

Queen's University Biological Station

Annual Report and Newsletter

1987



Director - Dr. R.J. Robertson

Manager - Frank Phelan

INTRODUCTION

Nineteen eighty-seven was a year of high levels of research and teaching activity at the Queen's University Biological Station. On average, 32 researchers: professors, graduate students, honours students and assistants, were in residence throughout the summer. Abstracts of research projects and personnel involved are contained in the following pages and are summarized in Table 4. In teaching activities, QUBS hosted six modules in the Ontario Universities Program in Field Biology. Titles and enrollments for modules held at QUBS and for the OUPFB program in general are found in Tables 1 to 3. The Naturalist Workshop was full to capacity with an enrollment of 20 - 18 full-time and 2 part-time. QUBS also provides an extremely important facility for a variety of field trips, especially those associated with fall and winter term university courses (cf. Table 6). In many cases, this exposure to field work is a key element in stimulating interest in field biology.

In 1987, QUBS, through the Department of Development, kicked off a special capital appeal. Contributions to this appeal will help to provide improved and expanded facilities for teaching and research programs at QUBS. The lion's share of monies from this appeal will go to replace the old lodge with a much-improved, winterized building. It is hoped that all past users of the station will contribute to this appeal, if only in a small way. Every donation puts us that much closer to realizing our goal.

Nineteen eighty-seven was the first season of operation of the new electronic weather monitoring system. This system was purchased with monies from Queen's Appeal, Provincial Excellence Fund and an NSERC Operating Grant per Dr. R.J. Robertson. Despite some initial problems with lightning strikes, the system performed well throughout the year. The initial installation enables monitoring of 9 variables: 1) 1 metre high enclosed air temperature 2) 1 metre high enclosed relative humidity 3) surface lake temperature 4) 1 metre deep lake temperature 5) 3.5 metre deep lake temperature 6) 50 cm deep soil temperature 7) rainfall (tipping bucket rain gauge) 8) wind speed (anemometer) 10 metres above ground 9) solar radiation (pyranometer) 12 metres above ground. Presently, we are deciding on a format for data storage. Once in operation, a yearly compendium of daily data summaries will be kept on hard copy in the library. A complete file of half-hourly data will be kept on computer disks.

Although not at the same level as during the international conferences held locally in 1986, there were many visitors to QUBS in 1987 (cf. Table 4). Table 5 documents research and teaching use in user-days for comparison with previous years.

QUBS continues to be a popular destination for field trips, small conferences and meetings. Table 6 presents a list of these uses through 1987.

The seminar schedule was organized by Dr. Raleigh Robertson in 1987. This forum is an interesting and valuable addition to events at QUBS. Table 7 lists the range of speakers and topics for 1987.

The new fee schedule for 1988 appears in Table 8. Note that there are new rates for non-academic and/or non-university groups. Conference fees are assessed on the basis of size of group, special arrangements and facilities used.

An updated list of theses and publications emanating from work done at QUBS is presented as an appendix to this report. Please forward copies of articles and theses as these become available. Please check your listings carefully for errors or omissions.

Nineteen eighty-seven saw continuing improvements to the facilities at QUBS. In spring, a new cabin, #13, was erected. Twice the size of our bunkie juniors, the new cabin was ready for summer use. Also in spring, a coin-operated dryer was purchased to assist with necessary laundry. In fall, the boathouse roof was resingled and the roofs of the storage barns at Hughson's were repaired. The common areas of Curran Cottage are presently undergoing renovation. Work on the bathrooms and wash-up room should be completed soon. In preparing to receive delivery of a new commercial propane range for the lodge kitchen, some renovation is taking place in the lodge kitchen and food service area - new flooring, enlarging kitchen doorways, adding to serving counter space, altering electrical service to the kitchen. In late fall, construction was begun on a boundary fence between QUBS and Curtis property on the East side of the station road. This fence should be completed by spring. Already Floyd has got a garden worked up in the field near the road. The removal of all old fencing within the new boundaries was started. Over time, all old fence will be removed from QUBS property.

The annual Open House was held on July 5. QUBS regulars hosted over 300 visitors who toured the displays of research species and projects. In June, the seventh edition of our Community Newsletter was delivered to most households in the area. This summary of activities at QUBS is aimed at those unable to attend the Open House. Response to the Open House remains high and many favourable comments have been received about the Community Newsletter. These public relation events are important in maintaining contact with our neighbours and friends throughout the area. The regulars at QUBS are to be heartily thanked for their efforts in making these events so successful.

A new portable fire pump was acquired through the Vice-Principal of Services Risk Committee. This pump was mounted with all the necessary equipment on a small trailer to allow quick response in case of emergency. Bob Bell, Queen's Fire Safety Officer conducted hands-on fire extinguisher courses for QUBS regulars on June 15. At the same time, Frank and Floyd practiced with the new fire pump. Later, on July 9, members of the Elgin Volunteer Fire Department came to QUBS on a familiarization tour of facilities and to review procedures to be utilized in case of fire. Thanks to Hank Neff, Elgin V.F.D. Fire Prevention Officer for arranging this visit.

Our kitchen staff, Melinda Warren, Janice Frame, Linda Hughson and Marg Phelan provided excellent table fare for the station users. The operation of the kitchen was outstanding in 1987. Thank you for your efforts.

In fall, a new program at QUBS was initiated. In response to requests from high schools, a field trip program in environmental biology, focussing on aquatic systems, was tried. Two high school groups, one biology, one environmental studies came for day-long modules on limnology. These trips were successful, leading to the possibility of developing a full-blown field studies teaching program in environmental biology at QUBS.

QUBS alumnus (read old-timer) Dr. Gary Bell was married to Rici Peterson in Peterborough, New Hampshire on July 26. Right after the ceremony, Gary packed his new bride and the 'best dog' in the truck and headed off to California to take up his new post at the Santa Rosa Plateau Preserve. Best of luck from all of us at QUBS!

In October, Janice Frame was married to Tom Radcliffe in Kingston. Best wishes from QUBS.

Thanks to Dr. Dolf Harmsen for his sketch which forms the cover of this report.

NATURALISTS' WORKSHOP 1987

The ninth annual Naturalists' Workshop was held May 23-30, 1987. We were pleased to have Dr. Adele Crowder once again at the helm, having returned from her 1986 sabbatical leave.

Twenty naturalists participated in the workshop. A few of these were returnees from past workshops. A fair cross-section of interests and organizations were represented - Parks Canada, Ducks Unlimited, Rideau Valley Conservation Authority, Provincial Parks (Carillon, Murphy's Point, Charleston Lake), Universities and Schools (Queen's University, Queen Elizabeth Collegiate and Vocational Institute, Welborne Public School, Humber College).

Dr. Jim Pringle (Royal Botanical Gardens) was once again a valuable asset as one of our teaching and resource team. Many thanks also to our other team members: Dr. Allen Keast (Queen's - Biology), Peter Good (Q.E.C.V.I.), Dr. Sandra McBride (Queen's - Geological Sciences), Dr. Raleigh Robertson (Queen's - Biology), Dr. Adrian Forsyth, Dr. Peter Boag (Queen's - Biology), Dr. Francis Cook (Curator of Herpetology - National Museums), Terence Dickinson, Dr. Al Gorman (Queen's - Geological Sciences), Dr. W. Vreeken (Queen's - Geography), Ken Robinson (St. Lawrence Islands National Park), Dorothy Young (Queen's - Biology), Jennifer Harker (M.M. Dillon Consultants), Dr. James Fullard (Erindale College - Zoology), Dr. Bruce Smith (University of New Brunswick - Zoology), Frank Phelan and Floyd Connor (both QUBS).

This year, the day-long trip took us to several islands in the St. Lawrence Islands National Park. Highlights of the day were geological formations and soils, rare plants and unusual habitats. Despite rainy conditions, we fully enjoyed the trip to this diverse and beautiful assemblage of islands.

Many of the sidelights to the main programme prove to be some of the highlights when judging from participant's comments. In particular, the three evening presentations by Terence Dickinson, Dr. Adrian Forsyth and Dr. James Fullard were excellent. Mr. Dickinson, a freelance author and contributor to Equinox magazine gave a superb slide presentation on astronomy. Dr. Forsyth, a freelance author, talked about insect behaviour and ecology using illustrations from his own experiences in Costa Rica and locally. Dr. Fullard's inimitable style and enthusiasm made the segment on bats and moths most informative and enjoyable.

Dr. Sandra McBride was new to the program this year. Her keen interest in geology and her articulate, enthusiastic manner brought new life to this component. With luck, we will be able to persuade her to become involved in the workshop on a regular basis.

Next year's plans are ready and include a transect of the Frontenac Axis to investigate geological formations and major habitat types and vegetation associations.

Suggestions for topics for inclusion in the main workshop programme or other week-long or weekend workshops are welcome.

Table 1: Summary of course credits in the Ontario Universities Program in Field Biology earned at Queen's University Biological Station in 1987.

Module Topic	Professor and Affiliation	Dates	Credit/ Students	Queen's	Carleton	York	Brock	Western	Waterloo	U of T	Total Students/ Module	Total 1/2-course credits
Insect Sampling	Gill (Carleton)	May 10-16	1/4	5	1	3	0	0	0	0	11	5.5
Limnology	Snail (Queen's)	May 17-23	1/4	5	0	2	1	0	0	0	8	4
Fish Ecology	Keast (Queen's)	May 17-23	1/4	4	0	4	1	0	0	1	10	5
Evolutionary Strategies	Harmeen (Queen's)	May 24-30	1/4	4	0	2	1	1	0	0	8	4
Bat Behaviour	Fenton (York)	Aug. 23-29	1/4	3	0	3	0	1	2	0	9	4.5
Scavenging Arthropods	Peck (Carleton)	Aug. 30- Sept. 5	1/4	5	0	3	1	0	1	1	11	5.5
Total Number of Student-weeks				27	1	17	4	2	3	2	57	
Half Course Credits				13.5	0.5	8.5	2	1	1.5	1		28.5

Table 2: Summary of course credits in the Ontario Universities Program in Field Biology earned at locations other than QUBS in 1987.

Module Topic	Professor and Affiliation	Dates	Location	Credit/ Students	Queen's	Carleton	York	Brook	Western	Waterloo	U of T	Total Students/ Module	Total 1/2-course credits
American Southwest	Handford (Western)	Apr. 25- May 20	Arizona	1/2	1	0	0	0	7	1	2	11	11
Arid Environments	Cameron (York)	May 6-25	California	1/2	1	0	8	0	2	0	1	12	12
Ornithology	Rising (U of T)	May 31- June 13	Hantsman	1/2	3	0	3	0	2	0	0	8	8
Aquatic Ecology	Bailey (Western)	Aug. 14-28	Dorset	1/2	3	1	0	0	7	0	1	12	12
Marine Biology	Sosa (U of T)	Aug. 15-30	Hantsman	1/2	6	2	1	1	0	0	20	30	30
Arctic Ecology	Jeffries (U of T)	Aug. 17-31	Churchill	1/2	4	0	0	0	1	0	15	19	19
Alpine Ecology	Millar (Western)	Aug. 21- Sept. 5	Kananaskis	1/2	2	1	0	1	5	0	3	12	12
Conservation Ecology	Middleton (Brook)	Aug. 23-30	Bacchus	1/4	3	1	4	1	0	0	1	10	5
Terrestrial-Aquatic Biology	Barrett (U of T)	Aug. 28 Sept. 12	Dorset	1/2	2	0	1	1	1	0	20	25	25
Experimental Marine Biology	Owen (Western)	Aug. 28 Sept. 13	Hantsman	1/2	4	0	0	0	15	0	0	19	19
Terrestrial-Aquatic Ecology	Hawthorn (Waterloo)	Aug. 29- Sept. 11	Algonquin	1/2	2	2	0	2	2	9	0	17	17
Total Number of Student-weeks					59	13	30	11	84	20	125	342	
Half-course Equivalents					29.5	6.5	15	5.5	42	10	62.5		171

Table 3: Overall Summary of the Ontario Universities Program in Field Biology for 1987.

	Queen's	Carleton	York	Brock	Western	Waterloo	U of T	Total Student Weeks in Modules	Total Half Course Credits
Total Student-weeks not at QUBS	59	13	30	11	84	20	125	342	171
Total Student-weeks at QUBS	27	1	17	4	2	3	2	57	28.5
Total Student-weeks in Field Modules	86	14	47	15	86	23	127	399	
Total Half-course Equivalents in Field Modules	43	7	23.5	7.5	43	11.5	63.5		199.5

ABSTRACTS OF RESEARCH CONDUCTED AT QUBS 1987

I. RESEARCH BY QUEEN'S UNIVERSITY STUDENTS AND STAFF

DR. L. AARSSSEN

"Competitive Ability in Plants"

Gary Epp - "Manipulative Field Experiments of Competition in Plants from Two Different-Aged Grassland Swards" - Ph.D. Thesis.

Research performed in the summer of 1987 was part of an on-going series of manipulative experiments on plant interactions in old hayfields. Previous experiments involved species removals, and annual surveys for species abundance. The experiments done in 1987 were a series of nutrient additions varying concentrations of nitrogen, phosphorus, and potassium. Results will be recorded as changes in biomass and will be interpreted using response coefficients. All of the above experiments were performed in the Cemetery Field site.

Assistant: Stan Vasiliauskas

Douglas R. Taylor - "Transitivity and Coexistence in three Species of Perennial Grass" - M.Sc. Thesis.

The hayfields on the QUBS property near Lake Opinicon provide a convenient system for studying competition and coexistence in grassland plant communities. Current theory on species coexistence suggests that if species compete, they may coexist only if they are sufficiently differentiated in their niche requirements. Nevertheless, in these grasslands (more specifically, the East Field) we commonly find different species of grass growing less than an inch apart and apparently in severe competition with each other. In the summer of 1986 I surveyed the field to assess distributional relationships, and collected neighbouring clones to be used in glasshouse experiments to assess the relative competitive abilities of neighbouring genotypes. The glasshouse experiments are in progress.

Thesis:

McKinley, K.J. 1987. Neighbour effects in mast year seedlings of sugar maple Acer saccharum Marsh. B.Sc. (Hons.) Thesis. Dept. of Biology, Queen's University, Kingston, Ontario.

DR. P.W. COLGAN

"Field Ethology of Fishes"

In 1987, Lake Opinicon was the source of Killifish for laboratory studies on habituation of predatory stimuli (Hons. B.Sc. student Carolyn Welch) and for behavioural comparisons with another population (M.Sc. student Liane Gabora) and of Bluegill and Largemouth Bass for studies on foraging and predator avoidance (research associate Vytenis Gotceitas).

Publications:

Brown, J.A., P.H. Johansen, P.W. Colgan and R.A.S. Mathers. 1987. Impairment of the early feeding behaviour of largemouth bass by pentachlorophenol exposure: A preliminary assessment. *Am. Fish. Soc. Trans.* 116: 71-78.

Colgan, P.W. and J.A. Brown. 1988. Dynamics of nest defense by male centrarchid fish. *Beh. Proc.* 15 (in press).

Gotceitas, V. and P.W. Colgan. 1987. Selection between densities of vegetation by young bluegill sunfish (Lepomis macrochirus) when avoiding predation. *Am. Fish. Soc. Trans.* 116: 40-49.

Morgan, M.J. and P.W. Colgan. 1987. The effects of predation presence and shoal size on foraging in bluntnose minnows, Pimephalus notatus, *Env. Biol. Fishes.* 20: 105-111.

Morgan, M.J. and P.W. Colgan. 1988. The role of experience in foraging shoals of bluntnose minnows (Pimephales notatus). *Behav. Proc.* (in press).

DR. R. HARMSSEN & DR. A. CROWDER

"Effects of Grazing on Succession in an Old-Field Community"

Co-Investigator: Bruce Henderson - Research Associate.
John-Paul Sigouin - Undergraduate.

This is a continuation of a long-term project initiated in 1975. In two old hayfields, 27 100m² research plots were permanently established in 1975. Every year, insect, rodent and plant populations are quantitatively sampled in all 27 plots, of which nine are screened with rodent-proof fencing and trapped empty once a year. In 1987 we continued to monitor closely the population of Trirhabda spp. (Goldenrod beetles) and the introduced grassfeeding caterpillar, Thymelicus lineola (the European Skipper). Unfortunately, the entire research area was affected by drift from nearby insecticide spraying against a declining gypsy moth infestation, so that all foliage feeding larval insects died. Since from 1988 onwards no further spraying is expected, we predict a rapid recovery of several species, including Trirhabda and Thymelicus over the next two or three years.

The emphasis this year was on sex-ratio and species distribution for the three species of Trirhabda in relation to overall population density and dispersal.

Publications:

McBrien, H.L. and Harmsen, R. Growth response of goldenrod, Solidago canadensis (Asteraceae), to periodic defoliation. *Can. J. Bot.* 65: 1478-1481.

DR. J.A. KEAST

"Ecology of Fish Communities, Inter-lake Comparisons"

Comparative studies on the fish communities of a series of lakes (Opinicon, Upper and Lower Beverley, Sydenham, Gould, Fish, Atkins) were continued with emphasis on the role of lake type, prey resource base, and potential competitors, on diets, habitat use, and growth rates of individual species. Objectives are to determine why fish species occur where they do, what governs their combination into communities and what 'contours' species ecology under different circumstances.

No two water-bodies have exactly the same combination of species, or species in equal proportions. Some individual species, however, occur in all the lakes so that their ecological role, age structure, and growth can be investigated relative to a precise set of physical and biological variables. Data accumulation and work with aquaria populations continues with special emphasis on game species like the Largemouth Bass and major prey species (Golden Shiner, Black-chinned Shiner).

"Long-term Changes in the Fish Community of Birch Bay, Lake Opinicon"

This broad sandy inlet was the site of the first fish community study in Lake Opinicon, published in 1965. The study involved a detailed assessment of the zoobenthic prey resource base, zooplankton, and diets of the fish species and their year classes on a monthly basis. Ten years later Jennifer Harker, as an M.Sc. thesis project, repeated the study, comparing fish ecology at this site with other sections of the foreshore. Now (1987) the site has changed slightly, with more weed growth so that some inshore areas are now used by young-of-year Yellow Perch, which were uncommon there previously. A third comparative study has now begun to see if, and what changes have occurred in this fish community over 20 years.

"Insect Cycles, Feeding Zones, and Locomotory Movements in Lake Opinicon Birds"

This study investigates the ecology of Lake Opinicon terrestrial birds in terms of the annual cycle, especially breeding and the prey resource base. During the summer of 1987, comprehensive weekly counts of caterpillars, spiders, and Diptera were made on the leaves and trunks of maple (the commonest tree in the area), and basswood. This was related to times of return and peak abundance of the major forest bird species and, particularly, their nestling periods.

Refoliation occurred in late April, 1987 (in 'late' years it takes place about May 10-12). Peak caterpillar abundance occurred early, preceding the nestling period of most bird species. A compounding factor was that caterpillar species diversity and abundance has now been lower for two years than during the early 1980's when detailed studies were last made: this is apparently due to the spraying of the adjacent property for Gypsy Moth. The birds adapted to low caterpillar numbers in late May - early June by feeding their young large numbers of odonates (eg. Tree Swallows, Red-eyed Vireos) diversifying the diet (eg. Song Sparrows), and making increasing use of the hairy gypsy moth caterpillars. This was done in one of two ways, by holding the larvae on a branch and extracting the insides (eg. Chickadee, Red-eyed Vireo) or banging the caterpillar against a branch until many of the stinging guard hairs came free. The beginnings of the habit were noted last year.

With these modifications to diet and feeding behaviour nestling success was apparently equal to that of other years.

"Periodicity of Territorial Song, Relationship to Stage of Breeding Cycle"

This work, part of a comparative study of the annual cycle in Ontario and New South Wales, Australia forest birds, had as one of its objectives the study of why different bird species differ in time of maximal territorial song. Does the timing of maximal territorial song differ in the members of a bird community because they breed at different times (a longer term evolutionary feature) or, since it is undesirable for different species to drown each other out, because of interspecific competition for 'broadcasting space'? The issue has now been resolved in favour of the former explanation. Notwithstanding this evidence remains that closely related species, eg. Red-eyed and Warbling Vireos, monitor each other's calling and partly avoid calling at the same time.

Assistants: Michele Flatters, Krista Johansen.

Michael Fox - "Pumpkinseed Feeding Ecology and Life History in Shallow Pond Environments" - M.Sc. Thesis

This is my second year of the project, which involves a comparison of pumpkinseed feeding, growth and life history in shallow ponds with that of Lake Opinicon. This year, with the help of Ian Smith, I sampled the fish populations, stomach contents and benthos of Lake Opinicon, Dowsley Pond (2.6 ha) and Upper Poole Pond (0.7 ha) in May, July, August and October. Water temperatures and dissolved oxygen concentrations were recorded; and the state of pumpkinseed reproductive organs were examined in breeding season. Pumpkinseed life history traits in Dowsley Pond are of special interest. They mature in their third growing season at lengths varying from 70-90 mm; this is 2-3 years earlier and 25-50 mm smaller than Lake Opinicon pumpkinseeds at first maturity (excluding sneakers). The small mature males of Dowsley are nesters, not cuckolders. Despite early maturity and large gonads, Dowsley pumpkinseeds grew faster in 1987 than comparably-sized lake fish. This ability to "burn the candle at both ends" was likely made possible by a winterkill in Dowsley, which reduced the population density by 85%. Life history characteristics of the fish of Upper Poole are intermediate to those of Dowsley and Lake Opinicon. It appears that summer growing conditions are near-optimal for pumpkinseeds in the shallow ponds, and that their population dynamics and life history patterns are determined by periodic winterkills.

Assistant: Ian Smith.

Mary-Alice Blyth Snetsinger - "Factors Governing Body Size and Longevity in Golden Shiner (Notemigonus crysoleucus)" - M.Sc. Thesis

Work continued on populations of Golden Shiner with the fish of the Cataraqui Conservation Pond (which are long-lived and grow to a large size) being compared with those in Lake Opinicon and other systems. First year shiners, that live in the littoral zone with a range of other fish species were found to grow at the same rate in different systems. Larger-bodied shiners inhabit the open waters of the Cataraqui Pond and apart from Brown Bullhead are the only other fish in that habitat. They thus have few competitors in that habitat compared with the open water habitat in other

systems. This, plus diet data, suggests that the large-bodied and long-lived population of shiners in the Cataraqui Pond is a result of low levels of competition.

Ian Smith - "Herbivory in Fine-scale Dace (Phoxinus eos)" - B.Sc. Thesis

Dace are a dominant component of beaver ponds and streams in the Lake Opinicon area. They are unusual for northern temperate zone fishes in being partly or largely herbivores or detritivores. This study examines growth rates in natural populations and assessment of the ability of dace to grow under aquarium conditions when their diet is limited to plant and detrital material.

Publications:

Deacon, L.I. and A. Keast. 1987. Patterns of reproduction in two populations of pumpkinseed sunfish, Lepomis gibbosus, with differing food resources. Environ. Biol. Fish 19: 281-296.

Hoyle, J.A. and A. Keast. 1987. The effect of prey morphology and size on handling time in a piscivore, the largemouth bass (Micropterus salmoides). Can. J. Zool. 65: 1972-77.

DR. R.D. MONTGOMERIE & DR. P.J. WEATHERHEAD (Carleton University)

"Sexual Selection and Parental Care in the American Robin"

In 1987 we continued our study (begun in 1986 on the interaction between sexual selection-mate choice and intersexual competition and parental care in American robins (Turdus migratorius) on the main QUBS property at Lake Opinicon. As a baseline for this work we attempt to colour band all adults and their offspring and monitor the fate of each nest in our 15 ha study area of mixed woods, pine plantation, and open lawns. This year all but a few wary adults were captured and most nests were accessible enough that they could be monitored. Because the breeding season can be quite long (April to August), robins can raise three or more broods in a single year so one of our goals is to examine the effect of several nesting attempts on the mating tactics, parental care behaviour, and overall reproductive success of individuals. In 1987 we began 5 specific projects focussing on different aspects of parental care and sexual selection as outlined below. Each of these will continue in 1988.

I. "Division of Broods by Parents"

The division of broods by male and female parents after nest departure has now been documented in a number of passerine birds. In this study we are asking whether robin parents also divide their broods, both within the nest and after fledging, and if so whether broods are divided according to the sex, size or some other characteristic of the offspring. We are also interested in documenting whether re-nesting activities influence brood division and in testing the variety of hypotheses proposed to explain this parental behaviour (foraging efficiency, predator avoidance, experience, etc.). The results from 1987 show clearly that parents do not divide the brood while it is still in the nest but that some division may occur after nest departure.

II. "Parasites, Plumage, and Performance"

We collected small blood samples from each adult captured and sent them to Dr. Gordon Bennett (Memorial University, Newfoundland) for analysis of blood parasites. The aim of this study is to determine whether blood parasite levels are correlated with plumage and other phenotypic characters quantified at the time of sampling, or with a variety of other measures of reproductive (mating, nesting, brood rearing) and behavioural (foraging, singing, territorial) performance. We know now that there is some variation in the parasite loads among individuals but some critical experiments are required to determine whether there is a plausible cause and effect relationship between blood parasite levels and performance.

III. "Song Performance of Territorial Males"

As a measure of song performance both for the study described above and also as part of a test of various hypotheses to explain the dawn chorus of birds in general, we quantified both the diurnal and seasonal patterns of singing by territorial males in this population. In addition, the songs of 15 individually-marked males were recorded on several occasions to look for seasonal and microgeographic patterns in song structure and complexity. These songs will also be compared with those of males recorded at Chaffey's Lock, Elgin, and Kingston to determine whether there are local dialects in this species. Data from each of the males studied in detail will be used to look for correlations between singing activity and song complexity and various measures of reproductive performance and aggression.

IV. "Foraging Mechanisms"

In collaboration with Dr. Barry Frost (Dept. of Psychology, Queen's University), we are examining in detail the behavioural and neurophysiological mechanisms used by robins when foraging for earthworms on a lawn. This work was prompted by someone asking whether robins used sight or sound to find worms. Contrary to an earlier paper published on this subject we discovered that robins can actually use both sensory modes to locate worms. This project will now focus on determining how and when birds use sight and sound and how prey localization is mapped within and between these two modes.

V. "Parenthood"

Since both egg-dumping and extra-pair copulations have been reported in this species, knowledge of the precise parenthood of broods is essential for the correct evaluation of patterns of both parental care and mate choice. To do this we hope to use recombinant DNA techniques (e.g. DNA fingerprinting) to determine the exact parentage of each nestling in the population. In collaboration with Dr. Peter Boag (Biology, Queen's University) we began collecting blood samples from both adults and offspring so that techniques and the feasibility of this sort of analysis could be assessed. One of our most important goals in this work will be to examine the variation in the actual reproductive success of males relative to our various measures of phenotypic quality (singing, plumage, parasites, territoriality, etc.).

Assistants: Tracey Thompson, Susan McRae, Tarmo Poldma, Karen Holder, Linda Dupuis, Elsie Krebs.

DR. L. RATCLIFFE

"Neighbour-Stranger Discrimination in Chickadees"

In 1987 I began field experiments at QUBS on individual recognition by song in Black-capped Chickadees (*Parus atricapillus*). This work complements and extends ongoing lab studies of chickadees' perception of note order (syntax) and relative pitch. We individually marked over 100 birds at feeders in late winter, and monitored approximately 25 territories from March to late May. To determine whether the "fee bee" advertising whistle conveys information about individual identity, we exposed territorial males to playback of songs of immediate neighbours and local strangers. In agreement with other neighbour-stranger studies, chickadees showed significantly stronger aggressive responses towards strangers. The 1988 season will examine which features of song contribute to this discrimination, using computer-synthesized playback stimuli.

Assistants: Pam Sinclair, Elsie Krebs.

DR. R.J. ROBERTSON

"Selective Forces and the Evolution of Breeding Strategies in Birds"

I. Behavioural Ecology of Tree Swallows

A. Settling patterns and extra-box defense: Defense of extra boxes may prove to be advantageous to a male through (i) enabling him to attract additional females, (ii) increasing the attractiveness of his territory to a given female by providing her with a choice of nest sites, (iii) providing an alternative site for renesting should the first nest fail. In the first case, females should prefer males which are not defending extra boxes, since there is good evidence polygyny is disadvantageous for the female. In the latter two cases, females should prefer males which are defending extra boxes. To test these hypotheses, every other box in Bridget's Grid and Hughson's was provided with a paired box 8 m away, and settling patterns were determined throughout April using the scan technique. There was no obvious pattern that males preferred to defend extra boxes, nor that females either preferred or avoided extra-box territories. However, detailed analysis of the data remains to be done.

B. Polygyny: We continued observations on division of labour in feeding nestlings by monogamous and polygynous males. Relatively few males were polygynous, and those were in boxes 27 m apart. Very few of the 8 m paired boxes resulted in polygyny. Males tend to feed only at the nest of the primary female, and where males try to assist at the nest of the secondary female, where nestlings are younger, the male occasionally tries to feed inappropriately large food items.

C. Infanticide: Males were removed shortly after clutch completion to determine whether replacement males would disrupt a clutch of eggs. Females were receptive and copulated with replacement males as long as 12 days after clutch completion. Males which replaced during the first few days of incubation adopted the nestlings. Males which replaced late in incubation, even though in some cases they had copulated with the female, killed the

nestlings as the eggs hatched. Apparently the former males had been "fooled" into "thinking" they had sired the brood. These studies on infanticide by replacement males and counter-strategies by females will continue in 1988.

Field Assistants: Catherine Vardy and Lisa Venier

Wallace B. Rendell - "Natural Populations of Tree Swallows
(Tachycineta bicolor)" - B.Sc. Thesis.

For the second breeding season, Tree Swallows breeding in natural cavities in Allen's Pond and Osprey Marsh were studied by Wally to enable comparisons with those breeding in grids of nest boxes. Information was obtained on nest dispersion, extra-site defense (quite common), polygyny (there was none), frequency of breeding by subadults (higher than in the grids), clutch size (lower than in the grids), and cavity characteristics in relation to nest success. Nest sites were measured using ropes, ladders, and the help of Floyd, Mark Mallory, Helen Gamble, Janet Cox, and RJR in January/February. Wally completed his thesis in Dec. and after a 6 month stint of working on finches in the Galapagos he will return to write papers from his thesis.

Lisa Venier - "Age-related Patterns of Reproductive Effort in Female Tree Swallows" -B.Sc. Thesis.

Feeding rate, nestling growth rate, and adult weight loss, as indicators of reproductive effort, were measured in paired nests of adult and subadult females.

II. Male Care and the Maintenance of Monogamy in Eastern Bluebirds

The role of paternal care in the maintenance of monogamy in Bluebirds is unclear. Gowaty found male care was unimportant to female success in South Carolina, yet in Ontario, we found male care did affect nesting success. In a cooperative study involving Greg Ball and Al Dufty in New York, and Patty Gowaty at Clemson, we did a geographic comparison, all in the same year, in which males were removed and held in captivity, and female feeding rates and nestling growth rates were measured. Results are currently being analysed. Of peripheral interest to this study was the large amount of variation in the behaviour of replacement males toward the brood of the previous male. This and other aspects of the study will be pursued in 1988.

Field Assistant: Monica Mather

III. Graduate Students

Monica Mather - "Bobolink Breeding Behaviour and Ecology"

As a pilot study for possible M.Sc. projects, Bobolink territories were mapped, nests were located, and model presentations were tried at a number of fields on the New Land and near Crosby and Elgin. A thesis proposal involving male song and female choice is being developed.

Kelvin Conrad - "Goldfinch Nesting Behaviour"

In exploring possible studies for Ph.D. research, goldfinch nests were located and the involvement of the male and any secondary males (none) was observed. Nests were found over a range of heights and habitats that were unexpected based on previous literature.

Jessie Deslauriers - "Phoebe Response to Cowbird Presence at the Nest" - B.Sc. Thesis

The nest parasitism of Brown-headed Cowbirds can provide a source of nesting failure for many small passerines. It is hypothesized that some passerines have learned to recognize female Cowbirds as a possible threat, and react aggressively to their presence near the nest. Some passerines may also have learned to recognize female Cowbird chatter. To test these hypotheses, during a one-week period in mid-May and during one day in late June, a series of presentations of female cowbird models and song sparrow models (non-threatening controls) was made to nesting phoebes on eggs. Presentations were made both silently, and accompanied by recordings of female cowbird and song sparrow songs. A female cowbird model was presented at one nest at one-hour intervals throughout one day to test the possibility of either habituation to the model or increased aggressiveness due to positive reinforcement by removal of the model by the investigator. It is planned to continue this project for at least a further five years.

As well, a mist-net banding program with consistent handling and recording of birds was carried out, a continuation of a program begun the previous year to serve as a control for banding data from Prince Edward Point being analysed for differences in temporal movement during spring migration of selected passerine groups and selected Parulid species. Captures were extremely sparse and insignificant data were obtained. However, it is planned to continue this project for at least one more year, since the poor capture results may have been the result of a notably poor spring migration showing throughout the eastern Ontario region.

Publications:

✓ Stutchbury, B.J. and R.J. Robertson. 1987. Signaling subordinate and female status: two hypotheses for the adaptive significance of subadult plumage in female Tree Swallows. *Auk* 104: 717-723.

✓ Stutchbury, B.J. and R.J. Robertson. 1987. Do nest building and first egg dates reflect settlement patterns of females? *Condor* 89:587-593.

✓ Stutchbury, B.J. and R.J. Robertson. 1987. Behavioral tactics of subadult female floaters in the tree swallow. *Behavioral Ecology and Sociobiology* 20:413-419.

✓ Stutchbury, B.J. and R.J. Robertson. 1987. Two methods of sexing adult Tree Swallows before they begin breeding. *Journal of Field Ornithology* 58:236-242.

✓ Stutchbury, B.J. and R.J. Robertson. Within-season and age-related patterns of reproductive performance in female tree swallows (*Tachycineta bicolor*). *Canadian Journal of Zoology*. In

Press (Accepted 15 April 1987).
Robertson, R.J. and B.J. Stutchbury. Experimental evidence for sexually selected infanticide in Tree Swallows. *Animal Behaviour*. In Press. (Accepted 4 August 1987).

Mountjoy, D.J. and R.J. Robertson. Nest construction tactics in the Cedar Waxwing. *Wilson Bulletin*. In Press (Accepted 14 July 1987).

Mountjoy, D.J. and R.J. Robertson. Why are waxwings waxy? Delayed plumage maturation in the Cedar Waxwing. *Auk*. In Press. (Accepted 30 Sept. 1987).

DR. J. SMOL

"Diatoms as Indicators of Lake Trophic Status"

Catherine Christie (M.Sc. Student) is describing the diatom floras from a suite of Southern Ontario lakes, and correlating these assemblages to lakewater characteristics, such as phosphorus and chlorophyll *a* levels. These analyses will eventually allow workers to use fossil diatoms to infer past production levels in lakes, much as these techniques are currently being used in acidification studies. Many lakes near QUBS (including Lake Opinicon) are being used in this study.

Michele Flatters - "Zooplankton and Fish Feeding in Beaver Ponds" - B.Sc. Thesis

Michele Flatters (B.Sc. Honours Student) is comparing the zooplankton communities in two small beaver ponds adjacent to Lake Opinicon. Upper Dowsley Pond is fishless, whilst nearby Lower Dowsley has fish. Otherwise, lake characteristics are similar. This study should elucidate the relationship between fish predation and zooplankton dynamics.

II. RESEARCH BY NON-QUEEN'S STUDENTS AND STAFF

DR. A. FORSYTH AND DR. M. WOOD - Biosystematics Research Institute, Ottawa, Ontario.

"Maternal Care in Treehoppers"

In 1987 work continued on the maternal care tactics of the treehopper *Publilia concava* (Homoptera: Membracidae). We conducted an ant exclusion experiment preventing ants from tending half of a membracid population located on 60 *Eupatorium* plants. Ant-tended females abandoned their egg masses twice as often as ant excluded females. Females which abandoned clutches usually began new clutches. Egg-guarding by females resulted in greater hatch success than clutches in which females were removed. Egg predation and parasitism by Mymarid wasps were major mortality sources. Survivorship of membracid nymphs was enhanced by ant-tending but the effect was reduced when large numbers of nymphs were found on the same plant. Lady beetles were more abundant on ant-excluded plants and consumed large numbers of young membracid nymphs. Ants, primarily *Camponotus pennsylvanicus*, aggressively exclude predatory insects. Preliminary evidence suggests that *Crematogaster* tending slows nymphal

developmental rate.

Assistant: David Bell

DR. J.H. FULLARD - Department of Zoology, Erindale College of University of Toronto, Mississauga, Ontario.

"Insect Sensory Physiology and Neuroethology"

The acquisition of several new pieces of equipment (Brown-Flaming microelectrode puller, Leitz micromanipulators, air cushion table) allowed for a number of projects involving the intracellular examination of neurons associated with sensory processing and behaviour in insects.

"Contralateral Sound Processing in Notodontid Moths"

The central nervous system of the notodontid moth Pheosia rimosa was intracellularly probed to locate auditory interneurons previously described for the noctuid moth, Heliothis virescens (Boyan and Fullard, 1986). Notodontids are of particular interest because of their one-celled ears which give them the world's simplest auditory systems. An auditory interneuron likely homologous with the noctuid 504 cell was encountered in the metathoracic ganglion of P. rimosa. This cell was strongly excited by ipsilateral sounds and appeared to be weakly inhibited by contralateral sounds. Its morphology differs from that of the noctuid 504 interneuron in that it possesses an extremely filamentous contralateral synaptic output which may be related to the increased role this cell plays in the one-celled notodontid. The inhibitory responses seen in 504 may function in bilateral sound localization, important in the detection of the echolocation signals of insectivorous bats.

Assistant: Jayne Yack.

"Low Frequency Acoustically-activated Interneurons in Moths"

Intracellular examinations revealed metathoracic interneurons that responded to sounds of frequencies between 1 and 3 kHz in moths from the following families: Noctuidae, Arctiidae, Notodontidae and Sphingidae. These cells were located in the metathoracic ganglion and appeared to ascend from the abdomen. Their axons curved into the metathorax and terminated with finely discussate arborizations posterior to the junction between the meta- and mesothoracic ganglia. Low frequency interneurons are of interest since the typical auditory characteristics of moths rule out such sensitivities and the sphingid moth does not possess ears. I predict that these cells have their input with the cercal receptors of Orthoptera.

Assistant: Jayne Yack

"Primitive Cercal Receptors and their CNS Connections"

The terminal ganglion and the anteriorly projecting ventral nerve cord of the neuropteran, Corydalus sp. and a trichopteran were examined for wind responses to filiform receptors located along fleshy cercal-like projections on the posterior margin of the last abdominal segment. Long hairs were found that would activate large (although not giant) extracellular spikes in the

nerve cord connective. These hairs were concentrated in patches facing outward on the terminal abdominal segment and may function as either wind or disturbance receptors. Large axons associated with rapid, anti-predator response are known in cockroaches and grasshoppers but homologous neural circuits in more primitive insects have not been investigated. A study examining such receptors and CNS interneurons in the firebrat, Thermobius suggested that only insects that undergo incomplete metamorphosis would be expected to possess such receptors. The presence of these cells in neuropterans and trichopterans, insects with complete metamorphosis suggests that functions other than predator avoidance (e.g., flight control) may be the primitive roles associated with such neurons.

Assistant: Jayne Yack

Dr. J. Fullard and Dr. G. Boyan (Australian National University)

"Functional Organization of the Moth Auditory System"

In a previous publication we identified a set of sound-sensitive interneurons in a noctuid moth (Heliothis virescens) and based on their physiological properties we proposed a model for how evasive behaviour (against bats) may be effected. Our results indicated that three of the four most commonly encountered interneurons (501, 503, 504) will receive monosynaptic input from the most sensitive (A1) auditory receptor and predicted the types of connections these neurons make with flight motor neurons. In Catocala noctuid moths, we identified the same set of sound-sensitive interneurons as in H. virescens and tested aspects of the model. Our results are summarized as follows: 1. Interneurons 501, 503 and 504 receive monosynaptic EPSP's from the A1 auditory afferent; 2. within this group, interneuron 504 appears not to receive input from the second auditory afferent (A2), suggesting a separate circuit processing information derived from this afferent; 3. intracellularly filled A1 receptor processes indicate this cell has outputs in: (a) the anterior region of the metathoracic ganglion (where interneurons 501, 503, 504 receive input), and where stainings of interneuron 503 and A1 afferent in the same preparation suggest synapses occur, (b) anterior in the mesothoracic ganglion, where we identified an interneuron (510) which does, indeed, receive monosynaptic input from the A1 afferent, and probably from other sound-sensitive interneurons as well; 4. we have yet to find a thoracic sound-sensitive interneuron whose morphology does not correspond to the U-shape we previously described. This suggests a ladder-like arrangement of intra- and inter-segmentally repeated morphologies; 5. we now have evidence to suggest that the previously reported 'pulse-coder' interneuron fires phasically as a result of inhibition which may have its origin in a feed-back loop; 6. we have now identified a rhythmically active (flight) interneuron (401) which receives powerful excitatory auditory input sufficient to reset the rhythm. The exclusively ipsilateral morphology of 401 and its excitatory response conform to a prediction as to how the auditory pathway to the flight musculature is organized. Further, the mesothoracic motor neuron innervating the dorsal longitudinal flight muscle contralateral to the stimulated ear is inhibited by sound as predicted by the model. Whilst results conform to our model of anti-bat evasive flight behaviour in moths, we

are impressed by the complexity of central auditory processing in an insect with only two auditory afferents.

Assistant: Mike Stoneman

Mike Stoneman - "Captive Studies of a Substrate-gleaning Bat, Myotis septentrionalis"

This summer we recorded the feeding and flight behaviour of two male eastern long-eared bats, Myotis septentrionalis, a species which, until now, has not been observed in close quarters. Observations were carried out under red lights in a plastic-screened enclosure. This enclosure (idea courtesy of R. Barclay) has the advantage of providing an ambient-temperature holding area with a durable type of screen not injurious to the bats. The animals were fed moths taken from a nearby collecting lamp, required no hand-feeding or additional vitamin supplements and were released two months later. Myotis septentrionalis orients to non-flying insects, either on the screen or in the hand whenever they were actively flapping their wings. Recordings were made of the bat's echolocation emissions as they flew in the room and as they approached the insects. We predict that M. septentrionalis like its western congener, M. evotis, feeds on substrate-located insects and uses high-frequency sounds emitted by the insect to find them. The success at keeping the bats healthy for so long without involved feeding programmes suggests that this cage type is an efficient method to study temperate substrate-gleaning species.

Jayne Yack - "Mechanoreceptor Origins of Insect Tympanal Organs - M.Sc. Thesis

It has been commonly supposed, although never tested experimentally, that insect tympanal organs represent the evolutionary adaptation of a primitively proprioceptive structure monitoring stretch or tension of the cuticle.

Moths of the superfamily Noctuidae possess a pair of metathoracic tympanal organs used primarily for the detection of the ultrasonic echolocation cries of insectivorous bats. Tympanal organs are absent however, in other taxa, such as the superfamilies Bombycoidea and Cossioidea. I predicted that atympanate moths possess neural elements which are homologous to the tympanic nerve cells in the noctuid moth, and that these homologues act as proprioceptors monitoring tension of the cuticle or body wall.

Morphological studies of the peripheral nervous system in 8 atympanate moth species show that atympanate moths possess an homologous nerve (IIIN1b) to the noctuid tympanal nerve. Neurophysiological recordings of the IIIN1b nerve in atympanate species suggested that individual cells are homologous to the acoustic cells of the noctuid ear and that they act as proprioceptors monitoring movements of the hindwing.

These data support the hypothesis that insect tympanal organs are derived from proprioceptive sensillae.

Thesis:

Yack, J.E. 1987. The mechanoreceptive origin of insect tympanal organs: A comparative study of homologous nerves in tympanate and atympanate species of lepidoptera. M.Sc. Thesis, Department of Zoology, Erindale College of University of Toronto, Mississauga, Ontario.

Publications:

Cardone, B. and J.H. Fullard. 1987. Sexual dimorphism in the auditory characteristics of the gypsy moth. *Phys. Ent.* (in press).

Fullard, J.H. 1987. Sensory ecology and neuroethology of moths and bats: interactions in a global perspective. In: Recent advances in the study on bats. Fenton M.B., Raynor, M. and Racey, P. (eds) - Cambridge Univ. Press, Cambridge.

Fullard, J.H. 1988. Sensory ecology of moths and bats: global lessons in staying alive. In: Predator-prey interactions. Evans, D. and Schmidt, J. (eds) - SUNY Press (in press).

Fullard, J.H. 1988. The tuning of moth ears. *Experientia* (in press).

DR. M.R. GROSS - Department of Zoology, University of Toronto, Toronto, Ontario.

"Evolutionary Ecology of Fish Reproduction"

We are conducting long-term field studies on fish (1) mating system evolution, (2) parental care evolution, and (3) alternative life history evolution. Much of the work on alternative life history evolution is in collaboration with Dr. David Philipp and his group from the Illinois Natural History Survey.

Publications:

Sargent, R.C., P. Taylor and M.R. Gross. 1987. Parental care and the evolution of egg size in fishes. *American Naturalist*. 129: 32-46.

Sargent, R.C. and M.R. Gross. 1986. Williams' principle: an explanation for parental care in teleost fishes. In, *The behaviour of teleost fishes* (T. Pitcher, ed.), Croom Helm Publishers, p. 275-293.

Theses:

Coleman, R.M. 1986. Parental investment theory: tests in bluegill sunfish (*Lepomis macrochirus*: Centrarchidae). M.Sc. Thesis, Department of Biological Sciences, Simon Fraser University, Burnaby, B.C.

Greenough, J. 1986. Male parental investment and the evolution of female choice. B.Sc. Thesis, Department of Biological Sciences, Simon Fraser University, Burnaby, B.C.

DR. D.P. PHILIPP - Aquatic Biology Section, Illinois Natural History Survey, Champaign, IL

"Bluegill Reproduction Studies"

Our group at the Illinois Natural History Survey is collaborating with Dr. Mart Gross and his research team at the University of Toronto to study a

number of aspects of bluegill reproduction. The bulk of our studies center on assessing the genetic, physiological and environmental factors which may influence alternative reproductive behaviors among male bluegill. During 1987, these studies included experiments designed to assess how the density of young-of-the-year bluegill and density of adult parental male bluegill affected the rate of precocious maturation of these young. That is, can precocious maturation be influenced by the social structure of the population? In addition, we have continued selective breeding experiments designed to construct all-parental and all-cuckolder strains of Lake Opinicon bluegill. We have also finished a four-year life history study on an experimental population of bluegill established in a research pond.

Assistants: Pam Austin, Desarae Bushong, John Reinke

Julie Claussen - "The Dynamics of Colony Formation and the Reproductive Effort of a Bluegill Population"

1987 was the third year of this study. For the last two years, we have tracked the spawning activity of all colonies formed in a five bay study area throughout the spawning season. To determine if parental males routinely respawn during a season, males were marked and recaptured. We have monitored how many of these males returned to the study area each year to spawn. We also have assessed how reproductive success varied spatially among nests on different areas within a colony, among colonies from different areas of the study site and temporally among the different individual spawning bouts during the season. In addition, during 1987 we determined the rates of egg fertilization and successful hatching in the field and under laboratory conditions for several colonies during each spawning bout to assess the spatial and seasonal variation in spawning success.

Pawel Kindler - "Hormonal Analysis of Male Bluegill during the Spawning Season" - Ph.D. Thesis.

Pawel has developed the radioimmune assay (RIA) techniques to quantify testosterone levels in the sera of male bluegill. Using this technique, Pawel has determined the pattern of testosterone production among male bluegills throughout the annual cycle. He has also studied how testosterone levels change during the spawning season in detail. In addition, by determining the differences in testosterone levels among parental males from different areas within a bluegill colony, he is assessing the relationship between hormone production, aggression and reproductive success. He is also assessing the role which testosterone plays in determining which life history, parental or cuckolder, a male bluegill assumes. In addition, during 1987, Pawel conducted a series of experiments in which he manipulated androgen and prolactin levels among parental male bluegill through exogenously implanted pellets. Behavioral observations of the ensuing spawning and parental care activities were then made to determine effects of these treatments.

Blake Konkle - "Interspecific Hybridization of Bluegill and Pumpkinseed"

Blake's research has several goals. First, he hopes to unravel the dynamics of the hybridization events, that is, to determine how these hybrids are being formed and why. This will be accomplished through a combination of behavioral studies in the field and laboratory studies using restriction endonuclease digestion analysis of mitochondrial DNA to determine maternity.

He also hopes to assess why total introgression between the two species does not occur even though the amount of F_1 hybrid production is quite significant. This will be accomplished through molecular genetic analysis of broods produced in the wild at Lake Opinicon and of broods produced in the laboratory from specific in vitro crosses. During 1987 behavioral observations were begun in the field, collections of known bluegill, pumpkinseed, and F_1 hybrids were made, and mitochondrial DNA isolated. In addition, F_1 crosses of known direction were produced and are being reared for further experimentation.

Publications:

Kindler, P.M., D.P. Philipp, M.R. Gross, and J.M. Bahr. Serum 11-ketotestosterone and testosterone concentrations associated with breeding behavior in male bluegill (Lepomis macrochirus: Centrarchidae). Submitted to General and Comparative Endocrinology.

Gross, M.R. and D.P. Philipp. Inheritance of alternative male reproductive patterns in fish. Submitted to Science.

DR. BRUCE P. SMITH - Dept. of Biology, University of New Brunswick, Fredericton, New Brunswick.

"Water Mite Parasitism of Aquatic Insects"

During 1987 I continued research on water mites of the genus Arrenurus. Intensive collections of emergent insects at Deadlock Bay were again conducted in order to determine patterns of host utilization, and spatial and temporal relationships within this host/parasite community. This concludes sampling for the descriptive phase of the study. Collections will be sorted and specimens will be identified through the upcoming year.

Intensive collecting of female Arrenurus, Hydrachna and Eylais mites was conducted, and females were maintained in the laboratory to obtain eggs, and subsequently, larvae. This rearing program resulted in many associations between adults and compose diagnoses and keys for the larval stage, and can identify larval mites encountered in my studies of the host/parasite community.

Assistants: Wanda Cook, Lori Laughland

Publications:

Smith, B.P. New Species of Hydrachna (Acari: Hydrachnidia; Hydrachnidae) parasitic on water boatmen (Insecta: Hemiptera; Corixidae). Can. J. Zool., 65(11): in press.

Wanda Cook - "A Comparative Study of Reproductive Strategy among Females of Arrenurus spp."

This summer I continued my study of the reproductive strategies of female water mites; I was able to significantly increase my sample sizes. Species of the genus Arrenurus show dramatic differences in the size and number of eggs which they produce in a clutch. I looked at these differences on an intraspecific level, among species in each of the four subgenera, and among the subgenera. The resulting patterns seem to be related to the the type of

host which the larval mites parasitize, either odonates or dipterans.

Lori Laughland - "Stimuli for successful detachment of larval Arrenurus danbyensis mites from Coquillettidia perturbans mosquitoes" - B.Sc. (Hons.) Thesis.

Larvae of most species of water mites are parasites of aerial insects, but must somehow return to the water to continue their lifecycle. Previous researchers have speculated that the larval mites cue to the host's egg-laying or to contact with water to initiate detachment from the host, while others suggest detachment is by chance. One author observed that crushing the host's head resulted in rapid detachment by the mite, while crushing other parts of the body had no effect. One possibility is that the head crush releases hormones from the corpora cardiaca and corpora alata located in the insect's brain - hormones known to be related to the host's ovarian cycle.

In the summer of 1987 I conducted experiments with larval Arrenurus danbyensis, a parasite of the mosquito Coquillettidia perturbans, to test potential stimuli for detachment. Mite behaviour (time to drop off) was recorded with respect to the following manipulations: 1. water, 2. carbon dioxide, 3. head crush, 4. abdominal crush, 5. thoracic crush, 6. head extract, 7. abdominal extract and 8. head crush with the head isolated by neck ligature. Free-flying mosquitoes for these experiments were caught as they were attracted to lights left on by late-working biologists in the trilab at the station. Research for this project has been completed, and analysis of data is nearing completion. Thesis and manuscript preparation should begin shortly.

Patti Ramsey - "Morphological Examination of the Male and Female Reproductive System of Parasitized and Nonparasitized Chironomids" - M.Sc. Thesis - Supervisor D.B. MacKinnon (U.N.B.)

During July of 1987, adult chironomids of the genus Chironomus were gathered at the Queen's Biological Station. These chironomids were examined for evidence of mermithid nematode parasitism. Nonparasitized chironomids and mermithids reared to adulthood were mounted for classification. Both parasitized and nonparasitized chironomids and all of the life-cycle stages of the mermithids (with the exception of the preparasitic stage) were fixed for later histological and ultrastructural examination.

My master's project will entail an investigation of any structural pathology of the chironomid reproductive system resulting from the presence of mermithid parasites. To fully explain such damage I will also examine the nervous, endocrine, digestive, and circulatory systems of the chironomid.

DR. S. VAN DER KLOET - Department of Botany, Acadia University, Wolfville, Nova Scotia

"Demography of Vaccinium corymbosum in Hebert Bog"

After nine years of observation, this population of 50 tagged shrubs is steadily losing its vigour. If I compare seed production prior to the December 1980 cold-wave, which killed all the flower buds resulting in no fruit production in 1981, I found that in 1979 and 1980 about 66% of the bushes bore some fruit with 8% yielding > 1000 berries. After 1981, only about 40% bore any fruit at all, and then rarely more than 300 berries. Thus

in 1987, although flowering began very early (1st corollas were at anthesis on 6 May 87) and consequently, fruiting also began a month earlier than usual. Thus by 20 July 1987, most of the fruit had already been dispersed. Nevertheless only 44% of the bushes produced any fruit at all and only four shrubs had between 300 and 500 berries, the rest fewer than 50. Furthermore, main stems are still dying back to the crown, and the emerging basal sprouts are still browsed by snow-shoe hares and deer.

DR. P. WEATHERHEAD - Department of Biology, Carleton University, Ottawa.

"Mate Choice and Sexual Selection in Red-winged Blackbirds"

This project, now in its third year, is aimed at applying molecular biological techniques to determine patterns of reproductive success, and therefore mate choice in red-winged blackbirds. Complete blood sampling of the breeding population and their offspring was continued in 1987. The laboratory work being done at Queen's by Drs. Boag and White, has proceeded to the point where preliminary results relevant to the project's aims are imminent. Blood sampling was also extended to include the production of smears for general blood parasite sampling. Information gained from the smears will allow the determination of the role of parasites in the expression of secondary sexual characteristics in mate choice. This project will be continued in 1988.

Assistants: Drew Hoysak, Kevin Dufour, Linda Dupuis.

"Mate Choice and Sexual Selection in Robins"

This project is under way in conjunction with Dr. R.D. Montgomerie (Queen's). Details of research during 1987 were presented in this report in Dr. R.D. Montgomerie's resume.

"Ecology and Behaviour of Black Rat Snakes"

No specific studies were undertaken with this project in 1987, but the long term monitoring of the population by marking and measuring all black rat snakes encountered near the field station was continued.

Assistants: Linda Dupuis, Drew Hoysak, most everyone.

Kit Muma - "Sexual Selection in Female Red-winged Blackbirds" - M.Sc. Thesis.

Field work was completed on this project in 1987. Two general approaches were used to address the question of whether "male" characteristics expressed in females are the result of direct sexual selection on females associated with female-female competition, or due only to incomplete suppression of a trait selected for in males. Field studies examined nesting parameters and the effect of female plumage variability on male and female behaviour. An aviary study investigated the role of plumage variation on dominance relationships. In general, the data appear to support the hypothesis that these traits in females are nonadaptive, reflecting only incomplete suppression of male traits.

Assistant: Linda Dupuis

Kevin Dufour - "Decoy Trap Biases in Brown-headed Cowbirds" - B.Sc. Thesis.

Studies conducted outside the breeding season have shown that trapping methods that rely on food or decoys disproportionately capture birds that are younger and in poorer condition. To determine whether these biases persisted during the breeding season (when food should be abundant), and in a brood-parasitic species (that is paying no cost for parental care), cowbirds caught throughout the breeding season in decoy traps were compared with those caught by other means. The data indicate that age and condition biases do persist, and that overlaying these biases are patterns specific to sex and habitat.

Susan McRae - "Nestling and Fledgling Behaviour of American Robins" - B.Sc. Thesis.

Robin nestlings were given identifying marks and then videotaped so that their movements in response to patterns of parental feeding could be observed. Variables of interest were the predictability of parental perch locations at the nest and how perch location affected the pattern of food distribution to various positions in the nest. Prior to fledging, nestlings were banded and their movements monitored for up to two weeks after fledging. The aim of this aspect of the study was to determine whether there was brood division by the parents and how fledgling movements affected parental foraging patterns before and after fledging.

Publications:

Eckert, C.G. and P.J. Weatherhead. 1987. Competition for territories: is resource holding potential realized in red-winged blackbirds? Behavioural Ecology and Sociobiology 20: 369-375.

Eckert, C.G. and P.J. Weatherhead. 1987. Owners, floaters and competitive asymmetries among territorial red-winged blackbirds. Animal Behaviour 35: 1317-1323.

Eckert, C.G. and P.J. Weatherhead. 1987. Ideal dominance distributions: a test using red-winged blackbirds (Agelaius phoeniceus). Behavioral Ecology and Sociobiology 20: 43-52.

Eckert, C.G. and P.J. Weatherhead. 1987. Male characteristics, parental quality and the study of mate choice in the red-winged blackbird (Agelaius phoeniceus). Behavioral Ecology and Sociobiology 20: 35-42.

Montgomerie, R.D. and P.J. Weatherhead. Risks and rewards of nest defence by parent birds. Quarterly Review of Biology, in press.

Teather, K.L., Muma, K.E. and P.J. Weatherhead. Estimating female settlement from nesting data. Auk 105: 196-200.

Weatherhead, P.J. 1987. Field testing information transfer in communally roosting birds. Animal Behaviour 35: 614-615.

Weatherhead, P.J., Greenwood, H. and R.G. Clark. Natural selection and sexual selection on body size in red-winged blackbirds. Evolution 41: 1402-

1403.

Weatherhead, P.J. and K.L. Teather. 1987. The paradox of age-related dominance in brown-headed cowbirds. Canadian Journal of Zoology 65: 2354-2358.

Theses:

Dufour, K. 1987. Decoy trap biases in brown-headed cowbirds. B.Sc. Thesis, Department of Biology, Carleton University, Ottawa, Ontario.

McRae, S. 1987. Nestling and fledgling behaviour of American robins. B.Sc. Thesis, Department of Biology, Carleton University, Ottawa, Ontario.

Muma, K.E. 1988. Sexual selection in female red-winged blackbirds. M.Sc. Thesis. Department of Biology, Carleton University, Ottawa, Ontario.

DR. R.C. WYNDHAM - Department of Biology, Carleton University, Ottawa.

Roberta Fulthorpe - "Studies on the survival of a 3-Chlorobenzoate degrading bacteria in natural water systems"

The size range of organisms studied at the Biological Station was expanded with the introduction of bacteriological investigations this summer. Dr. Wyndham's work at the University of Toronto had uncovered a strain of a common surface water bacterium, Alcaligenes, capable of degrading 3-chlorobenzoate which is a chlorinated organic molecule intermediate in the breakdown of herbicides, PCB's and related compounds. This strain, named Alcaligenes sp. BR60, evolved in the Niagara region in contaminated waters and shows potential as a biological agent for waste water cleanup. Its ability to survive in natural communities other than its place of origin is unknown, so the object of research is to determine the survival characteristics of BR60 under a range of chlorobenzoate contamination conditions. The QUBS station was chosen because of its surface water chemistry and because of the availability of a convenient toxicology facility. This facility was used to set up natural water mesocosms receiving different concentrations of chlorobenzoate. The survival of BR60 was tracked using specific DNA probes.

Preliminary experiments carried out in summer of 1987 indicate that the bacteria persist in natural waters even in the absence of chlorobenzoate contamination and that genetic material is transferred from BR60 to other bacterial species within the community. The nature of this genetic transfer and its implications for the use of specialized bacteria in waste water cleanup are being investigated, and more refined mesocosm experiments are planned for the coming summer.

Table 4: Summary of Research use at Queen's University Biological Station 1987.

Project Supervisor and Affiliation	Project Title	Students and Affiliation	Residency
Dr. L. Aarssen (Queen's)	Competitive Ability in plants		Occasional
	Competition in Grassland Plants	Garry Epp (Queen's)	Occasional
		Stan Vasiliasuskas (Queen's)	Occasional
Dr. P.W. Colgan (Queen's)	Field Ethology of Fishes		Occasional
	Habitation of Predatory Stimuli in Killifish	Carolyn Welch (Queen's)	Occasional
	Behavioural Comparisons of Killifish Populations	Liane Gabora (Queen's)	Occasional
	Predator Avoidance in Fishes	Vytenis Gotceitas (Queen's)	Occasional
Dr. A. Crowder and Dr. R. Harmsen (Queen's)	Effects of Grazing on Old Field Succession		Occasional Occasional
	Population Ecology and Herbivory of Skippers	Bruce Henderson (Queen's)	Occasional
		John-Paul Sigouin (Queen's)	Occasional
Dr. J.A. Keast (Queen's)	Community Ecology of Fish and Songbirds		May 1-Sept. 5
		Michelle Flatters (Queen's)	May 8 - July 31
	Fish Community Ecology of Beaver Ponds	Michael Fox (Queen's)	May 17 - Aug. 20
		Ian Smith (Queen's)	May 17 - Aug. 20

Table 4 (continued)

Project Supervisor and Affiliation	Project Title	Students and Affiliation	Residency
Dr. R.D. Montgomerie (Queen's)	Sexual Selection and Parental Care in Robins		May 1 - Aug. 1
		Tracey Thompson (Queen's)	May 1 - July 31
		Elsie Krebs (Queen's)	June 9 - July 12
		Tarmo Poldma (Queen's)	May 8 - 17
		Karen Holder (Queen's)	May 8 - 27
Dr. L. Ratcliffe (Queen's)	Neighbour-Stranger Recognition in Chickadees		Occasional
		Pam Sinclair (Queen's)	Occasional
		Elsie Krebs (Queen's)	Occasional
Dr. R.J. Robertson (Queen's)	Breeding Strategies in Birds		May 1 - Sept. 5
		Monica Mather (Queen's)	Apr. 15 - Aug. 27
		Wally Rendell (Queen's)	Apr. 29 - Sept. 1
		Catherine Vardy (Queen's)	Apr. 20 - July 16
		Lisa Venier (Queen's)	May 1 - Aug. 23
	Pheobe Behavioural Responses to Cowbirds	Jessie Deslauriers (Queen's)	May 10-17 June 14-23

Table 4 (continued)

Project Supervisor and Affiliation	Project Title	Students and Affiliation	Residency
Dr. J. Smol (Queen's)	Diatoms as Indicators of Lake Trophic Status		Occasional
	Zooplankton Communities in Beaver Ponds	Michelle Flatters (Queen's)	May 9 - July 31
Dr. A. Forsyth and Dr. M. Wood (Bio- systematics Research Institute)	Maternal Care in Treehoppers		Occasional Occasional
		David Bell (Queen's)	May 18- Aug. 17
Dr. J. Fullard (Erindale - U. of Toronto)	Insect Neuroethology and Sensory Physiology		May 9 - July 29
	Functional Organization of Moth Auditory System	Dr. George Boyan (Australian National University)	July 2 - 31
	Mechanoreceptor Origins of Insect Auditory Systems	Jayne Yack (Erindale - U of T)	May 8 - July 7
	Captive Studies of a Substrate-gleaning Bat	Mike Stoneman	June 1 - Sept. 10
Dr. M.R. Gross (U. of Toronto)	Evolutionary Ecology of Fish Reproduction		Occasional
		Ron Coleman (U of T)	July 2 - 7
Dr. D.P. Philipp (Illinois Natural History Survey)	Genetic Aspects of Bluegill Reproduction		May 26 - July 31
	Colony Formation and Reproductive Effort in Bluegill	Julie Claussen (INHS)	May 26 - July 31

Table 4 (continued)

Project Supervisor and Affiliation	Project Title	Students and Affiliation	Residency
		Pam Austin (U. of Illinois)	May 30 - July 20
		Desarae Bushong (U. of Illinois)	May 30 - July 20
	Hormonal Analysis of Male Bluegill during Spawning	Pawel Kindler (INHS)	June 1 - July 14
		John Reinke (U. of Illinois)	May 30 - July 20
	Intraspecific Hybridiz- ation between Bluegill and Pumpkinseed	Blake Konkle (INHS)	June 9 - July 15
		Anna Toline (U. of Toronto)	June 9 - July 15
Dr. B.P. Smith (U. of New Brunswick)	Water Mite Parasitism of Aquatic Insects		May 3 - Sept. 1
	Reproductive Strategies among Female Mites	Wanda Cook (U.N.B.)	May 4 - Sept. 1
	Stimuli for Detachment of Larval Mites	Lori Laughland (U.N.B.)	May 16 - Sept. 1
	Structural Pathology of Parasitized Chironomids	Patti Ramsey (U.N.B.)	June 1 - 3, July 1 - 14
Dr. S. Vander Kloet (Acadia)	Demography of <u>Pinus</u> <u>rigida</u> and <u>Vaccinium</u> <u>corymbosum</u>		Occasional
Dr. P. Weatherhead (Carleton)	Mate Choice and Sexual Selection in Red-winged Blackbirds		Apr. 24 - July 21
		Drew Hoysak (Carleton)	Apr. 1 - Aug. 14

Table 4 (continued)

Project Supervisor and Affiliation	Project Title	Students and Affiliation	Residency
Dr. Wyndham (Carleton)	Ecology and Behaviour of Black Rat Snakes	Linda Dupuis (Carleton)	May 1 - July 31
	Decoy Trap Biases in Brown-headed Cowbirds	Kevin Dufour (Carleton)	Apr. 15 - Aug. 17
	Nestling and Fledgling Behaviour of Robins	Susan McRae (Carleton)	Apr. 24 - Aug. 9
	Sexual Selection in Female Red-winged Blackbirds	Kit Muma (Carleton)	Apr. 1 - Sept. 1
			Occasional
		Roberta Fulthorpe (Carleton)	June 7 - Sept. 4

Other Visitors to QUBS 1987

Sheila Macfie (U. of Alberta)
Chris Eckert (M.N.R.)
Tracey Burton
Lorne Wolfe (U. of Illinois)
Dr. W. Redmond (S.U.N.Y.)
Brent Charland (U. of Victoria)
Dr. P. Gregory and Family (U. of Victoria)
Dr. R.D. Oliver (Biosystematics Research Institute)
Valerie Palda (Queen's)
Barbara Martin
Margaret Beilharz (U. of Melbourne, Australia)
Dr. S.E. Frey (U. of Indiana)
Janet Cox (Queen's)
Dr. Tombl Singh (U. of Manipur, India)
Dr. Miko Azuma (Nagasaki University)
Bridget Stutchbury (Yale)
Hamish McIntosh
Sandy Connell
Dr. P.H. Johansen (Queen's)
Sean Sharpe (Queen's)
Dr. Green
Lenore Fahrig
Dr. G. Whitt
Dr. R. Wattendorf
Dr. C. Kroeger
Andrew Mason (U. of T. - Erindale)
Myron Smith (U. of T. - Erindale)
Michelle Venance
Liz Dobson
Johanne Ranger (Pele Island National Park)
Jane Watson
Jennifer Templeton (Queen's)
Caroline Dunlop (Queen's)
H. Lisle Gibbs (U. of Michigan)
Dr. Jim Sutcliffe (Queen's)
Brad Strawbridge
Shannon McCorquodale
Peggy Latimer
Alan Dufour
Mike Eliaszew
Andre Rudnicki
Charles Rendell
Jean Greig (Queen's)
Dr. J. Michael Bristow
Dr. George Williams (S.U.N.Y.)
Linda Fleming
Sharon Fleming
Sharon Stoneman
Wilt Lambo
Doug Menard
Barbara Hilder
Roman Romaniuk
Yves Lariviere

Sue and Nick Alcock
Frank Rohwer and Family (Queen's)
Jim Mountjoy
Ted Joens and Family
Charlotte London
Perry Johnson-Green (Queen's)
Kevin Teather (Carleton)
Jim Complak
Michael Harrison and Family
Patty Rivera
Tim Thompson
Anders Kraus
Don Franklin
Gary Mallen (M.N.R.)
Dr. Ken Budd (Queen's)
Morgan Hull
Jennifer Smith
Fran and Peter Thompson

Table 5 (continued)

	Supervisor	Graduate Student	Assistant	Total
<u>Internal</u>				
Queen's:				
Aarssen	0	121	11	132
Colgan	0	6	3	9
Crowder	1	2	3	7
Harmsen	13	13	10	36
Johansen	7	6	6	19
Keast	129	61	147	337
Montgomerie	93	20	146	259
Ratcliffe	2	0	88	90
Robertson	112	166	347	625
Smol	1	1	1	3
Sutcliffe	2	0	9	11
Total Internal	360	396	772	1528
Total External	398	419	1100	1917
Grand Total	758	815	1872	3445
% Queen's	47.5	48.6	41.2	44.4
% External	52.5	51.4	58.8	55.6

User-days in teaching activities: 1476

Miscellaneous User-days (visitors, families of researchers, field trip participants): 1260

Total User-days: 6181

(Part-time and full-time support staff excluded from above figures)

Table 6: Summary of Conference, Meeting and Field Trip Use of Queen's University Biological Station - 1987.

Organizers	Function	No. of Participants	Duration
Sheila Macfie (Queen's)	Bio 202 (Ecology) Weekend	10	Jan 9 - 11
Kit Muma (Carleton)	Station Reunion	12	Jan 16 - 18
Dr. R. Harmsen (Queen's)	Bio 439 (Population Ecology) Weekend	12	Jan 30 - Feb 1
Dr. D. Bastianutti (Queen's)	Italian Club Weekend	8	Feb 6 - 8
Dr. W. Reeve (Queen's)	German Language Immersion Field Camp	30	Apr 25 - May 2
Dr. G.P. Morris (Queen's)	Departmental Retreat	35	Apr 27 - 28
Bob Bell (Queen's Safety)	Fire Extinguisher Course	40	June 15
Peter Hall	Ottawa Field Naturalists	49	July 12
Hamish McIntosh	Biology Specialist course (MacArthur Coll.) Field Trip	6	July 16
Dr. Peter Zarzecki (Queen's)	Ottawa U.-Queen's Physiology Conference	45	July 18
Dr. D. McQueen	Limnology Field Trip	15	Sept 18 - 20
Rose Jones (Lasalle H.S.)	Gr. 13 Ecology Field Trip	30	Sept 29
Sean Sharpe (Queen's)	Bio 202 (Ecology) Field Trip	69	Oct 2 - 4
Roger Lupton (Lasalle H.S.)	Environmental Studies Field Trip	17	Oct 6
Mary Brodie	Faculty Wives Association Field Trip	8	Oct 8
Dr. J.J. Hamm (Queen's)	Yoga Weekend	9	Oct 16 - 18

Table 6 (continued)

Organizers	Function	No. of Participants	Duration
Sean Sharpe (Queen's)	Bio 202 (Ecology) Field Trip	65	Oct 23 - 25
George Lamarcraft (S. Grenville Dist. H.S.)	Working Session on Needs of Special Students	5	Oct 28 -29
Jocelyne Devi-Leyton	Yoga Workshop	8	Dec 13

Table 7: Queen's University Biological Station Seminar Schedule 1987.

19 May	Dr. John Smol Queen's	"Paleolimnology & Acid Rain"
21 May	Dr. John Smol Queen's	"High Arctic Limnology"
26 May	Terence Dickenson	"Astronomy"
3 June	Dr. Raleigh Robertson Queen's	"Delayed Breeding, Polygyny, and Infanticide: Facultative Reproductive Tactics of Tree Swallows"
10 June	Dr. Pat Weatherhead Carleton	"The Black Rat Snake: Know Thine Enemy"
17 June	Monica Mather Queen's	"A Sheep in Wolf's Clothing"
24 June	Dr. Bill Redmond S.U.N.Y. St. Paul's, New York	"Feeding Apparatus of Water Mites"
1 July	Julie Claussen, Illinois & Pat Weatherhead, Carleton	"Conch Genetics & Belize Travelogue"
8 July	Sean Sharpe	"Punkmice: Why Breed Early?"
15 July	Dr. George Boyan Australia (A.N.U.)	"Neuronal Segmentation & Development in the Insect"
20 July	Kit Muma Carleton	"Breeding Tactics of Female Redwings"
27 July	Honours Student Symposium - Michele Flatters, Sue McRae, Ian Smith, Lisa Venier, Wally Rendell, Kevin Dufour	
29 July	Dr. George C. Williams S.U.N.Y. Stony Brook	"Demographic Consequences of Natural Selection"
5 August	Michael Fox Queen's	"Pumpkinseed Growth, Feeding & Life History in Beaver Ponds"
12 August	Mike Stoneman U. of T.	"Bats & Things"

Table 8: Fee Schedule for 1988

Accommodation - Room and)Board

\$250/mo	-	includes obligation for chores on a rotating schedule
\$375/mo	-	no obligation for chores
\$135/wk	-	including weekend, eg. Field courses (includes a lab fee)
\$ 18/day	-	24 hr. room and board (includes meals & overnight, no chores)
\$ 3.25	-	breakfast only
\$ 3.25	-	lunch only
\$ 6.50	-	dinner only
\$ 7.50	-	overnight accommodation - academic purposes - no food - Queen's
\$ 12.00	-	overnight accommodation - academic purposes - no food - non-Queen's
\$ 12.00	-	overnight accommodation - nonacademic purposes - no food - Queen's
\$ 20.00	-	overnight accommodation - nonacademic purposes - no food - non-Queen's

Fees for conferences are negotiated directly with the manager or director.
Accommodation Surcharges (applied as additional % to above charges).

<u>Surcharge</u>	<u>Accommodation Type</u>
0%	Whitehouse (Dormitory, Curran Cottage (multi)
5%	Cabins 1-7, 9, 10, 12, 13 and Shaker
10%	Cabins 8 (if solo), 11 and White House apartment
15%	Keast, Earl, and Suac Cottages

Boat Rental

\$150/mo, \$65/wk - includes maintenance on boats and motors
- gas and oil not included in rental fee

Bench Fees

\$3.83/day - Non-Queen's staff or major researcher (M.Sc., Ph.D. candidate, project coordinator or Post-doctoral Fellow)
\$1.31/day - each non-Queen's assistant

If sufficient research funds are not available, bench fees may be reduced or waived upon written application to the Director.

Queen's University Biological Station
List of Theses

Ph.D THESES:

Updated March 15, 1988.

- BARCLAY, R. M. R. 1981. Interindividual use of echolocation calls: Eavesdropping by the Little Brown Bat, Myotis lucifugus. Ph.D. thesis. Department of Biology, Carleton University, Ottawa, Ontario.
- BROWN, J. A. 1983. A comparative study of behavioural ontogeny in four species of centrarchid fish. Ph.D. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- CAVALCANTI, R. B. 1981. Nest desertion: Theory and tests of its adaptive significance in birds. Ph.D. thesis, Department of Biology, McGill University, Nontreal, P.Q.
- FULLARD, J. H. 1979. Auditory components in the defensive behaviour of certain tympanate moths. Ph.D. thesis, Department of Biology, Carleton University, Ottawa, Ontario.
- GOTCEITAS, V. 1987. Microhabitat selection by bluegills (Lepomis macrochirus) avoiding predation. Ph.D. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- GROSS, M. R. 1980. Sexual selection and the evolution of reproductive strategies in sunfishes (Lepomis: Centrarchidae). Ph.D. thesis, Department of Biology, Univ. of Utah.
- LONKER, S. 1979. Conditions of metamorphism in high grade pelites from the Frontenac Axis, Ontario, Canada, calculated from experimental and theoretical equilibria. Ph.D. thesis, Department of Geological Sciences, Harvard Univ.
- STUDD, M.V. 1987. Alternative strategies of allocation of reproductive effort in Yellow Warblers. Ph.D. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- VANDER KLOET, S.P. 1971. The North American Blueberries revisited: A taxonomic study of Vaccinium section Cyanococcus Gray. Ph.D. thesis, Department of Biology, Queen's University, Kingston, Ontario.

M.Sc. THESES:

- AMUNDRUD, J. R. 1970. Ecological interrelationships of the larvae of Perciform fish in Lake Opinicon, Ontario. M.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- ARNOLD, S. 1986. Reproductive patterns of darters (Percidae: Etheostomati): Female mate choice and patterns of allocation of reproductive effort. M.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.

- BALLANTYNE, P. K. 1976. Sound production during agonistic and reproductive behaviour in the Pumpkinseed (Lepomis gibbosus), the Bluegill (L. macrochirus) and their hybrid sunfish. M. Sc. thesis. Department of Biology, Queen's University, Kingston, Ontario.
- BARCLAY, R. M. R. 1978. Vocal communication and social behaviour of the Little Brown Bat, Myotis lucifugus (Chiroptera: Vespertilionidae). M.Sc. thesis, Department of Biology, Carleton University, Ottawa, Ontario.
- BLANCHER, P. J. 1978. Habitat distribution of the Eastern Kingbird (Tyrannus tyrannus): The influence of intraspecific competition. M.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- BOOTH, D. 1984. Energetics, feeding and growth in year II bluegills (Lepomis macrochirus) relative to season. M.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- BOTTOMLEY, E.Z. 1983. The effect of root uptake by Myriophyllum spicatum L. on temporal and spatial distributions of bioavailable phosphorus in a littoral sediment. M.Sc. thesis, Department of Biology, Carleton University, Ottawa, Ontario.
- BROWN, K. E. 1977. Feeding and growth performance of Yellow Perch (Perca flavescens) in relation to differing backgrounds of resources and potential competitor species. M.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- BROWN, S. R. 1952. Some aspects of lake soils in relation to the productivity of a lake. M. A. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- CLARK, K. L. 1978. The selective advantages of Yellow Warblers (Dendroica petechia) nesting in interspecific aggregations. M.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- CLARKE, S. E. 1979. Comparison of courtship sequences in parental and hybrid sunfish (Lepomis spp.): Evidence for a behavioural isolating mechanism. M.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- COLEMAN, R. 1986. Parental investment theory: Tests in bluegill sunfish (Lepomis macrochirus: Centrarchidae). M.Sc. thesis, Department of Biology, Simon Fraser University, Burnaby, British Columbia.
- COMPLAK, J. A. 1982. Relationship between lake type and the performance (growth, body condition, feeding patterns) of four littoral zone fish species. M. Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- COUTTS, R. A. 1972. The development of a technique to determine insect species from stomach contents and feces of some bats. M.Sc. thesis, Department of Biology, Carleton University, Ottawa, Ontario.

- CRAIG, S. R. 1976. Seasonal development of structure in two macrophytic communities in Lake Opinicon, Ontario. M.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- CURTIS, C. 1946. The soils of the Queen's University Biology Station. M.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- DEACON, L. I. 1984. A comparison of growth, reproduction and habitat utilization in two populations of pumpkinseeds, Lepomis gibbosus, M.Sc. thesis. Department of Biology, Queen's University, Kingston, Ontario.
- DUCKWORTH, G. A. 1978. Adaptive aspects of spawning in female small-bodied fish from Jones Creek and Lake Opinicon, near Kingston, Ontario, Canada. M.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- DUNLOP, C. 1987. A comparison of antipredator behaviour in two populations of the Banded Killifish (Fundulus diaphanus). M.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- ECKERT, C.G. 1985. The law of battle and polygyny in the red-winged blackbird. M.Sc. thesis, Department of Biology, Carleton University, Ottawa, Ontario.
- EMBORSKY, S. J. 1971. Feeding and growth of the Bluegill sunfish (Lepomis macrochirus Rafinesque) in Lake Opinicon, Ontario. M.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- EPP, G. 1986. Attributes of competitive ability and local coexistence in two different-aged hayfields. M.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- FULLARD, J. H. 1976. A preliminary study of sounds produced by arctiid moths. M.Sc. thesis, Department of Biology, Carleton University, Ottawa, Ontario.
- GERRISH, N. 1981. Some aspects of the selection of odonate host species by Arrenurus water mites (Acari hydrachnellae) in Lake Opinicon, Ontario. M.Sc. thesis, Department of Zoology, University of Toronto, Toronto, Ontario.
- GRANT, J. W. A. 1980. Territoriality, reproductive success and mate choice in the Johnny Darter (Etheostoma nigrum Rafinesque). M.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- HARKER, J. M. 1976. Prey selection relative to availability and size: A comparison of the feeding of four inshore fish assemblages, Lake Opinicon, Ontario. M.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- HENDERSON, J.B. 1986. The European skipper (Thymelicus lineola): population ecology and herbivory in an old-field community. M.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.

- HILDER, B. E. 1983. The territorial system of Nannothemis bella (Anisoptera: Libellulidae). M. Sc. thesis. Department of Biology, Queen's University, Kingston, Ontario.
- HOYLE, J.A. 1986. The comparative feeding ecology of two top piscivores, Northern Pike (Esox lucius) and Largemouth Bass (Micropterus salmoides). M.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- HURLY, A. P. 1982. Female competition in Red-winged Blackbirds. M.Sc. thesis. Department of Biology, Queen's University, Kingston, Ontario.
- JORGENSEN, C. R. 1966. The annual reproductive cycle in six Lake Opinicon fishes: Lepomis macrochirus x gibbosus (hybrid population), Ambloplites rupestris, Pomoxis nigromaculatus, Percina caprodes, Perca flavescens, and Esox lucius. M. Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- KONKLE, B. 1987. Artificial substrates as indicators of food limitation in sunfishes (Centrarchidae). M.Sc. thesis, Department of Zoology, Erindale College of University of Toronto, Mississauga, Ontario.
- LEFFELAAR, D. 1983. Reproductive strategies in the Tree Swallow, Tachycineta bicolor. M.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- LEWIS, C. 1965. The Largemouth Bass fishery of Lake Opinicon, Ontario. M.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- LONGAIR, R. W. 1978. Aspects of resource partitioning in some chareomorphilous Hymenoptera. M.Sc. thesis, Department of Biology, University of Alberta, Edmonton, Alberta.
- LOTHIAN, T. M. 1949. The biology of the Basswood leaf-mining beetle. M.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- MACFIE, S.M. 1986. Wetland influence on ferric hydroxide plaque formation. M.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- McBRIEN, H. L. 1983. Insect-plant interactive dynamics in an old-field community: Trirhabda and Solidago. M.Sc. thesis. Department of Biology, Queen's University, Kingston, Ontario.
- McNICOL, D. K. 1979. Seasonal, habitat and sex-specific patterns of food utilization by Red-winged Blackbirds (Agelaius phoeniceus) in Eastern Ontario and their economic importance. M.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- MILLER, S. 1978. Pollination of selected entomophilous aquatic plants in Southern Ontario. M.Sc. thesis, Department of Entomology, University of Guelph, Guelph, Ontario.

- MILLS, A.M. 1985. The influence of moonlight on the behaviour of goatsuckers (*Caprimulgidae*). M.Sc. thesis, Department of Biology, Carleton University, Ottawa, Ontario.
- MUMA, K. 1988. Sexual selection and plumage variation in female red-winged blackbirds. M.Sc. thesis. Department of Biology, Carleton University, Ottawa, Ontario.
- NORMAN, R. F. 1980. Behavioural ecology of the Brown-headed Cowbird (*Molothrus ater*) and its hosts: Host aggression and the importance of prior experiences with cowbirds. M. Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- ORSATTI, S. D. 1983. The effects of sublethal acid exposure on growth, behaviour and predator efficiency of young-of-the-year Largemouth Bass (*Micropterus salmoides*). M. Sc. thesis. Department of Biology, Queen's University, Kingston, Ontario.
- OXLEY, D. J. 1973. The effects of roadways on movements of some mammals. M.Sc. thesis, Department of Biology, Carleton University, Ottawa, Ontario.
- ROSE, M. R. 1976. An experimental simulation and mathematical study of an outbreak insect: The Forest Tent Caterpillar (Lepidoptera: Lasiocampidae). M.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- SIMMS, K. E. 1977. A seasonal study of associative symbiotic nitrogen fixation in the rhizosphere of *Najas flexilis*. M.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- STUDD, M. V. 1983. Patterns of plumage variation, territoriality and parental investment in Yellow Warblers. M.Sc. thesis. Department of Biology, Queen's University, Kingston, Ontario.
- STUTCHBURY, B.J. 1986. The adaptive significance of delayed plumage maturation in female tree swallows. M.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- TEATHER, K. L. 1983. Female spacing patterns and factors influencing the diversity of mating systems in Brown-headed Cowbirds. M.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- TEMPLETON, J. 1987. Individual differences in the foraging behaviour of juvenile Rock Bass, *Ambloplites rupestris*. M.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- THACKER, D. G. 1951. Investigations of heart rots of Sugar Maple. M. A. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- THOMSON, C. E. 1980. Mother-infant interactions in free-living Little Brown Bats, *Myotis lucifugus* (Chiroptera: Vespertilionidae). M.Sc. thesis, Department of Biology, Carleton University, Ottawa, Ontario.

- TIPPETT, R. 1963. An investigation into the nature of the layering of deep water sediments in two Eastern Ontario lakes. M. Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- WEATHERHEAD, P. J. 1975. Polygyny in the Red-winged Blackbird (Agelaius phoeniceus). A study of the selective advantage of a polygynous mating system. M. Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- WEBBER, P. J. 1963. Vegetation gradients in swamp forests of Eastern Ontario. M.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- WERNER, T. K. 1979. Behavioural responses of non-volant tympanate moths to simulated bat echolocation calls. M.Sc. thesis, Department of Biology, Carleton University, Ottawa, Ontario.
- WILLIAMSON, M. 1987. Visual capacity relative to prey selection. M.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- WOLFE, L. M. 1985. The pollination of Pontederia cordata L. (Pontederiaceae). M.Sc. thesis, Department of Botany, University of Toronto, Toronto, Ontario.
- WONG, P. Y. 1969. Lichen growth in Eastern Ontario. M.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- YACK, J.E. 1987. The microreceptive origin of insect tympanal organs: A comparative study of homologous nerves in tympanate and atympanate species of lepidoptera. M.Sc. thesis, Department of Zoology, Erindale College of University of Toronto, Mississauga, Ontario.

B.Sc. THESES:

- ALLAN, L.J. 1975. The feeding and breeding ecology of the Eastern Belted Kingfisher. B.Sc. thesis, Department of Biology, Carleton University, Ottawa, Ontario.
- ALVO, R. 1981. Some effects of human activity on the breeding success of the common Loon (Gavia immer). B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- BACKMAN, C.L. 1980. Seasonality and habitat utilization in insects and spiders in the Lake Opinicon region. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- BANKEY, T.A. 1979. The feeding relationships of cohabiting fish in a Lake Ontario stream. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- BARDACH, J.H. 1944. The reptiles of the Lake Opinicon district. Biology. 19 report. Queen's University.

- BARKER, D.M. 1981. An analysis of genetic variability in the web-building behaviour of an Araneid spider. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- BEASLEY, B.A. 1982. The evolution of clutch size in the Eastern Kingbird (Tyrannus tyrannus). B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- BELL, G.P. 1977. Microgeographic variation in avian species diversity. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- BELWOOD, J.J. 1975. Some aspects of the feeding habits of Myotis lucifugus (Chiroptera: Vespertilionidae). B.Sc. thesis, Department of Biology, Carleton University, Ottawa, Ontario.
- BIERMANN, G.C. 1978. A study of some aspects of parental investment in the Red-winged Blackbird (Agelaius phoeniceus). B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- BLACHFORD, A.M. 1978. Spatial and temporal patterns of the abundances of fishes in Lake Opinicon. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- BOAK, K.A. 1983. Factors influencing within-year dispersal of male song sparrows (Melospiza melodia) on Lake Opinicon. B.Sc. thesis, Department of Biology, Carleton University, Ottawa, Ontario.
- BRIGHAM, M.R. 1983. The bowing display of the male Brown-headed Cowbird (Molothrus ater) and its importance to social dominance. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- CAMERON, C.A. 1987. The effect of protocallophoran ectoparasites on the development, survival and feeding of nestling tree swallows. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- CAMERON, D.R. 1978. The spacing system of the Brown-headed Cowbird (Molothrus ater). B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- CAPREOL, M.J. 1983. The adaptive significance of the feather lining in Tree Swallow (Tachycineta bicolor) nests and its effect on reproductive success. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- CARTIER, J. 1978. Song convergence between Chipping Sparrows and Pine Warblers. B.Sc. thesis, Department of Biology, McGill University, Montreal, P.Q..
- CHARLAND, M.B. 1983. Habitat selection in a Rideau Lakes population of black rat snakes (Elaphe o. obsoleta). B.Sc. thesis, Department of Biology, Carleton University, Ottawa, Ontario.

- CLARK, K.L. 1976. The selective advantages of alarm calling by the Yellow Warbler (Dendroica petechia). B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- CONNELL, S. 1987. Parental care in male red-winged blackbirds. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- COOK, W. 1987. A comparative study of reproductive strategy among species of Arrenurus. B.Sc. thesis, Department of Zoology, University of Guelph, Guelph, Ontario.
- COURTNEY, P.A. 1974. The effects of a rural garbage dump on populations of small mammals. B.Sc. thesis, Department of Biology, Carleton University, Ottawa, Ontario.
- DEGN, S. 1986. A comparison of the behavioural ontogeny of the Iowa Darter, Etheostoma exile and the Tessellated Darter, E. olmstedii. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- DEVLIN, A. 1977. A comparative study of three freshwater benthic communities. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- DICKINSON, T.E. 1975. Patterns of resource utilization and certain ecological aspects of brood parasitism shown by the Brown-headed Cowbird (Molothrus ater). B.Sc. thesis, Department of Biology, Queen's University.
- DOMARCHUK, M.A. 1983. Foraging preferences and inflorescence visitation patterns of Ruby-throated Hummingbirds. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- DUFOUR, K. 1987. Decoy trap biases in brown-headed cowbirds. B.Sc. thesis, Department of Biology, Carleton University, Ottawa, Ontario.
- DUPUIS, L.A. 1987. A look at Sylphid populations, with specific reference to the reproductive activity of N. tomentosus. B.Sc. thesis, Department of Biology, Carleton University, Ottawa, Ontario.
- FAHRIG, L. 1981. Competition and coexistence in a lichen community. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- FENTON, M.B. 1965. The distribution of small mammals relative to microclimatic factors. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- FLOOD, N.J. 1977. The effects of recreational land and water use on avian breeding populations. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- FORSYTH, A. 1974. The ecology of Blaesoxipha fletcheri (Diptera: Sarcophagidae). B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.

- FRANKS, P.J.S. 1981. Parental investment in nests parasitized by the Brown-headed Cowbird (Molothrus ater). B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- FULLERTON, A. 1977. Population dynamics of the Copepoda and Cladocera in two thermally stratified lakes. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- GAZENDAM, N. 1976. Induction, dormancy and germination in turions of three aquatic angiosperms. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- GIBBS, H.L. 1980. Spacing behaviour of nesting Tree Swallows (Iridoprocne bicolor). The dispersion pattern and its determinants. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- GIBSON, C.G.M. 1974. Seasonal abundance of Cladocera and Copepoda in Lake Opinicon. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- GLEN, J.R. 1971. Temporal and spatial characteristics of the zooplankton community in a small meromictic lake in Southern Ontario. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- GREENOUGH, J. 1986. Male parental investment and the evolution of female choice. B.Sc. thesis, Department of Biology, Simon Fraser University, Burnaby, British Columbia.
- GREER, D.A.M. 1980. An investigation of aspects of the ecology of mosses in the Thousand Islands. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- GROSS, M.R. 1975. Aggressive behaviour of male Pumpkinseed sunfish (Lepomis gibbosus). B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- HAFFNER, D. 1971. A preliminary report on the relationship of the Forest Tent Caterpillar (Malacosoma disstria Hbn) with various host plants in Ontario. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- HARRISON, T.M. 1975. Chemiluminescent tags as a means of observing nocturnal behaviour of Myotis lucifugus from two summer colonies. B.Sc. thesis, Dept of Biology, Carleton University, Ottawa, Ontario.
- HAWLEY, A.W.L. 1972. A comparison of representative macrofauna and mesofauna of island and mainland soil of a freshwater lake. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- HAYES, P. 1987. Behaviour of replacement male Eastern Kingbirds (Tyrannus tyrannus) and the importance of male parental care. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.

- McBRIEN, H.L. 1981. The effect of phytophagous beetles of the genus Trirhabda Blake (Coleoptera: Chrysomelidae) on plant succession in a Solidago canadensis L. (Asteraceae) community. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- McCLUNG, C.R. 1976. Bacterial nitrogen fixation in the phyllosphere of freshwater macrophytes. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- McINTOSH, D.C. 1945. Forest regeneration on sub-marginal land and wood waste utilization. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- McINTOSH, H. 1978. Vegetation gradients and soil moisture at Lake Opinicon. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- MCKINLEY, K.J. 1987. Neighbour effects in mast year seedlings of Sugar Maple, Acer saccharum Marsh. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- MCRAE, S. 1987. Nestling and fledgling behaviour of American robins. B.Sc. thesis, Department of Biology, Carleton University, Ottawa, Ontario.
- MILLER, A.G. 1966. Lichen growth and species composition in relation to duration of thallus wetness. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- MILLER, D. 1979. Discriminatory behaviour of male White-footed Mice. B.Sc. thesis, Department of Biology, Carleton University, Ottawa, Ontario.
- MIREHOUSE, P.D. 1983. Pollen-collecting tactics of individuals in two bumblebee species (Bombus fervidus and B. rufocinctus). B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- NORMAN, R.F. 1975. Behavioural ecology of the Brown-headed Cowbird (Molothrus ater) and its hosts: Aggressive behavioural defenses. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- NOWELL, W.A. 1977. Spatial aspects of defense in Pumpkinseed sunfish (Lepomis gibbosus) including a catastrophe theory model. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- RENDELL, W.B. 1987. Natural populations of tree swallows (Tachycineta bicolor). B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- ROSE, M.R. 1975. A simulation modelling study of cyclical population dynamics in the Forest Tent Caterpillar (Malacosoma disstria Hbn). B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- SCHUT, P.H. 1981. Some aspects of competition between Myriophyllum spicatum and other aquatic macrophytes B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.

- SEGALL, S.L. 1971. An investigation of the mortality factors of a Malacosoma disstria Hbn. population. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- SMITH, P.C. 1978. Some aspects of the biology and taxonomy of Myriophyllum populations in Lake Opinicon (Eastern Ontario). B.Sc. thesis, Department of Biology, Acadia University, Wolfville, Nova Scotia.
- SNELL, M.J. 1978. Predation and parasitism of artificial nests. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- SOUDEK, D. 1975. Seasonal changes in the phytoplankton of Lake Opinicon. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- STOKES, N.W. 1979. The effect of intruder speed on the nest defense of Pumpkinseed sunfish (Lepomis gibbosus). B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- STUTCHBURY, B.J. 1984. The adaptive significance of delayed plumage maturation in female Tree Swallows (Tachycineta bicolor). B.Sc. thesis, Department of Biology, Kingston, Ontario.
- SUTHERLAND, D.L. 1984. Intersexual and intrasexual foraging differences in relation to habitat structure and prey abundance in the Yellow Warbler (Dendroica petechia). B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- TAYLOR, D.R. 1986. Consequences of natural selection on patterns of phenotypic plasticity and genotypic variation in Agropyron repens (L.). B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- TAYLOR, G. 1977. Growth and distribution of Maianthemum canadense in The Thousand Islands region. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- TEMPLETON, J. 1985. The influence of experience with differing prey types on the development of feeding behaviour in Rock Bass fry. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- THOMPSON, W.K. 1948. Scale reading of Sunfish scale. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- TSUCHIYA, E. 1986. A salivary amylase isozyme study of two sympatric species populations (Peromyscus leucopus noveboracensis and P. maniculatus gracilis). B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- TURNBULL, D.A. 1975. The molluscan fauna of Lake Opinicon. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- VENANCE, M. 1986. Large body size in burying beetles, (Sylphidae; Nicrophorus). Is it a competitive advantage? B.Sc. thesis, Department of Biology, Carleton University, Ottawa, Ontario.

- VILLENEUVE, S. 1982. Parental investment as exhibited by the Rose-breasted Grosbeak (Pheucticus ludovicianus). B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- VITTORIO, P.U. 1948. Fungi attacking forest trees in the Opinicon area with particular reference to White Pine Blister rust. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- WALLACE, C. 1985. Male parental care in Red-winged Blackbirds (Agelaius phoeniceus). B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- WARD, P.S. 1973. The effects of environmental disturbance on species diversity and species abundance patterns in a taxocene of phytophagous insects. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- WEBB, D.E. 1964. The structural and functional features related to the food and feeding habits of the fishes of Lake Opinicon. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- WERESUB, L. 1950. Preliminary work in physiological and ecological studies of vegetation at Queen's University Biological Station, Chaffey's Lock, Ontario. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.
- WOODSIDE, D.P. 1975. Some aspects of the feeding ecology of six species of bats at Lake Opinicon, Ontario. B.Sc. thesis, Department of Biology, Carlton University, Ottawa, Ontario.
- WYNNE-EDWARDS, K.E. 1981. The utilization of benthic invertebrate resource by the fish population of Sunfish Lake, Waterloo, Ontario. B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.

Queen's University Biological Station
List of Publications

Updated March 15, 1988.

- Abrahams, M.V., and P.W. Colgan. 1985. Risk of predation, hydrodynamic efficiency and their influence on school structure. *Env. Biol. Fishes* 13: 195-202.
- Abrahams, M.V. and P.W. Colgan. 1987. Fish schools and their hydrodynamic function: A reanalysis. *Env. Biol. Fishes* 20: 79-80.
- Alvo, R. 1981. Marsh nesting of Common Loons (Gavia immer). *Can. Field-Nat.* 95: 357.
- Amundrud, J.R., D.J. Faber and A. Keast. 1974. Seasonal succession of free-swimming Perciform larvae in Lake Opinicon, Ontario, J. Fish. Res. Bd. Can. 31: 1661-1665.
- Ballantyne, P. K. and Colgan, P. 1978. Sound production during agonistic and reproductive behaviour in the pumpkinseed (Lepomis gibbosus) the bluegill (L. macrochirus), and their hybrid sunfish. I: Context. *Biol. of Behav.* 3: 113-135.
- Ballantyne, P. K. and Colgan, P. 1978. Sound production during agonistic and reproductive behaviour in the pumpkinseed (Lepomis gibbosus, the bluegill (L. macrochirus), and their hybrid sunfish. II: Recipients. *Biol. of Behav.* 3: 207-220.
- Ballantyne, P. K. and Colgan, P. 1978. Sound production during agonistic and reproductive behaviour in the pumpkinseed (Lepomis gibbosus, the bluegill (L. macrochirus), and their hybrid sunfish. III: Response. *Biol. of Behav.* 3: 221-232.
- Barclay, R.M.R., M.B. Fenton and D.W. Thomas. 1979. Social behaviour of the little brown bat, Myotis lucifugus. II Vocal communication. *Behav. Ecol. Sociobiol.* 6: 137-146.
- Barclay, R.M.R. and D.W. Thomas. 1979. Copulation call of Myotis lucifugus: A discrete, situation-specific communication signal. *J. Mammal.* 60: 632-4.
- Belwood, J.J. and M.B. Fenton. 1976. Variation in the diet of Myotis lucifugus (Chiroptera:Vespertilionidae). *Can. J. Zool.* 54: 1674-1678.
- Bendell, J.F. 1955. A biological survey of terrestrial vertebrates at Lake Opinicon. Unpublished report.
- Beschel, R.E. and P.J. Webber. 1962. Gradient analysis in swamp forests. *Nature* 194: 207-209.
- Beschel, R. E., P. J. Webber and R. Tippet. 1962. Woodland transects of the Frontenac Axis region, Ontario. *Ecol.* 43: 386-396.

- Biermann, G.C. and R.J. Robertson. 1981. An increase in parental investment during the breeding season. *Anim. Behav.* 29: 487-489.
- Biermann, G.C. and R.J. Robertson. 1983. Residual reproductive value and parental investment. *Anim. Behav.* 31(1): 311-312.
- Blancher, P.J. and R.J. Robertson. 1982. Kingbird aggression: does it deter predation? *Anim. Behav.* 30: 929-930.
- Blancher, P.J. and R.J. Robertson. 1982. A double-brooded Eastern Kingbird. *Wilson Bull.* 94: 212-213.
- Blancher, P.J. and R. J. Robertson. 1984. Response to Peck. *Wilson Bull.* 96: 142.
- Blancher, P.J. and R.J. Robertson. 1985. Predation in relation to spacing of Kingbird nests. *Auk* 102: 654-658.
- Blancher, P.J. and R.J. Robertson. 1985. Site consistency in Kingbird breeding performance: Implications for site fidelity. *J. Anim. Ecol.* 54(3): 1017-1027.
- Blancher, P. J. and R. J. Robertson. 1985. A comparison of Eastern Kingbird breeding biology in lakeshore and upland habitat. *Can. J. Zool.* 63: 2305-2312.
- Booth, D. and A. Keast. 1985. Bioenergetics of year I Bluegill, a seasonal study. *J. Fish Biology* 12: 23-31.
- Booth, D.J. and A. Keast. 1986. Growth energy partitioning by juvenile bluegill sunfish, Lepomis macrochirus Rafinesque. *J. Fish. Biol.* 28: 37-45.
- Bristow, J.M. 1974. Nitrogen fixation in the rhizosphere of freshwater angiosperms. *Can. J. Bot.* 52: 217-221.
- Bristow, J.M., A.A. Crowder, M.R. King, and S. Vander Kloet. 1977. The growth of aquatic macrophytes in the Bay of Quinte prior to phosphate removal by tertiary sewage treatment (1975-1976). *Naturaliste Can.* 104: 465-473.
- Brown, J.A. 1984. Parental care and the ontogeny of predator avoidance in two species of centrarchid fish. *Anim. Behav.*, in press.
- Brown, J.A. 1984. The adaptive significance of behavioural ontogeny in some centrarchid fishes. *Env. Biol. Fish.*, in press.
- Brown, J.A. and P.W. Colgan. 1981. The use of lateral-body bar markings in identification of young-of-year sunfish Lepomis in Lake Opinicon, Ontario. *Can. J. Zool.* 59: 1852-1855.
- Brown, J.A. and P.W. Colgan. 1982. The inshore vertical distribution of young-of-year Lepomis in Lake Opinicon, Ontario. *Copeia* 1982: 957-960.

- Brown, J. A. and P.W. Colgan. 1984. The ontogeny of feeding behaviour in four species of centrarchid fish. *Behav. Processes* 9: 395-411.
- Brown, J.A. and P.W. Colgan. 1985. The ontogeny of social behaviour in four species of centrarchid fish. *Behaviour* 92: 254-276.
- Brown, J.A. and P.W. Colgan. 1985. Interspecific differences in the ontogeny of feeding behaviour in two species of centrarchid fish. *Zeits. Tierpsychol.* 70: 70-80.
- Brown, J.A. and P.W. Colgan. 1986. Individual and species recognition in centrarchid fishes: Evidence and hypotheses. *Beh. Ecol. Sociobiol.* 19: 373-379.
- Brown, J.A., P.H. Johansen, P.W. Colgan and R.A. Mathers. 1985. Changes in the predator-avoidance behaviour of juvenile guppies (Poecilia reticulata) exposed to pentachlorophenol. *Can. J. Zool.* 63: 2001-2005.
- Brown, J.A., P.H. Johansen, P.W. Colgan and R.A.S. Mathers. 1987. Impairment of the early feeding behaviour of largemouth bass by pentachlorophenol exposure: a preliminary assessment. *Am. Fish. Soc. Trans.* 116: 71-78.
- Cardone, B. and J.H. Fullard. 1987. Sexual dimorphism in the auditory characteristics of the gypsy moth. *Phys. Ent.*, in press.
- Chapleau, F. and A. Keast. Evolution of the Pleuronectiformes (flatfishes). *Can. J. Zool.*, in press.
- Chua, K.E., J.C.E. Riotte, and C. Gilmour. 1976. Investigation of selected species of the genus Orgyia. *Jour. Res. Lepid.* 15: 215-224.
- Clark, K.L. and R.J. Robertson. 1979. Spatial and temporal multi-species nesting aggregations in birds as anti-parasite and anti-predator defenses. *Behav. Ecol. Sociobiol.* 5: 359-371.
- Clark, K.L. and R.J. Robertson. 1981. Cowbird parasitism and evolution of anti-parasite strategies in the Yellow Warbler. *Wilson Bulletin* 93: 249-258.
- Clarke, S. E., P. W. Colgan and N. P. Lester. 1984. Courtship sequences and ethological isolation in two species of sunfish (Lepomis spp.) and their hybrids. *Behaviour* 91: 93-114.
- Coleman, R.M., M.R. Gross and R.C. Sargent. 1985. Parental investment decision rules and the Concorde fallacy. *Behav. Ecol. and Sociobiol.* 17: 43-45.
- Coleman, R.C., M.R. Gross and R.C. Sargent. 1985. Parental investment decision rules: A test in bluegill sunfish. *Behavioural Ecology and Sociobiology* 18: 59-66.
- Colgan, P.W. 1974. Burying experiments with the banded killifish, Fundulus diaphanus. *Copeia*. 1974 (1): 258-259.

- Colgan, P.W. 1979. Is a super-territory strategy stable? *Am. Nat.* 114: 604-605.
- Colgan, P.W., P.K. Ballantyne and M.V.H. Wilson. 1976. Numerical taxonomy of hybridizing Lepomis (Centrarchidae) in Lake Opinicon, Ontario. *Can. J. Zool.* 54: 42-47.
- Colgan, P.W. and J.A. Brown. 1988. Dynamics of nest defense by male centrarchid fish. *Beh. Proc.* 15: in press.
- Colgan, P.W., J.A. Brown and S.D. Orsatti. 1986. Role of diet and experience in the development of feeding behaviour in largemouth bass (Micropterus salmoides). *J. Fish. Biol.* 28: 161-170.
- Colgan, P., and D. Ealey. 1973. Role of woody debris in nest site selection by pumpkinseed sunfish, Lepomis gibbosus. *J. Fish. Res. Bd. Can.* 30: 853-856.
- Colgan, P.W., & M.R. Gross. 1977. Dynamics of aggression in pumpkinseed sunfish (Lepomis gibbosus) over the nesting phase. *Zeit. Tierpsychol.* 43: 139-151.
- Colgan, P.W., W.A. Nowell, M.R. Gross, and J.W.A. Grant. 1979. Aggressive habituation and rim circling in the social organization of bluegill sunfish (Lepomis macrochirus). *Env. Biol. Fishes* 4: 29-36.
- Colgan, P. W., W. A. Nowell, and N. W. Stokes. 1981. Spatial aspects of nest defense by pumpkinseed sunfish (Lepomis gibbosus): Stimulus features and an application of catastrophe theory. *Anim. Behav.* 29: 433-442.
- Colgan, P. W. and B. Silburt. 1984. Feeding behaviour of the central mudminnow (Umbra limi) in the field and laboratory. *Env. Biol. of Fishes* 10: 209-214.
- Colgan, P.W. and J.T. Smith. 1985. Experimental analysis of food preference transitivity in pumpkinseed sunfish (Lepomis gibbosus). *Biometrics* 41: 227-236.
- Colgan, P.W. and J.T. Smith. 1986. Statistical analysis of feeding behaviour in fish. Chap. in P.W. Colgan and R. Zyan (eds.) Quantitative Models in Ethology. Paris: Privat. Pp. 47-61.
- Courtney, P.A. and M.B. Fenton. 1976. The effects of a small rural garbage dump on populations of Peromyscus leucopus Rafinesque, and other small mammals. *J. Appl. Ecol.* 13: 413-422.
- Coutts, R.A., M.B. Fenton, and E. Glen. 1973. Food intake by captive Myotis lucifugus and Eptesicus fuscus (Chiroptera: Vespertilionidae) *J. Mammal.* 54: 985-990.
- Crowder, A.A. and J.M. Bristow. 1986. Bibliography of wetlands in the Kingston region. *Blue Bill supplement to Vol. 33*, p. 1-71.

- Colgan, P.W. 1979. Is a super-territory strategy stable? *Am. Nat.* 114: 604-605.
- Colgan, P.W., P.K. Ballantyne and M.V.H. Wilson. 1976. Numerical taxonomy of hybridizing Lepomis (Centrarchidae) in Lake Opinicon, Ontario. *Can. J. Zool.* 54: 42-47.
- Colgan, P.W. and J.A. Brown. 1988. Dynamics of nest defense by male centrarchid fish. *Beh. Proc.* 15: in press.
- Colgan, P.W., J.A. Brown and S.D. Orsatti. 1986. Role of diet and experience in the development of feeding behaviour in largemouth bass (Micropterus salmoides). *J. Fish. Biol.* 28: 161-170.
- Colgan, P., and D. Ealey. 1973. Role of woody debris in nest site selection by pumpkinseed sunfish, Lepomis gibbosus. *J. Fish. Res. Bd. Can.* 30: 853-856.
- Colgan, P.W., & M.R. Gross. 1977. Dynamics of aggression in pumpkinseed sunfish (Lepomis gibbosus) over the nesting phase. *Zeit. Tierpsychol.* 43: 139-151.
- Colgan, P.W., W.A. Nowell, M.R. Gross, and J.W.A. Grant. 1979. Aggressive habituation and rim circling in the social organization of bluegill sunfish (Lepomis macrochirus). *Env. Biol. Fishes* 4: 29-36.
- Colgan, P. W., W. A. Nowell, and N. W. Stokes. 1981. Spatial aspects of nest defense by pumpkinseed sunfish (Lepomis gibbosus): Stimulus features and an application of catastrophe theory. *Anim. Behav.* 29: 433-442.
- Colgan, P. W. and B. Silburt. 1984. Feeding behaviour of the central mudminnow (Umbra limi) in the field and laboratory. *Env. Biol. of Fishes* 10: 209-214.
- Colgan, P.W. and J.T. Smith. 1985. Experimental analysis of food preference transitivity in pumpkinseed sunfish (Lepomis gibbosus). *Biometrics* 41: 227-236.
- Colgan, P.W. and J.T. Smith. 1986. Statistical analysis of feeding behaviour in fish. Chap. in P.W. Colgan and R. Zyan (eds.) Quantitative Models in Ethology. Paris: Privat. Pp. 47-61.
- Courtney, P.A. and M.B. Fenton. 1976. The effects of a small rural garbage dump on populations of Peromyscus leucopus Rafinesque, and other small mammals. *J. Appl. Ecol.* 13: 413-422.
- Coutts, R.A., M.B. Fenton, and E. Glen. 1973. Food intake by captive Myotis lucifugus and Eptesicus fuscus (Chiroptera: Vespertilionidae) *J. Mammal.* 54: 985-990.
- Crowder, A.A. and J.M. Bristow. 1986. Bibliography of wetlands in the Kingston region. Blue Bill supplement to Vol. 33, p. 1-71.

- Crowder, A. A. 1983. The frequency of introduced plants and litter on paths as indices of impact in the St. Lawrence Islands National Park, Ontario. *Env. Management* 7 (4): 345-354.
- Crowder, A.A., J.M. Bristow, M.R. King, S. Vander Kloet. 1977. Distribution, seasonality, and biomass of aquatic macrophytes in Lake Opinicon. *Naturaliste Can.* 104: 441-456.
- Crowder, A.A., J.M. Bristow, M.R. King and S. Vander Kloet. 1977. The aquatic macrophytes of some lakes in southeastern Ontario. *Naturaliste Can.* 104: 457-464.
- Crowder, A.A. and S.M. Macfie. 1986. Seasonal deposition of ferric hydroxide plaque on roots of wetland plants. *Can. J. Bot.* 64: 2120-2124.
- Curran, H.W. 1947. A biological survey of Lake Opinicon. Progress Report, Queen's University.
- Dale, H.M. and T. Gillespie. 1976. The influence of floating vascular plants on the diurnal fluctuations of temperature near the water surface in the early spring. *Hydrobiologia*, 49: 245-256.
- Deacon, L.I. and A. Keast. 1987. Patterns of reproduction in two populations of pumpkinseed sunfish, Lepomis gibbosus, with differing food resources. *Env. Biol. Fishes* 19: 281-296.
- Eadie, J. McA. and A. Keast. 1984. Resource heterogeneity and fish species diversity in lakes. *Can. J. Zool.* 62: 1689-1695.
- Eadie, J. McA. and A. Keast. 1984. Do goldeneye and perch compete for food? *Oecologia*, 55,: 225-230.
- Eckert, C.G. and P.J. Weatherhead. 1987. Competition for territories: is resource holding potential realized in red-winged blackbirds? *Behavioral Ecology and Sociobiology* 20: 369-375.
- Eckert, C.G. and P.J. Weatherhead. 1987. Owners, floaters and competitive asymmetries among territorial red-winged blackbirds. *Animal Behaviour* 35: 1317-1323.
- Eckert, C.G. and P.J. Weatherhead. 1987. Ideal dominance distributions: A test using red-winged blackbirds (Agelaius phoeniceus). *Behavioral Ecology and Sociobiology* 20: 43-52.
- Eckert, C.G. and P.J. Weatherhead. 1987. Male characteristics, parental quality and the study of mate choice in the red-winged blackbird (Agelaius phoeniceus). *Behavioral Ecology and Sociobiology* 20: 35-42.
- Fenton, M.B. 1969. Summer activity of Myotis lucifugus (Chiroptera: Vespertilionidae) at hibernacula in Ontario and Quebec. *Can. J. Zool.* 47: 597-602.
- Fenton, M.B. 1970. A technique for monitoring bat activity with results obtained from different environments in southern Ontario, *Can. J. Zool.* 48: 847-851.

- Fenton, M.B. 1970. The deciduous dentition and its replacement in Myotis lucifugus (Chiroptera: Vespertilionidae). Can. J. Zool. 48: 817-820.
- Fenton, M.B. 1970. Population studies of Myotis lucifugus (Chiroptera: Vespertilionidae) in Ontario. Life Sci. Contrib. R. Ont. Mus. No. 77, pp. 1-34.
- Fenton, M.B. 1971. Bats questions, answers and issues. The Ontario Naturalist 9(3): 12-19.
- Fenton, M.B. 1972. The structure of aerial-feeding bat faunas as indicated by ears and wing elements. Can. J. Zool. 50: 287-296.
- Fenton, M.B. 1972. Distribution and overwintering of Myotis leibii and Eptesicus fuscus (Chiroptera: Vespertilionidae) in Ontario. Royal Ontario Museum, Life Sciences Occasional Papers No. 21.
- Fenton, M.B. 1974. Feeding ecology of insectivorous bats, Bios XLV (1): 3-15.
- Fenton, M.B. 1977. Variation in the social calls of little brown bats (Myotis lucifugus) Can. J. Zool. 55: 1151-1157.
- Fenton, M.B. and G.P. Bell 1979. Echolocation and feeding behaviour in four species of Myotis (Chiroptera). Can. J. Zool. 57: 1271-1277.
- Fenton, M.B. and G.P. Bell. 1981. Recognition of species of insectivorous bats by their echolocation calls. J. Mamm. 62: 233-243.
- Fenton, M.B., J.J. Belwood, J.H. Fullard and T.H. Kunz. 1976. Responses of Myotis lucifugus (Chiroptera: Vespertilionidae) to calls of conspecifics and to other sounds. Can. J. Zool. 54: 1443-1448.
- Fenton, M.B. and J.H. Fullard. 1979. The influence of moth hearing on bat echolocation strategies. J. Comp. Physiol. 132: 77-86.
- Fenton, M.B. and J.H. Fullard. 1981. Moth hearing and the feeding strategies of bats. Amer. Sci. 69: 266-275.
- Fenton, M.B., S.L. Jacobson, and R.N. Stone. 1973. An automatic ultrasonic sensing system for monitoring the activity of some bats. Can. J. Zool. 51: 291-299.
- Fenton, M.B. and K.D. Roeder. 1974. The microtymbals of some Arctiidae. J. Lepid. Soc. 28: 205-211.
- Flood, N. and H. McIntosh. 1976. The effect of recreational land use on avian populations. Blue Bill, 23: 36-37.
- Forsyth, A.B. and R.D. Montgomerie. 1987. Alternative reproductive tactics in a territorial damselfly: sneaking by older males. Behav. Ecol. Sociobiol. 21: 73-81.
- Forsyth, A.B. and R.J. Robertson. 1975. K reproductive strategy and larval behavior of the pitcher plant sarcophagid fly, Blaesoxipha fletcheri. Can. J. Zool. 53: 174-179.

- Fullard, J.H. 1977. Phenology of sound producing arctiid moths and the activity of insectivorous bats. *Nature* 267: 42-43.
- Fullard, J.H. 1977. Variability and absence of sexual dimorphism in the sounds of Cycnia tenera Hubner (Lepidoptera: Arctiidae). *J. New York Ent. Soc.* 85: 21-25.
- Fullard, J.H. 1979. Behavioral analysis of auditory sensitivity in Cycnia tenera Hubner (Lepidoptera:Arctiidae). *J. Comp. Physiol.* 129: 79-83.
- Fullard, J.H. 1982. Cephalic influences on the defensive behaviour of the Dogbane Tiger Moth, Cycnia tenera. *Physiol. Ent.* 7: 157-162.
- Fullard, J.H. 1982. Echolocation assemblages and their effects on moth auditory systems. *Can. J. Zool.* 60: 2572-2576.
- Fullard, J.H. 1984. Listening for bats: pulse repetition rate as a cue for defensive behaviour in Cycnia tenera (Lepidoptera: Arctiidae). *J. Comp. Physiol.* 154: 249-252.
- Fullard, J.H. 1984. Acoustic relationships between tympanate moths and the Hawaiian hoary bat (Lasiurus cinereus semotus). *J. Comp. Physiol.* 155: 795-801.
- Fullard, J.H. 1987. Sensory ecology and neuroethology of moths and bats: interactions in a global perspective. In, *Recent advances in the study of bats*. Fenton, M.B., M. Raynor and P. Racey (Eds.). Cambridge Univ. Press, Cambridge.
- Fullard, J.H. 1988. The tuning of moth ears. *Experientia*, in press.
- Fullard, J.H. 1988. Sensory ecology of moths and bats: global lessons in staying alive. In: *Predator-prey Interactions*, Evans, D. and J. Schmidt (Eds.) SUNY Press.
- Fullard, J.H. and R.M.R. Barclay. 1980. Audition in spring species of arctiid moths as a possible response to differential levels of insectivorous bat predation. *Can. J. Zool.* 58: 1745-1750.
- Fullard, J.H. and M.B. Fenton. 1977. Acoustic and behavioural analyses of the sounds produced by some species of Nearctic Arctiidae (Lepidoptera). *Can. J. Zool.* 55: 1213-1224.
- Fullard, J.H., M.B. Fenton, and C. L. Furlonger. 1983. Sensory relationships of moths and bats sampled from two nearctic sites. *Can. J. Zool.* 61: 1752-1757.
- Fullard, J.H., M.B. Fenton, and J.A. Simmons. 1979. Jamming bat echolocation: the clicks of arctiid moths. *Can. J. Zool.* 57: 647-649.
- Gerrish, N. and J.M. Bristow. 1979. Macroinvertebrate associations with aquatic macrophytes and artificial substrates. *J. Great Lakes Res.* 5: 69-72.

- Gotceitas, V. and P.W. Colgan. 1987. Selection between densities of vegetation by young bluegill sunfish (Lepomis macrochirus) when avoiding predation. *Am. Fish. Soc. Trans.* 116: 40-49.
- Gross, M.R. 1979. Cuckoldry in sunfishes (Lepomis: Centrarchidae). *Can. J. Zool.* 57: 1507-1509.
- Gross, M.R. 1982. Sneakers, satellites and parentals: Polymorphic mating strategies in North American sunfish. *Z. Tierpsychol.* 60: 1-26.
- Gross, M.R. 1984. Sunfish, salmon and the evolution of alternative reproductive strategies and tactics in fishes. In *Fish Reproduction: Strategies and Tactics*, T.G. Potts and R. Wootton, Eds., Academic Press, pp. 55-75.
- Gross, M.R. and E.L. Charnov. 1980. Alternative male life histories in bluegill sunfish. *Proc. Natl. Acad. Sci.* 77: 6937-6940.
- Gross, M.R. and A. MacMillan. 1981. Predation and the evolution of colonial nesting in bluegill sunfish (Lepomis macrochirus). *Behav. Ecol. Sociobiol.* 8: 163-174.
- Gross, M.R. and W. Nowell. 1980. The reproductive biology of rock bass, Ambloplites rupestris (Centrarchidae), in Lake Opinicon, Ontario. *Copeia* 1980: 482-494.
- Gross, M.R. and R.C. Sargent. 1985. The evolution of male and female parental care in fishes. *Am. Zool.* 25: 807-822.
- Gross, M.R. and R. Shine. 1981. Mode of fertilization and parental care in ectothermic vertebrates. *Evolution*, 35(4): 775-793.
- Harmsen, R. 1984. Field testing of a general model for insect outbreak. In: *Mathematical Models of Renewable Resources*. Vol. III. Ed. R. Lamberson. Humboldt. State Univ. pp. 53-57.
- Harmsen, R., P.D.N. Hebert, and P.S. Ward, 1973. Austral elements in the moth fauna of South-Eastern Ontario. *J. Res. Lepid.* 12: 127-134.
- Harmsen, R. and M.R. Rose. Habitat effects on larval mortality in the forest tent caterpillar Malacosoma disstria: (Lepidoptera: Lasiocampidae). *Proc. Ent. Soc. Ont.* 114: 87-89.
- Hebert, P.D.N., P.S. Ward and R. Harmsen. 1974. Diffuse competition in lepidoptera. *Nature* 252: 389-391.
- Hebert, P.D.N., P.S. Ward and R. Harmsen. 1985. Competition and abundance: A reply. *Nature* 256: 123.
- Hilder, B.E. and P.W. Colgan. 1985. Territorial behaviour of male Nannothemis bella Uhler (Anisoptera: Libellulidae). *Can. J. Zool.* 63: 1010-1016.

- Hoyle, J.A. and A. Keast. 1987. The effect of prey morphology and size on handling time in a piscivore the largemouth bass (Micropterus salmoides). Can. J. Zool. 65: 1972-1977.
- Hoyle, J.A. and A. Keast. 1987. Prey handling time in two piscivores with contrasting morphologies, the grass pickerel (Esox americanus vermiculatus) and largemouth bass (Micropterus salmoides). Can. J. Zool. 65:
- Hurly, T.A. and R.J. Robertson. 1984. Aggressive and territorial behaviour in female Red-winged Blackbirds. Can. J. Zool. 62(2): 148-153.
- Hurly, T.A. and R.J. Robertson. 1985. Do female red-winged blackbirds limit harem size? I. A removal experiment. Auk 102: 205-209.
- Johansen, P.H., R.A.S. Mathers, J.A. Brown and P.W. Colgan. 1985. Mortality of early life stages of Largemouth Bass, Micropterus salmoides, due to Petachlorophenol exposure. Bull. Env. Contam. Toxicol. 34: 377-384.
- Johansen, P.H., R.A.S. Mathers and J.A. Brown. 1987. Effect of exposure to several pentachlorophenol concentrations on growth of young-of-year largemouth bass (Micropterus salmoides) with comparisons to other indicators of toxicity. Bull. Environ. Contam. Toxicol. 39: 379-384.
- Keast, A. 1965. Resource subdivision amongst cohabiting fish species in a bay, Lake Opinicon, Ontario. Gr. Lakes Res. Div., Univ. of Michigan 13: 106-132.
- Keast, A. 1966. Trophic interrelationships in the fish fauna of a small stream. Gr. Lakes. Inst. Proc. 15: 51-79.
- Keast, A. 1968. Feeding biology of the Black Crappie, Pomoxis nigromaculatus. J. Fish. Res. Bd. Can. 25: 285-297.
- Keast, A. 1968. Feeding of some Great Lakes fishes at low temperatures. J. Fish. Res. Bd. Can. 25: 1199-1218.
- Keast, A. 1970. Food specializations and bioenergetic inter-relationships in the fish faunas of some small Ontario waterways from Marine Food Chains (ed. J. H. Steele), Oliver and Boyd, Edinburgh, pp. 377-411.
- Keast, A. 1974. Fish are what they eat. Nat. History 83: 78-81.
- Keast, A. 1977. Diet overlaps and feeding relationships between the year classes in the yellow perch (Perca flavescens). Env. Biol. Fish. 2(1): 53-70.
- Keast, A. 1977. Mechanisms expanding niche width and minimizing intraspecific competition in two Centrarchid fishes. Evol. Biol. 10: 333-395.
- Keast, A. 1977. Mechanisms expanding niche width and minimizing intraspecific competition in poikilotherms, a comparison of the Rock Bass and Bluegill Sunfish (Centrarchidae). Evolutionary Biology. Hecht, Steere and Wallace (eds.). Plenum Publishing Corp.

- Keast, A. 1978. Trophic and spatial interrelationships in the fish species of an Ontario temperate lake. *Env. Biol. Fish.* 3: 7-31.
- Keast, A. 1978. Feeding interrelationships between age-groups of pumpkinseed (*Lepomis gibbosus*) and comparisons with bluegill (*L. macrochirus*). *J. Fish. Res. Bd. Can.* 35: 12-27.
- Keast, A. 1979. Patterns of predation in generalist feeders. In: *Predator-Prey Systems in Fisheries Management*. H. Clepper (ed.) Sport Fishing Institute, Washington, D.C.
- Keast, A. 1980. The beginning of exogenous feeding, foods and feeding relationships of young fish in the first weeks of life, open water community, Lake Opinicon, Ontario. *Env. Biol. Fish.* 5: 305-314.
- Keast, A. 1984. The introduced aquatic macrophyte, *Myriophyllum spicatum*, as habitat for fish and their invertebrate prey. *Can. J. Zool.* 62: 1289-1303.
- Keast, A. 1984. The piscivore feeding guild of fishes in small freshwater ecosystems. *Env. Biol. Fish.* 121: 119-129.
- Keast, A. 1984. Assessment of community composition and species richness in contrasting habitats, in Davies, A.J.J.R. (Ed). *Methods of censusing birds in Australia*. Dept. Conserv. & Environment Bull. 153, pp. 19-24.
- Keast, A. 1984. Adaptations, environmental: the production of fitness of particular functions. in Campbell, B. and E. Lack (eds.). *A dictionary of biology*, Oxford Univ. Press.
- Keast, A. 1985. Development of dietary specializations in a summer community of juvenile fishes. *Env. Biol. Fish.* 132: 211-224.
- Keast, A. 1985. Implications of chemosensory feeding in catfishes: analysis of the diets of *Ictalurus nebulosus* and *I. natalis*. *Can. J. Zool.* 63: in press.
- Keast, A. 1985. Planktivory in a littoral-dwelling lake fish association: prey selection and seasonality. *Can. J. Fish. Aquatic Sci.* 42: 1114-1126.
- Keast, A. 1985. Growth responses of the brown bullhead (*Ictalurus nebulosus*) to temperature. *Can. J. Zool.* 63: 1510-1515.
- Keast, A. 1986. Bird community structure in southern forests and northern woodlands: a comparison. pp. 97-116 in Keast, A., H.F. Recher, H. Ford and D. Saunders. 1986. *Birds of forests and woodlands: Ecology, conservation and management*. Publ. Warren Beatty and Sons, Chipping Norton, NSW, Australia.
- Keast, A. 1986. Springtime song, periodicity and sequencing, a comparison of a southern forest and north woodland bird community. pp. 119-128 in Keast, A., H.F. Recher, H. Ford and D. Saunders. 1986. *Birds of forest and woodlands: Ecology, conservation and management*. Publ. Warren Beatty and Sons, Chipping Norton, NSW, Australia.

- Keast, A. 1988. Forest bird communities in historic and ecological perspective: a synthesis. Proc. 19 International Ornithology Congress, Ottawa, Ontario, in press.
- Keast, A. 1988. Annual cycle and taxonomic composition of an Ontario deciduous forest bird community. Proc. 19 International Ornithology Congress, Ottawa, Ontario, in press.
- Keast, A. and J. McA. Eadie. 1984. Growth in the first summer of life: a comparison of nine co-occurring fish species. Can. J. Zool. 62: 1242-1250.
- Keast, A. and J. McA. Eadie. 1985. Growth depensation of Year-0 largemouth bass: the influence of diet. Trans. Am. Fish. Soc.: in press.
- Keast, A. and J. Harker. 1977. Strip counts as a means of determining densities and habitat utilization patterns in lake fishes. Env. Biol. Fish. 1(2): 181-188.
- Keast, A. and J. Harker. 1977. Fish distribution and benthic invertebrate biomass relative to depth in an Ontario lake. Env. Biol. Fish 2: 235-240.
- Keast, A., J. Harker and D. Turnbull. 1978. Nearshore fish habitat utilization and species associations in Lake Opinicon (Ontario, Canada). Env. Biol. Fish 3: 173-184.
- Keast, A. and D. Webb. 1966. Mouth and body form relative to feeding ecology in the fish fauna of a small lake, Lake Opinicon, Ontario, J. Fish. Res. Bd. Can. 23(12): 1845-1874.
- Keast, A. and L. Welsh. 1968. Daily feeding periodicities, food uptake rates and dietary changes with hour of day in same lake fishes. J. Fish. Res. Bd. Can. 25(6): 1133-1144.
- Kindler, P.W., J. Bahr, M.R. Gross and D.P. Philipp. 1986. Patterns of testosterone production among male bluegill. J. Fish. Biology, in press.
- Lee, R.C.P. and P. McGinn. 1986. Male territoriality and mating success in Nannothemis bella (Uhler) (Odonata: Libellulidae). Can. J. Zool. 64: 1820-1826.
- Lee, R.C.P. and M. Nyffeler. 1987. Comparison of vocalizations of two sibling spider species. Mit. Schweiz. Ent. Gesell. 59: 337-348.
- Leffelaar, D. 1984. Do male tree swallows guard their mates? Behav. Ecol. Sociobiol. 16: 73-79.
- Leffelaar, D. and R.J. Robertson. 1985. Nest usurpation and female competition for breeding opportunities in the Tree Swallow. Wilson Bull. 97: 221-224.
- Leffelaar, D. and R.J. Robertson. 1985. Equality of feeding roles and the maintenance of monogamy in Tree Swallows. Behav. Ecol. and Sociobiol. 18: 199-206.

- Lemon, R.E., J. Struger, M.L. Lechowicz and R.F. Norman. 1982. Song features and singing heights of American warblers: maximization or optimization of distance? *J. Acoust. Soc. Amer.* 69: 1169-1176.
- Macfie, S.M. and A.A. Crowder. 1986. Soil factors influencing ferric hydroxide plaque formation on roots of Typha latifolia L. *Plant and Soil*, in press.
- Mathers, R.A.S., J.A. Brown and P.H. Johansen. 1985. The growth and feeding behaviour responses of largemouth bass (Micropterus salmoides) exposed to PCP. *Aquatic Toxicology* 6: 157-164.
- McBrien, H.L. and R. Harmsen. 1984. Growth responses of goldenrod, Solidago canadensis L., (Asteracea) to periodic defoliation. *Can. J. Bot.* 65: 1478-1481.
- McBrien, H., R. Harmsen and A. Crowder. 1983. A case of insect grazing affecting plant succession. *Ecology*. 64(5): 1035-1039.
- McIntosh, H., N. Flood, W. Morton, D. Cameron and M. Bordt. 1976. Environmental impact of recreational shoreline use on breeding bird populations. Ontario Ministry of the Environment Report.
- McNicol, D.K., R.J. Robertson and P.J. Weatherhead. 1982. Seasonal, habitat and sex-specific food habits of red-winged blackbirds: implications for agriculture. *Can. J. Zool.* 60: 3282-3289.
- Mills, A.M. 1986. The influence of moonlight on the behaviour of goatsuckers (Caprimulgidae). *Auk* 103: 370-378.
- Montgomerie, R.D. 1984. Nectar extraction by hummingbirds: response to different floral characters. *Oecologia* 63: 229-236.
- Montgomerie, R.D., J. McA. Eadie and L. Harder. 1984. What do foraging hummingbirds maximize? *Oecologia*, 63: 357-363.
- Montgomerie, R.D. and P.J. Weatherhead. Risks and rewards of nest defence by parent birds. *Quarterly Review of Biology*, in press.
- Morgan, M.J. and P.W. Colgan. 1987. The effects of predation presence and shoal size on foraging in bluntnose minnows, Pimephales notatus. *Env. Biol. Fishes* 20: 105-111.
- Morgan, M.J. and P.W. Colgan. 1988. The role of experience in foraging shoals of bluntnose minnows (Pimephales notatus). *Behav. Proc.* in press.
- Mountjoy, D.J. and R.J. Robertson. Nest construction tactics in the Cedar Waxwing. *Wilson Bull.*, in press.
- Mountjoy, D.J. and R.J. Robertson. Why are waxwings waxy? Delayed plumage maturation in the Cedar Waxwing. *Auk*, in press.
- Muldal, A.M., H. L. Gibbs and R. J. Robertson. 1985. Preferred nest spacing of an obligate cavity-resting bird, the Tree Swallow (Tachycineta bicolor). *Condor* 87: 356-363.

- Muldal, A., J.D. Moffat and R.J. Robertson. 1986. Parental care of nestlings by male Red-winged Blackbirds (Agelaius phoeniceus). Behav. Ecol. and Sociobiol. 19: 105-114.
- Norman, R.F. and R.J. Robertson. 1975. Nest-searching behavior in the Brown-headed Cowbird. Auk 92: 610-611.
- Norman, R.F., P.D. Taylor, and R.J. Robertson. 1977. Stable equilibrium strategies and penalty functions in a game of attrition. J. Theor. Biol. 65: 571-578.
- Oxley, D.J., M.B. Fenton, and G.R. Carmody. 1974. The effects of roads on populations of small mammals. J. Appl. Ecol. 11: 51-59.
- Pringle, J.S. 1983. Solidago caesia X S. canadensis (Compositae). A hybrid goldenrod new to Canada. The Plant Press 1(4): 64-65.
- Reid, D.G. and R. Harmsen. 1975. Trirhabda borealis Blake (Coleoptera: Chrysomelidae): A major phytophagous species on Solidago canadensis L. (Asteraceae) in south-eastern Ontario. Proc. Ent. Soc. Ont. 105: 44-47.
- Riotte, J.C.E. 1972. A review of the North American hawk moth genus Lapara (Lepidoptera: Sphingidae). Life Sci. Contr., R. Ont. Mus. No. 79, pp. 1-40.
- Riotte, J.C.E. 1973. Observations on seasonality in some moth species, made over the last four years at the biological station of Queen's University at Chaffey's Locks, Ontario. The Blue Bill. 20 (No. 3): 51-53.
- Riotte, J.C.E. 1973. Pheromones in action. The Blue Bill. 20 (No. 4): 60-61.
- Riotte, J.C.E. 1974. New food plant for Darapsa pholus (Cramer) (Sphingidae) 13 (4): 247-248.
- Riotte, J.C.E. 1976. Significant additions to the lepidopterous fauna of southeastern Ontario. J. Res. Lep. 15 (2): 101-102.
- Robertson, R.J. and G.C. Biermann. 1979. Parental investment strategies determined by expected benefits. Zeit. f. Tierpsychol. 50: 124-128.
- Robertson, R.J. and N.J. Flood. 1980. Effects of recreational use of shorelines on breeding bird populations. Can. Field-Nat. 94(2): 131-138.
- Robertson, R.J. and H.L. Gibbs. 1982. Superterritoriality in Tree Swallows: a reexamination. Condor 84: 313-316.
- Robertson, R.J. and R.F. Norman. 1976. Behavioral defenses to brood parasitism by potential hosts of the Brown-headed Cowbird. Condor 78: 166-173.
- Robertson, R.J. and R.F. Norman. 1977. The function and evolution of aggressive host behavior towards the brown-headed cowbird (Molothrus ater). Can. J. Zool. 55: 508-518.

- Robertson, R.J., H.L. Gibbs and B.J. Stutchbury. 1986. Spitefulness, altruism and the cost of aggression: evidence against superterritoriality in Tree Swallows. *Condor*, 88: 104-105.
- Robertson, R.J. and B.J. Stutchbury. Experimental evidence for sexually selected infanticide in tree swallows. *Anim. Behav.*, in press.
- Sargent, R.C. and M.R. Gross. 1985. The evolution of male and female parental care in fishes. *Am. Zool.* 25(3), in press.
- Sargent, R.C. and M.R. Gross. 1986. Williams' principle: an explanation for parental care in teleost fishes. In, *The behaviour of teleost fishes*. T. Pitcher (Ed.). Croom Helm Publishers. pp. 275-293.
- Sargent, R.C., P. Taylor and M.R. Gross. 1987. Parental care and the evolution of egg size in fishes. *Amer. Natur.* 129: 32-46.
- Sheppe, W.A. 1965. Characteristics and use of Peromyscus tracking data. *Ecology* 46: 630-634.
- Sheppe, W. 1965. Dispersal by swimming in Peromyscus leucopus. *J. Mammal.* 46: 336-337.
- Sheppe, W. 1965. Island populations and gene flow in the deer mouse, Peromyscus leucopus. *Evolution* 19: 480-495.
- Sheppe, W.A. 1965. Unseasonal breeding in artificial colonies of Peromyscus leucopus. *J. Mammal.* 46: 641-646.
- Sheppe, W.A. 1966. Determinants of home range in the deer mouse, Peromyscus leucopus. *Proc. California Acad. Sci.* 34: 377-418.
- Sheppe, W.A. 1966. Exploration by the deer mouse, Peromyscus leucopus. *Amer. Midl. Natur.* 76: 257-276.
- Sheppe, W.A. 1967. The effect of live trapping on the movements of Peromyscus. *Amer. Midl. Natur.* 78: 471-480.
- Sheppe, W. and S. Carnes. 1965. Smoked paper tracking technique. *California Acad. Sci.* 34: 377-418.
- Smith, B.P. 1986. New species of Eyllias (Acari: Hydrachnellae; Eylaidae) parasitic on water boatmen (Insecta: Hemiptera; Corixidae) and a key to North American larvae of the subgenus Syneylais. *Can. J. Zool.* 64(10): 2363-2369.
- Smith, B.P. 1987. New species of Hydrachna (Acari: Hydrachnidia; Hydrachnidae) parasite on water boatmen (Insecta: Hemiptera; Corixidae). *Can. J. Zool.* 65, in press.
- Smith, B.P. and S.B. McIver. 1984. Factors influencing host selection and successful parasitism of Aedes spp. mosquitoes by Arrenurus spp. mites. *Can. J. Zool.* 62: 1114-1120.

- Smol, J.P. 1984. The statospore of Mallomonas pseudocoronata (Mallomonadaceae, Chrysophyceae). Nord. J. Bot. 4: 827-831.
- Studd, M.V. and R.J. Robertson. 1985. Sexual selection and variation in reproductive strategy in male Yellow Warblers (Dendroica petechia). Behav. Ecol. and Sociobiol. 17: 101-109.
- Studd, M.V. and R.J. Robertson. 1985. Lifespan, competition and delayed plumage maturation in male passerines: a multiple factor model. Am. Nat. 126: 101-115.
- Studd, M.V. and R.J. Robertson. 1985. Evidence for reliable badges of status in territorial Yellow Warblers (Dendroica petechia). Anim. Behav. 33: 1102-1113.
- Stutchbury, B.J. and R.J. Robertson. 1985. Floating populations of female tree swallows. Auk. 102: 651-654.
- Stutchbury, B.J. and R.J. Robertson. 1986. A simple trap for catching birds in nest boxes. J. Field Ornithol. 57: 64-65.
- Stutchbury, B.J. and R.J. Robertson. 1987. Behavioural tactics of subadult female floaters in the Tree Swallow. Behav. Ecol. Sociobiol. 20: 413-419.
- Stutchbury, B.J. and R.J. Robertson. 1987. Do nest building and first egg dates reflect settlement patterns in the Tree Swallow? Condor 89: 587-593.
- Stutchbury, B.J. and R.J. Robertson. 1987. Two methods of sexing adult Tree Swallows before they begin breeding. J. Field. Ornithol. 58: 236-242.
- Stutchbury, B.J. and R.J. Robertson. 1987. Signaling subordinate and female status: two hypotheses for the adaptive significance of subadult plumage in female Tree Swallows. Auk 104: 717-723.
- Stutchbury, B.J. and R.J. Robertson. Within-season and age-related patterns of reproductive performance in female tree swallows (Tachycineta bicolor). Can. J. Zool. in press.
- Teather, K.L. and R. J. Robertson. 1985. Female spacing patterns in Brown-headed Cowbirds. Can. J. Zool. 63: 218-222.
- Teather, K.L. and R.J. Robertson. 1986. Pair bonds and factors influencing the diversity of mating systems in Brown-headed Cowbirds. Condor 88: 63-69.
- Teather, K.L. K.E. Muma and P.J. Weatherhead. 1988. Estimating female settlement from nesting data. Auk 105: 196-200.
- Tippett, R. 1964. An investigation into the nature of the layering of deep water sediments in two eastern Ontario lakes. Can. J. Bot. 42: 1693-1709.

- Thomas, D.W., M.B. Fenton and R.M.R. Barclay. 1979. Social behaviour of the little brown bat, Myotis lucifugus. I. Mating behaviour. Behav. Ecol. Sociobiol. 6: 129-136.
- Thomas, D.W., M.B. Fenton and R.M.R. Barclay. 1979. Social behaviour of the little brown bat, Myotis lucifugus. II. Vocal communication. Behav. Ecol. Sociobiol. 6: 137-146.
- Toohey, J. 1983. Fungus fairy rings in soil: Etiology and chemical ecology. Can. Field Nat. 97: 9-15.
- Toohey, J.I., C.D. Nelson and G. Krotkov. 1965a. Toxicity of phenazine carboxylic acids to some bacteria, algae, higher plants and animals. Can. J. Bot. 43: 1151-1155.
- Toohey, J.I., C.D. Nelson & G. Krotkov. 1965b. Isolation and identification of two phenazines from a strain of Pseudomonas aureofaciens. Can. J. Bot. 43: 1055-1062.
- Toohey, J.I., C.D. Nelson & G. Krotkov. 1965c. Barren ring, a description and study of causal relationships. Can. J. Bot. 43: 1043-1054.
- Vander Kloet, S.P. 1968. Occurrence of Rhus copallina in Leeds County, Ontario. Can. Field Nat. 82: 291-293.
- Vander Kloet, S.P. 1973. The biological status of Pinus rigida Miller in Ontario and adjacent New York. Can. Field-Nat. 87: 249-253.
- Vander Kloet, S.P. 1976. Dispersal and seedling establishment of Vaccinium angustifolium Aiton in Leeds County, Ontario and Pictou County, Nova Scotia: A comparative analysis. Can. Field Nat. 90: 176-180.
- Vander Kloet, S.P. 1976. Natural barriers to gene exchange between Vaccinium angustifolium Aiton and Vaccinium corymbosum L. Rhodora, 78: 503-515.
- Vander Kloet, S.P. 1977. The taxonomic status of Vaccinium boreale. Can. J. Bot. 55: 281-288.
- Vander Kloet, S. 1978. The taxonomic status of Vaccinium pallidum, the Hillside Blueberries, including Vaccinium vacillans. Can. J. Bot. 56: 1559-1574.
- Vander Kloet, S. 1978. Systematics, distribution and nomenclature of the polymorphic Vaccinium angustifolium. Rhodora, 80 (823): 358-376.
- Vander Kloet, S.P. 1980. The taxonomy of the highbush blueberry, Vaccinium corymbosum. Can. J. Bot. 58: 1187-1201.
- Vander Kloet, S. 1984. Differences in vegetative and reproductive growth among Ontario, Nova Scotia and Newfoundland populations of Vaccinium angustifolium. Amer. Midl. Nat., in press.
- Vander Kloet, S.P. 1985. Effects of pollen donors on seed production, seed weight, germination and seedling vigor in Vaccinium corymbosum L. Am. Midl. Nat. 112(2): 392-396.

- Vander Kloet, S.P. and P.J. Austin-Smith. 1986. Energetics, patterns and timing of seed dispersal in Vaccinium section Cyanococcus. Amer. Midl. Nat. 115 (2): 386-396.
- Ward, P.S., R. Harmsen and P.D.N. Hebert. 1974. An annotated checklist of the Macroheterocera of south-eastern Ontario. J. Res. Lep. 13 (1): 23-42.
- Ward, P.S., P.D.N. Hebert, and R. Harmsen. 1973. A note on the distribution of Oeneis chryxus strigulosa (Lepidoptera: satyridae). Can. Ent. 105: 1373-1374.
- Werren, J., M.R. Gross and R. Shine. 1980. Paternity and the evolution of male parental care. J.Theor. Biol. 82: 619-631.
- Weatherhead, P.J. 1982. Risk-taking by Red-winged Blackbirds and the Concorde fallacy. Z. Tierpsychol. 60: 199-208.
- Weatherhead, P.J. 1983. Two principal strategies in avian communal roosts. Amer. Nat. 121: 237-243.
- Weatherhead, P.J. 1983. Secondary sex ratio adjustment by Red-winged Blackbirds (Agelaius phoeniceus). Behav. Ecol. and Sociobiol. 12: 57-61.
- Weatherhead, P.J. 1984. Fecal sac removal by tree swallows: the cost of cleanliness. Condor 86: 187-191.
- Weatherhead, P.J. 1984. Mate choice in avian polygyny: Why do females prefer older males? Am. Nat. 123: 873-875.
- Weatherhead, P.J. 1984. Patterns in roosting flocks: a re-evaluation of data and conclusions. Condor 86: 497-498.
- Weatherhead, P.J. 1985. Sex ratio of Red-winged Blackbirds by egg size and laying sequence. Auk 102: 298-304.
- Weatherhead, P.J. 1985. The bird's communal connection. Natural History 94: 34-41.
- Weatherhead, P.J. 1986. How unusual are unusual events? American Naturalist 128: 150-154.
- Weatherhead, P.J. 1987. Field tests of information transfer in communally roosting birds. Anim. Beh. 35: 614-615.
- Weatherhead, P.J. 1988. Adaptive disposal of fecal sacs? Condor, in press.
- Weatherhead, P.J. and F.W. Anderka. 1984. An improved radio transmitter and implantation technique for snakes. J. Herpetology 18: 264-269.
- Weatherhead, P.J. and K.A. Boak. 1986. Site infidelity in song sparrows. Animal Behaviour 34: 1299-1310.

- Weatherhead, P.J. and Charland, M. B. 1985. Habitat selection in an Ontario population of the snake Elaphe obsoleta. J. Herpet. 19: 12-19.
- Weatherhead, P.J. and R.J. Robertson. 1977. Harem size, territory quality, and reproductive success in the Red-winged Blackbird. Can. J. Zool. 55: 1261-1267.
- Weatherhead, P.J. and R.J. Robertson. 1977. Male behaviour and female recruitment in the Red-winged Blackbird. Wilson Bull. 89: 583-592.
- Weatherhead, P.J. and R.J. Robertson. 1979. Offspring quality and the polygyny threshold: "The sexy son hypothesis". Am. Nat. 113: 201-208.
- Weatherhead, P.J. and R.J. Robertson. 1981. In defense of the sexy son hypothesis. Am. Nat. 117: 349-356.
- Weatherhead, P.J. and K.L. Teather. 1987. The paradox of age-related dominance in brown-headed cowbirds. Canadian Journal of Zoology 65: 2354-2358.
- Weatherhead, P.J., H. Greenwood and R.G. Clark. 1987. Natural selection and sexual selection on body size in red-winged blackbirds. Evolution 41: 1402-1403.
- Williamson, M. and A. Keast. 1988. Retinal structure relative to feeding in the rock bass (Ambloplites rupestris) and bluegill (Lepomis macrochirus). Can. J. Zool., in press.
- Williamson M. and A. Keast. 1988. Retinal structure in the piscivorous largemouth bass (Micropterus salmoides) relative to generalist feeding centrarchids. Can. J. Zool., in press.
- Wolfe, L.M. 1981. Feeding behavior of a plant: differential prey capture in old and new leaves of the pitcher plant (Sarracenia purpurea). Amer. Midl. Natur. 106: 352-359.
- Wolfe, L.M. 1983. The effect of plant size on reproductive characteristics in Erythronium americanum (Liliaceae). Can. J. Botany 61: 3489-3493.
- Wolfe, L.M. and S.C.H. Barrett. 1987. Pollinator foraging behavior and pollen collection on the floral morphs of tristylous Pontederia cordata L. Oecologia, 74: 347-351.
- Woolhouse, M.E.J., R. Harmsen and L. Fahrig. 1985. On succession in a saxicolous lichen community. Lichenologist 17: 167-172.