that residual seed was not lacking in the site as the control plots, which had no seed applied, produced just as much *Chenopodium* as the seeded plots.

Wildlife Utilization

The managed sites were flooded in the fall to attract migrating teal. Large mixed flocks of green- and blue-wing teal with mallards were observed to use the Cook Creek and Akins Bay areas in the latter part of September, but the Round Pond sites were never utilized. Possibly the heavier plant cover was not attractive to these birds.

Deer browsing sign was observed in October with patches of *Chenopodium* several meters square all eaten down to the same level. The large *Chenopodium* found along the dykes did not appear to be browsed.

The conditions most favourable for wildlife use appear to be open areas with *Chenopodium* growing in association with a few other species like *Aster brachyactis*, *Atriplex patula* and *Scolochloa festucacea*. Deer nibbled these plants, especially near their travel routes and ducks use those areas which are flooded in the fall.

Survey of the Parasitic Fauna of the Leopard Frog and Western Toad

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Department of Zoology

Introduction

In 1969 L. Hlynka initiated a survey of the helminth parasites of the leopard frog (*Rana pipiens* Schreber) and western toad (*Bufo hemiophrys* Cape) in the Delta Marsh. Mr. M. Quaye in 1970-71 studied in detail the lung parasites of these two amphibians. In 1974 B. Scaife carried out the second survey of the helminths in these amphibians. Last summer the survey of parasitism was continued, but broadened to include protozoan parasites. The purpose of the survey was to gain knowledge of the parasites of these amphibians which are major components of the marsh ecosystem, and to build a data base for the construction of a biological model of the host parasite relations of these organisms.

Methods

In 1969 eight samples of frogs and toads were taken. In 1974 and 1975 five samples were taken at monthly intervals from May to September (Table 1). Each sample consisted of 30 animals, 10 from each of three size classes. The first size class corresponds to juveniles, the second to mature adults of two overwinterings, and the third to those of three or more overwinterings.

Each animal was examined thoroughly for parasites. Parasites were preserved and a representative sample mounted for taxonomic purposes. Numbers and locations of the parasites in the host were recorded in field sheets and transferred later to computer data cards.

TABLE 1. Sampling

FROGS		TOADS	
Sample No	Dates	Sample No.	Dates
1	May 14 - May 27	1	May 13 - May 20
2	June 17 - July 1	2	June 9 - June 12
3	July 15 - July 24	3	July 20 - July 28
4	Aug. 11 - Aug. 13	4	Aug. 12 - Aug. 19
5	Aug. 30 - Sept. 19	5	Aug. 30 - Aug. 31

Results

Table 2 indicates that in 1975 we recovered and identified to generic level 19 species of parasites. This includes 3 nematode species, 8 trematode species, 1 cestode species, and 7 species of protozoa. In addition to this list unidentifiable egg masses, which we believe are eggs of a cyclorrhapha diptera, were found.

TABLE 2. Parasites found

Location	Parasite	1969 FGS	1969 TDS	1974 FGS	1974 TDS	1975 FGS	1975 TDS
Lungs	*Rhabdias*	X	X	X	X	X	X
	Haematoloechus	X	X	X	X	X	X
Intestine	*Oswaldocruzia*	X	X	X	X	X	X
	Cephalogonimus	X	X	X		X	
	Glypthelmins					X	
	Ophiotaenia	X		X	X	X	
Rectum	*Cosmocercoides*	X	X	X	X	X	X
	Megalodiscus	X	X	X	X	X	X
	Opalina					X	X
	Nyctotherus					X	X
	Trichomonas					X	X
	Balantidium						X
	Cepedia			X(?)	X(?)	X	X
Blood	*Trypanosoma*			X	X	X	X
	Haemogregarina			X			
Kidney	*Echinostoma* (*Metacercaria*)					X	X
Body Muscle	*Alaria* (*Mesocercaria*)					X	X
Tympanum	*Halipegus*					X	
Bladder	*Gorgoderina*	X	X	X	X	X	

The trematodes, *Halipegus*, *Alaria* and *Echinostoma* were not found during the 1969 and 1974 surveys. *Halipegus* occurs in the tympanum of frogs and was found in only two frogs throughout the summer. Mesocercaria of

Alaria occurred at a high rate of incidence loosely encysted in the muscles of the frog and more rarely in toads. *Echinostoma* metacercaria were often encysted in the kidneys of young frogs and less frequently in toads. The definitive hosts for *Alaria* are foxes and dogs; and for *Echinostoma* are various birds and mammals.

The rectal protozoans, *Opalina*, *Nyctotherus*, *Trichomonas*, *Balantiduim*; as well as the bood protozoans *Trypanosoma* and *Haemogregarina* were not included in the previous surveys.

Discussion

We have in the past described the parasite populations by the mean number of parasites per host, per cent parasitism per sample, and per cent parasitism multiplied by the mean. These indices assume a normal distribution of the parasites, but this is not the case (Fig. 1). We note that the mean is 1.77, the range 0 to 13, and the median is 0. None of these parameters properly describe the data.

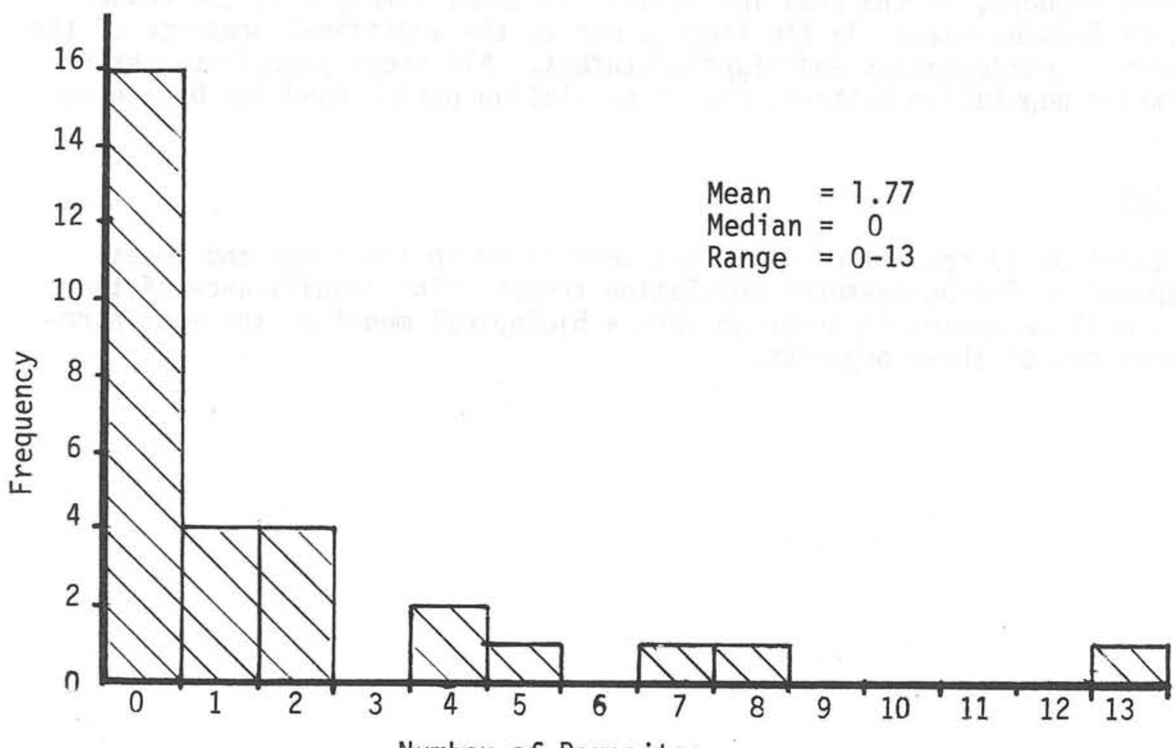

FIGURE 1. Frequency distribution for *Rhabdias* in frog sample No. 4.

The data appear to follow a negative binomial pattern. Analyses are underway and transformation of data will be necessary. We intend to compare seasonal abundance for each host, age class and sex.

Another area of investigation is the possible relationships between occurrence of parasites. For example, frogs and toads both have high incidences of *Rhabdias*, a nematode, and *Haematoloechus*, a trematode in their lungs. (Fig. 2 and 3) The mean numbers of each parasite are inversely related to each other. The rise in mid-July of *Haematoloechus* may reflect its annual cycle through its two intermediate hosts, the snail and dragonfly nymph, to its definitive hosts, the frogs and toads. The peak periods of the nematodes correspond with the low points in the trematode populations. Of additional interest is the inversion of the dominant parasite in the frog lung to that of the toad. The explanation lies in the more aquatic behaviour of frogs, which brings them in contact with the infective trematode cercaria.

A different type of parasitic relationship occurs in the intestinal tract (Fig. 4 and 5). Toads commonly contain *Oswaldocruzia*, a nematode, in their intestine. It reaches a maximum peak from late June to early July, after which a drop in the population occurs. This same nematode was present, in reduced numbers, in the frog intestine. It seems likely that the reduced numbers of *Oswaldocruzia* in the frog is due to the additional presence of the trematodes, *Cephalogonomus* and *Glypthelminthes*. All these parasites conform to a similar population pattern, with a population peak around the beginning of July.

Conclusion

A total of 19 species of parasites were found in the frogs and toads. These appear to follow seasonal population trends. The significance of the patterns will be tested in order to form a biological model of the host parasite relations of these organisms.

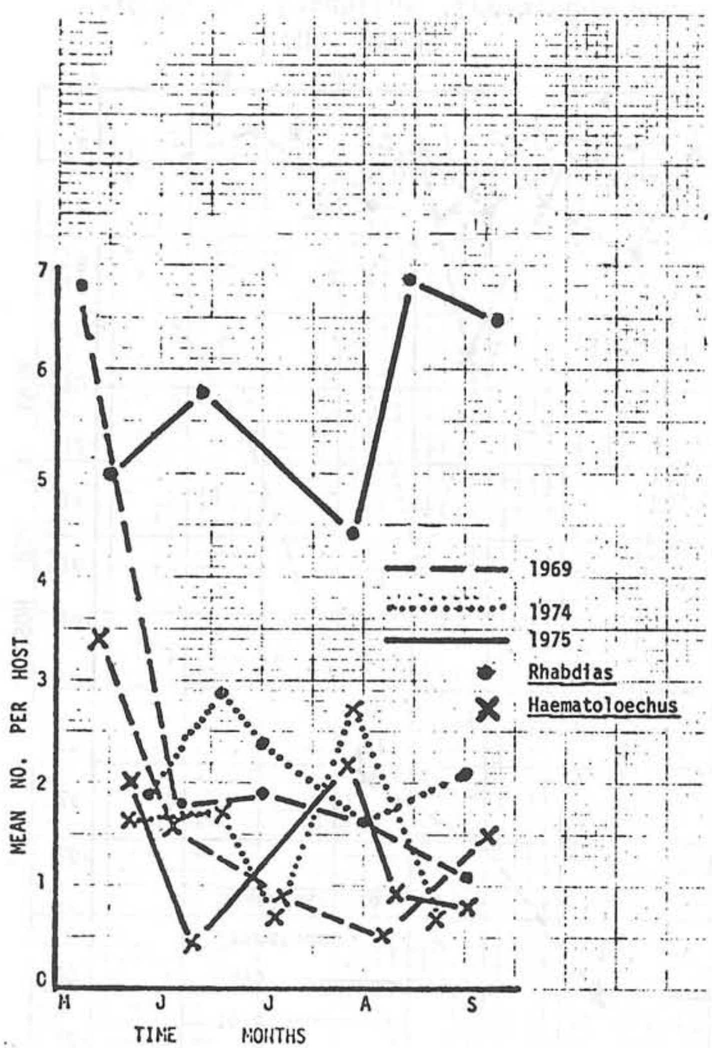

FIGURE 2. *Haematoloechus* and *Rhabdias* in toads.

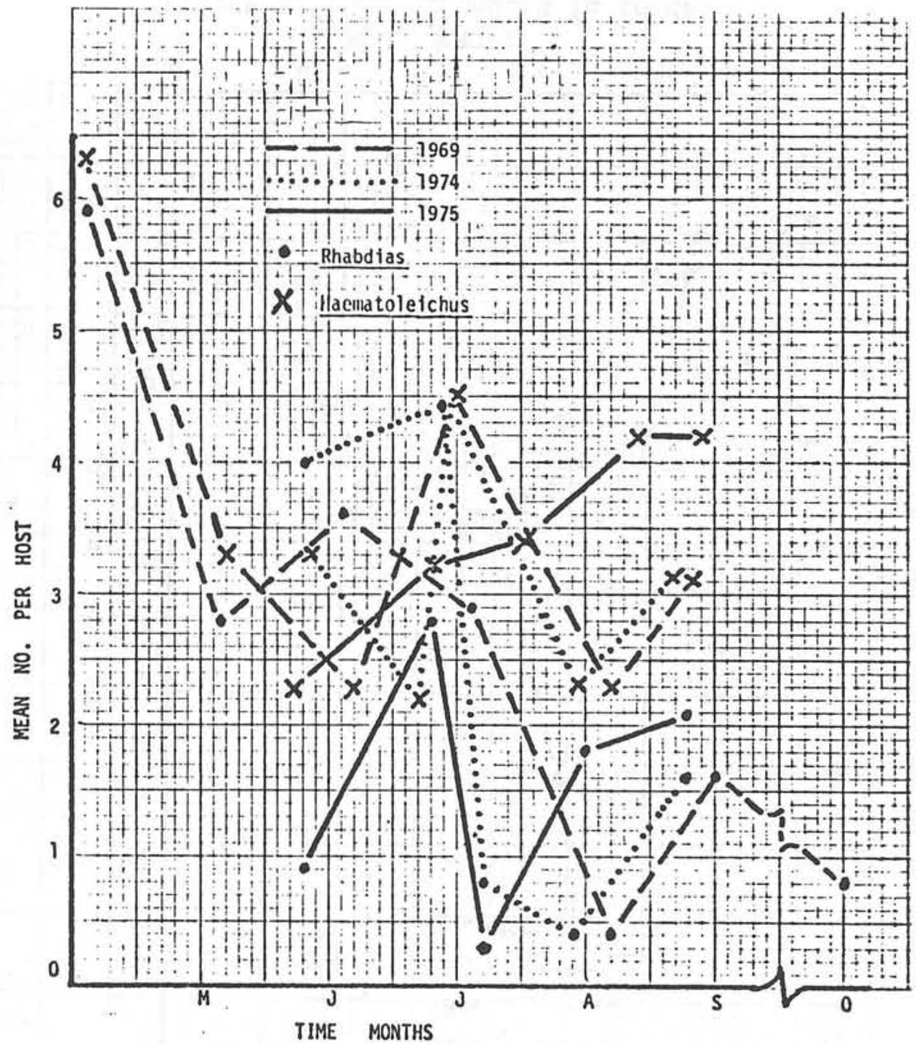

FIGURE 3. *Rhabdias* and *Haematoleichus* in frogs.

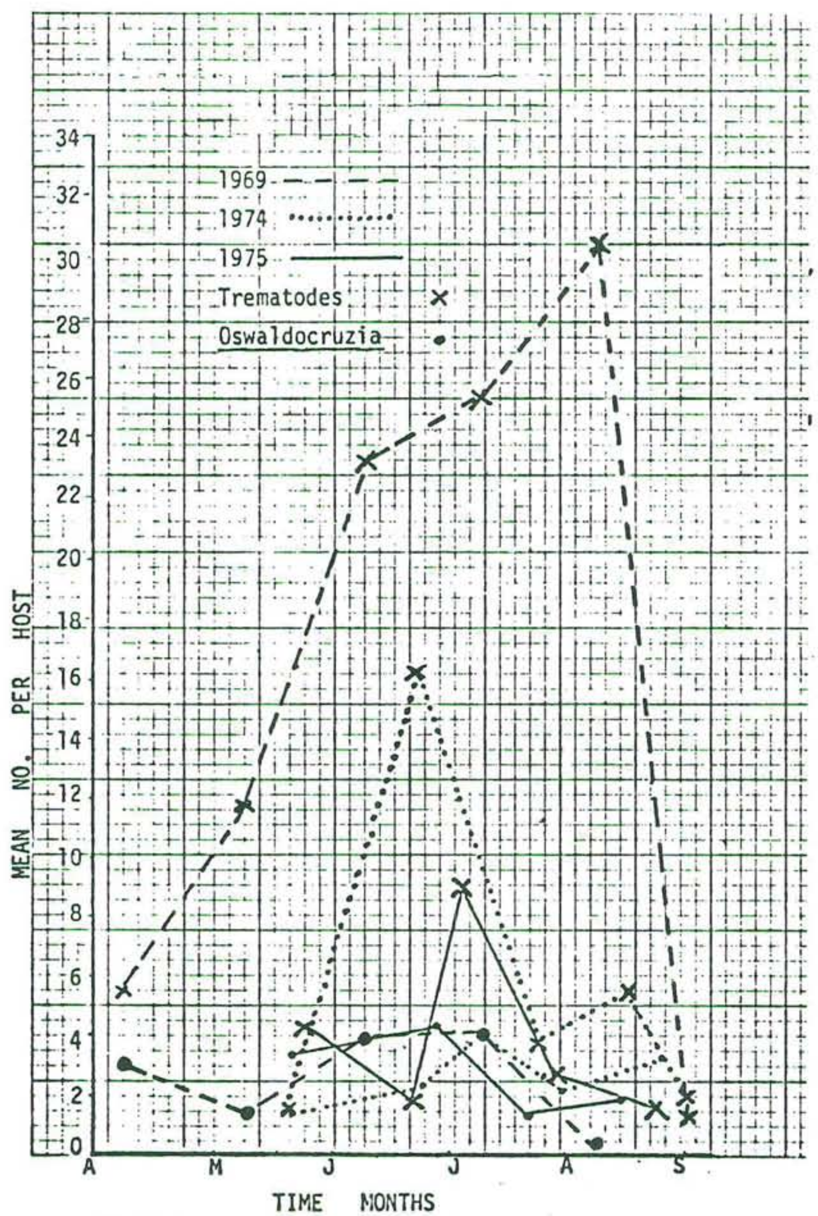

FIGURE 4. Intestinal Trematodes and *Oswaldocruzia* in frogs.

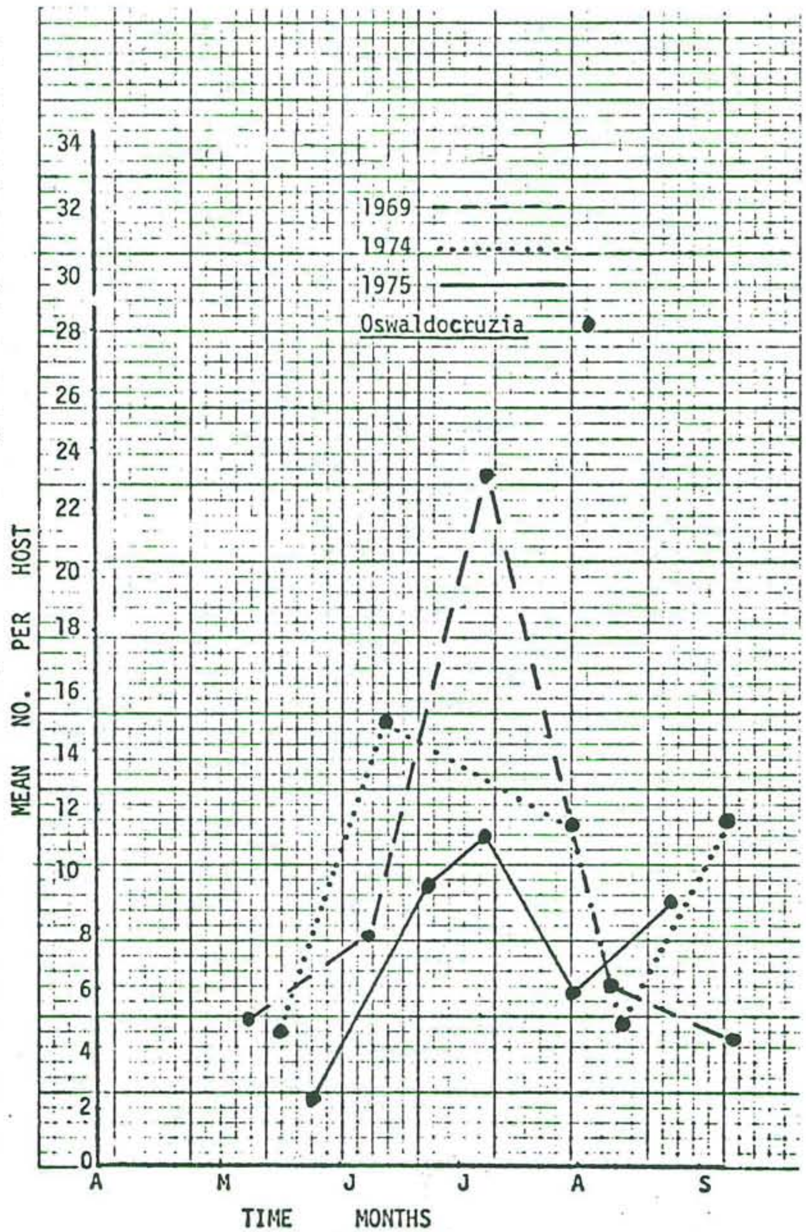

FIGURE 5. *Oswaldocruzia* in toads.

Preliminary Observations on the Infestation of Saugers and Walleyes with *Ergasilus* Sp.

Dr. H. E. Welch

Department of Zoology

Introduction

In spring 1975 Dr. K. H. Doan and Mr. A. Derkson told me that the sauger, *Stizostedion canadense* (Smith) and the walleye, *Stizostedion vitreum* (Mitchill) of Lake Manitoba carried high populations of an ectoparasite on their gills. Through arrangements made by Mr. Derkson, two shipments of fish collected off Cayer, northern Lake Manitoba, were sent to me in May and early September in 1975. In addition I obtained samples of walleyes taken by trawl offshore from the University Field Station on the southern shore of Lake Manitoba.

Methods

Fork lengths and weights of each specimen were taken along with scale samples to determine host age. The opercula, left and right, were cut away and each gill carefully removed from the gill chamber and placed in petri dishes containing saline. The number of organisms and their location on the gill arch were recorded. Records were made of the ectoparasite development; namely, (a) females without eggs, (b) females with eggs in ovary and no ovisacs, (c) females with ovisacs, and (d) females with ripe eggs. All data were recorded on field record sheets and will be transferred to computer cards.

Observations

The gill ectoparasite is a parasitic copepod of the genus *Ergasilus*. I have tentatively identified it as *Ergasilus luciopercarum* Henderson, 1926. Material will shortly be sent to Dr. R. Kabata, Nanaimo, and Dr. L. S. Roberts, University of Massachusetts, for confirmation of the identification.

It occurred on the gills of both the sauger and the walleye, but was not found on the gills of the common sucker also taken at off Cayer, nor on the gills of the common sucker and perch collected by trawl with walleyes offshore from the University Field Station.

The parasites are attached to both the anterior and posterior gill hemibranchs by means of modified second antennae. These are shaped into strong hooks for attachment. Only females are parasitic. Mature parasites with eggs have a bluish tinge.

Every sauger and walleye examined was infected with *Ergasilus*. Examination of Table 1 reveals the mean infestation for saugers and walleyes. Means for 31 May were 425 and 364 respectively. Means for fish from the same habitat in September were significantly lower but not significantly different between host species. All of these fish were taken in commercial nets and ranged from 300 to 500mm in fork length (295-618grms. in weight in spring and 350-1291grms in autumn).

TABLE 1. Mean No. of *Ergasilus* sp. per host

Date	*Stizostedion canadense*	*Stizostedion vitreum*
31 May 1975	425 ± 113* n = 16 Range 75 - 1600	364 ± 194 n = 5 Range 20 - 1100
22 July 1975	-	Under 300mm 13 ± 4 n = 14 Range 1 - 38
	-	Over 300mm 21 ± 6 n = 3 Range 14 - 32
17 September 1975	135 ± 62 n = 5 Range 50 - 383	112 ± 17 n = 12 Range 33 - 215

* 1 standard error

The July 22 sample taken offshore from the University Field Station had significantly lower infestation averaging 21 ± 6 *Ergasilus* per walleye over 300mm in fork length, though admittedly the sample is a very small one.

Walleyes under 300mms had 13 ± 4 *Ergasilus*. These infections are significantly lower than those taken in the north.

A higher proportion of *Ergasilus* with egg sacs were found in the May sample than in the September sample. Approximately half of the September females had egg sacs.

The range of infestation attained 1600 in one sauger and 1100 in one walleye in May. These were not accurate counts but estimations. The gills in both cases had ectoparasites crowded side by side along their lamellae. The damage inflicted must be considerable. Gills appear pock-marked and mutilated in these high levels of infestation. In heavy infestations the gills have a much greater accumulation of mucous than normal, lamellae are bent or twisted, and occasionally fused. Lamellae and supporting structures revealed necrosis. A small smount of bleeding was observed inside the epithelium. The action of the *Ergasilus* sp. would provide an excellent site for secondary infection by bacteria and fungi.

Smears of *Ergasilus* specimens taken from such infestations revealed loose cells, probably epithelial tissue of the gill lamellae, and a few red blood cells. More precise and careful dissections of the guts of *Ergasilus* sp. are needed to clearly identify the food of these ectoparasitic copepods.

Table 2 deals with the distribution of the parasites on the gills of the fish both left and right sides, at two different population levels; namely 13 per fish and 111 per fish. Statistical tests reveal that there are no significant differences for each side or between each gill on one side. This is surprising for morphologically gill IV is smaller in size.

TABLE 2. Number of *Ergasilus* sp. per right and left gills at two population levels.

	Left					Right					
	1	2	3	4	Σ	1	2	3	4	Σ	Σ
n = 14 fish											
Σ =	29	29	18	23	99	23	19	26	23	91	190
n = 12 fish											
Σ =	203	216	154	118	691	191	182	154	122	649	1340

Comparisons of the number of parasites attached on the anterior and posterior hemibranchs show no significant differences.

Discussion

Perhaps, not surprisingly, there is a large taxonomic literature on these bizarre animals. Roberts (1970) is the best compendium of descriptions. He presents an easily used key to the species. The species, *Ergasilus luciopercarum* Henderson, 1926, is known principally from the host genus *Stizostedion* and *Perca* in Quebec, Ontario and British Columbia. Henderson 1926, described *E. luciopercarum* originally from the walleye, *Stizostedion vitreum*, in northern Quebec. Junior synonyms according to Roberts (1970) include *Ergasilus confusus* Bere, 1931 and *Ergasilus caeruleus* Wilson of Muller 1936b. It is surprising that we have not found *E. luciopercarum* on *Perca flavescens* of Lake Manitoba.

The seasonal changes in abundance in females with ovisac in spring to a lower ratio to non-ovisac females was noted by Tedla and Fernando (1970) of *E. confusus* on *Perca flavescens* in the Bay of Quinte, Ontario.

The striking drop in intensity (mean no. per host) between May and September samples was also observed by Tedla and Fernando (1970) in perch.

The intensities recorded for northern Lake Manitoba far exceed any records that I could find in the literature. Most records (Rogers, 1969, and Tedla and Fernando, 1969 and 1970) are of similar magnitude to those that were recorded in walleyes offshore of the Field Station. Why the infestation should be so different in two parts of a lake is unknown. Bere (1931) suggested that higher pH favours *Ergasilus* infestation.

General pathology of the infestation agrees with that of Rogers, 1969, for *Ergasilus cyprinaceus* Rogers, 1969, on various *Notropis* spp. and *Semotilus atromaculatus* in Alabama. We need to carry out a detailed examination of the gut of *Ergasilus* as did T. Einszporn (1965) on *Ergasilus sieboldi* parasitizing the tench, *Tinca tinca*, to determine the food of *E. luciopercarum*.

To really determine the effect of the parasite burden, it would be particularly revealing to test heavily and lightly infested fish in tanks for speed of swimming, endurance and oxygen consumption.

Our findings of an equal number of parasites on the left and right side agree with most authors. On the distribution per gill most workers, unlike ourselves, found the highest concentrations on gills II and III.

Conclusion

The saugers and walleyes of northern Lake Manitoba have the highest infestation of *Ergasilus luciopercarum*, yet recorded for any *Ergasilus* sp. on a host. Only walleyes have been found infected in southern Lake Manitoba.

The ratio of gravid females (those with ovisacs) decreases through the summer. Intensity, likewise, diminishes. Pathological damage from the infestation is noticeable. Distribution on right and left gills, between gills on one side, and on anterior and posterior hemibranchs appears equal.

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Appendix III

UNIVERSITY FIELD STATION (DELTA MARSH)

RESEARCH 1975

Introduction

This is the tenth season of activity at the University Field Station. A wide range of research projects are in progress building on slowly accumulating basic data and focused upon our long range goals of obtaining a greater understanding of the marsh ecosystem.

The year-round studies of activity and ecology in the muskrat and skunk are continuing and the recent explosion of Black Bullhead fish in the marsh and lake is being monitored.

Four studies involve birds - one on the breeding biology of the Ring-billed Gull, two on the ecology and productivity of Yellow Warblers and one on the endocrine system and parasite fauna of the Red-winged Blackbird. Parasite fauna is also being examined in the Leopard frog and Canadian toad.

Three botanical projects are in their final summer - the productivity of epiphytic algae on emergent aquatic plants, the ecology of pigweed and studies of the dynamics of two aquatic plant-snail associations. In addition a new project has been started to examine temporal aspects of the fungal flora of the lakeshore.

Zoology

Thermoregulation in the Muskrat (*Ondatra zibethica*): A Field Approach

R. A. MacArthur (Ph.D. Candidate)
Supervised by Dr. M. Aleksiuk

This study initiated in 1973 is evaluating those behavioral and physiological adaptations which enable the muskrat to maintain a favorable thermal equilibrium with its environment, both summer and winter.

The behavioral component consists of an evaluation of the "construction plan" and microclimate of muskrat shelters and daily activity patterns of free-living animals. Physiological parameters under study include deep body temperatures of free-ranging animals, and the body temperature and metabolic responses of seasonally acclimatized muskrats to various air and water temperatures in the laboratory. The dimensions and spatial orientations of lodges, burrows, and pushups are being measured, as are micro - and macroclimatic temperatures. A radio-telemetry system provides simultaneous data concerning activity and body temperature dynamics, both in the field and in the laboratory. For metabolic studies, the oxygen consumption of acclimatized animals is being measured in the laboratory in Winnipeg.

To date, the majority of the field data have been collected. Additional information is required concerning the microclimate, and the daily activity pattern in summer - particularly in relation to prevailing weather conditions. In mid-July it is hoped to shift research emphasis to laboratory studies, some of which are aimed at clarifying certain field observations made over the past two years.

This project is funded by the Province of Manitoba.

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Winter Ecology of the Striped Skunk (*Mephitis mephitis*)

G. R. P. Mutch (M.Sc. Candidate)
Supervised by Dr. M. Aleksiuk

The striped skunk, as a year-round resident of southern Manitoba, is exposed to a wide variety of macro-environmental conditions, the most important of these from the point of view of year-round survival being those of winter, namely lack of food, extremes of low temperature, and deep, frequently soft snow. While many other species cope by hibernation, migration, or utilization of special adaptations enabling them to remain active, these adaptations are not those of the striped skunk. The objectives of this study are to determine the over-wintering strategies which the striped skunk has evolved: to describe quantitatively the changes in the male animals' activity patterns (both on a diurnal and seasonal basis), to determine their use of a winter micro-habitat and to describe the temperature conditions in this environment, to measure fat stored as a source of energy for the over-wintering period, and to examine possible body temperature depressions as a means of lowering energy requirements.

In the coming season the study will be brought to a conclusion. The skunks' return to activity will be documented with data gathered on both the captive animals and free ranging individuals. In spring (March or April, depending on weather conditions), radio-telemetric tracking of free ranging animals will be resumed, using steady-tone transmitters. This will be done on an intensive basis until the end of May, and then through the summer to supplement the data gathered in the summer of 1974. During this summer period data analyses will also be carried out, and the writing of the thesis started. It is anticipated that this will be completed, and the project terminated, by November 1975.

The project is funded by the Province of Manitoba and the National Research Council.

The Black Bullhead Population of Delta Marsh

A. C. Day (Pre M.Sc. Candidate)
Supervised by Dr. J. Gee

This study is an investigation of the Black bullhead population (*Ictalurus melas*) in Delta Marsh. Data will be obtained through examination of catfish caugh daily at several sites in the marsh, Lake Manitoba and the Assiniboine diversion.

Knowledge of catfish and their ecological role in Delta Marsh will be obtained through studying characteristics of the *I. melas* population such as:

1) population size
2) age class distribution
3) sex ratio
4) distribution in Delta Marsh
5) diet
6) behaviour
7) hourly, daily, weekly and monthly movements
8) fecundity

This project is of great interest ecologically because *I. melas* is a relatively recent arrival at Delta and is believed to have been introduced into the marsh in significant numbers by the fusion of the Delta Marsh and the Assiniboine River diversion when the diversion dyke broke during high water in 1974. Prior to this there was no record of Black Bullhead in the marsh or the lake. The summer of 1974 revealed a sudden appearance of a sizable *I. melas* population in the above two locations. The Black bullhead may have become a permanent resident in the Delta Marsh.

This project is funded by the National Research Council.

* * * * * * *

Post-breeding Dispersal, Migration, and Age-Specific Activities and Characteristics of the Ring-billed Gull (*Larus delawarensis*) in Manitoba

R. W. MacCharles (M.Sc. Candidate)
Supervised by Dr. S. G. Sealy

The Objectives of this study are:

1. To establish the nesting chronology of Ring-billed gulls in two colonies in northern Manitoba and to estimate breeding productivity in these colonies.

2. To band adult and young Ring-billed gulls and to mark each with a feather dye indicative of the particular colony in which the bird bred or was reared.

3. To study patterns of post-breeding dispersal (by observing the color-marked birds) and daily activities (feeding, loafing, etc.) of the various age classes of Ring-billed gulls in the vicinity of Delta Marsh.

4. To determine the feeding habits and importance of dumps, agricultural areas, and natural areas (lakes, etc.) as sources of food during the annual cycle of Manitoba Ring-billed gulls.

5. To attempt to quanitify age-related changes in eye color for use as an aging technique, and to study the molt sequences and the timing of the molt in the different age classes.

This project is funded by the Province of Manitoba and the National Research Council.

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Feeding Ecology of the Yellow Warbler
(*Dendroica petechia*), in Delta Marsh, Manitoba.

D. G. Busby (M.Sc. Candidate)
Supervised by Dr. S. G. Sealy

The relatively dense population of breeding Yellow warblers at Delta Marsh, Manitoba, suggests optimal availability of resources to this common wood warbler (Family Parulidae). An important aspect of the niche requirements of all animals pertains to food availability and usage since a major portion of the animal's activities center around feeding of the individual and the offspring.

The purpose of this study is to examine the feeding ecology of this insectivorous bird with particular reference to the following aspects: (1) Determination of the organisms upon which Yellow warblers prey throughout their breeding season, (2) Foraging behaviour of both males and females, (3) The influence of environmental changes on foraging behaviour, (4) Correlation of abundance of insects with the food requirements of the birds (e.g. egg production by the female; raising of young, etc.) (5) The significance of intraspecific and interspecific competition, and (6) an attempt to assess the role of the Yellow warbler in this marsh ecosystem will be made.

The project is funded by the National Research Council and the University of Manitoba Research Board.

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Protozoan and Helminth Parasites of the Leopard frog (*Rana pipiens*) and the Canadian toad (*Bufo hemiophrys*)

J. Pearson (3rd year student)
Supervised by Dr. H. E. Welch

These studies will confirm and extend our knowledge of the kinds and occurrence of protozoan and helminth parasites of frogs and toads in Delta Marsh. Such knowledge will provide a model for interpreting the role of parasites in wild animal populations; give better understanding of the natural history of these amphibians which constitute one of the major animal groups in the marsh; and provide a base-line for studies of frog parasites elsewhere in Manitoba.

The work extends parasite surveys carried out in the summers of 1968 and 1969 and studies of *Rhabdias* spp. (lungworm of frogs and toads) conducted in 1971 and 1972. Research will involve monthly surveys of representative samples of frog and toad populations. Three protozoa, six trematodes, four nematodes and one acanthocephalan are known to occur in these hosts.

The work is funded by the National Research Council of Canada.

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Botany

Primary Production of Epiphytic Algae in Delta Marsh, Manitoba

N. M. Hooper (Ph.D. Candidate)
Supervised by Dr. G. G. C. Robinson

In marshes and littoral zones of lakes, the submerged portions of vascular plants are often heavily colonized by algae. These epiphytic (attached) algae may contribute a significant amount to the production of organic material in the aquatic ecosystem. Relatively few studies on this community have been carried out.

The purpose of this project is to examine various aspects of the production and species succession of the epiphytic algae community in Delta Marsh. Algae colonizing *Scirpus*, *Phragmites*, *Typha*, *Myriophyllum* and *Potamogeton* are being assessed. In the initial study year (1973), a method estimating production by the $^{14}CO_2$ uptake technique was evaluated. In 1974, this method was applied to estimate overall seasonal primary production of epiphytic algae in a small marsh pond. In the 1975 season, plans

Breeding Ecology and Productivity of the Yellow Warbler

P. Goosen (M.Sc. Candidate)

Supervised by Dr. S. G. Sealy

Islands frequently support passerine populations at greater density than that usually encountered on the adjacent mainland. An "insular" effect appears to exist near the Delta Marsh in that the habitat used for nesting and feeding by Yellow Warblers (*Dendroica petechia*) is linear in distribution (arborescent vegetation bordered on one side by Lake Manitoba and by the Delta Marsh on the other).

The major objectives of this study are to ascertain factors which permit an extremely dense population of the Yellow Warbler to inhabit areas adjacent to the Delta Marsh. Basic aspects of Yellow Warbler natural history, productivity and factors influencing it, for example, Cowbird parasitism will be determined.

The project is funded by the National Research Council.

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The Interaction of the Endocrine System and Parasite Fauna of the Red-winged blackbird (*Agelaius phoeniceus*)

D. Hood (M.Sc. Candidate)
Supervised by Dr. H. E. Welch

Differences in male and female susceptibility to parasites have been frequently reported for a number of hosts at any stage in their life-cycle, and generally to all parasites during the breeding season. Male and female Red-winged blackbirds are being sampled at 10 stages throughout the spring and summer at times corresponding to major hormone maxima and minima. A complete picture of the hormonal condition of the species during the season will be obtained to compare with the parasite data. Young of the year will be captured upon fledging to be used in experiments to test any correlations found.

In addition this study will yield the first comprehensive survey of Red-winged blackbird parasites in Manitoba as well as information on infective organisms brought north by the migrating birds.

Funded by National Research Council and Manitoba Wildlife Federation.

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include investigations of pigmentation, photosynthetic rates, heterotrophy and species succession of algae in the epiphytic habitat.

This project is funded by the Aquatic Biology Research Unit, University of Manitoba and the National Research Council.

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The Dynamics of Two Plant-snail Associations in the Delta Marsh

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During the 1972-74 seasons two submerged plant-snail associations were studied on a quantitative basis: those of *Potamogeton pectinatus* and *Physa gyrina*, and of *Potamogeton richardsonii* and *Lymnaea stagnalis*. The molluscan host plant preferences were found to be specific, constant from year to year and were related to the developmental cycles of the plants. During the 1975 season monitoring of the plants and environmental parameters will be continued.

The project is funded by a National Research Council Scholarship.

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Temporal Aspects of Fungus Distribution in Beach Sands

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A definite fungal distribution pattern is evident in Lake Manitoba beach sands. Causal factors possibly included physical, chemical and biological affects. Among those included in this study are: temperature, moisture, solar radiation, organic matter, cations, sand particle size, precipitation, competition and population density. Also beach configuration relative to various microhabitats is being studied with the possible affects of wave action on the dune strand being determined.

This project is funded by the National Research Council.