THE UNIVERSITY OF MICHIGAN
BIOLOGICAL STATION
1909 · 1983

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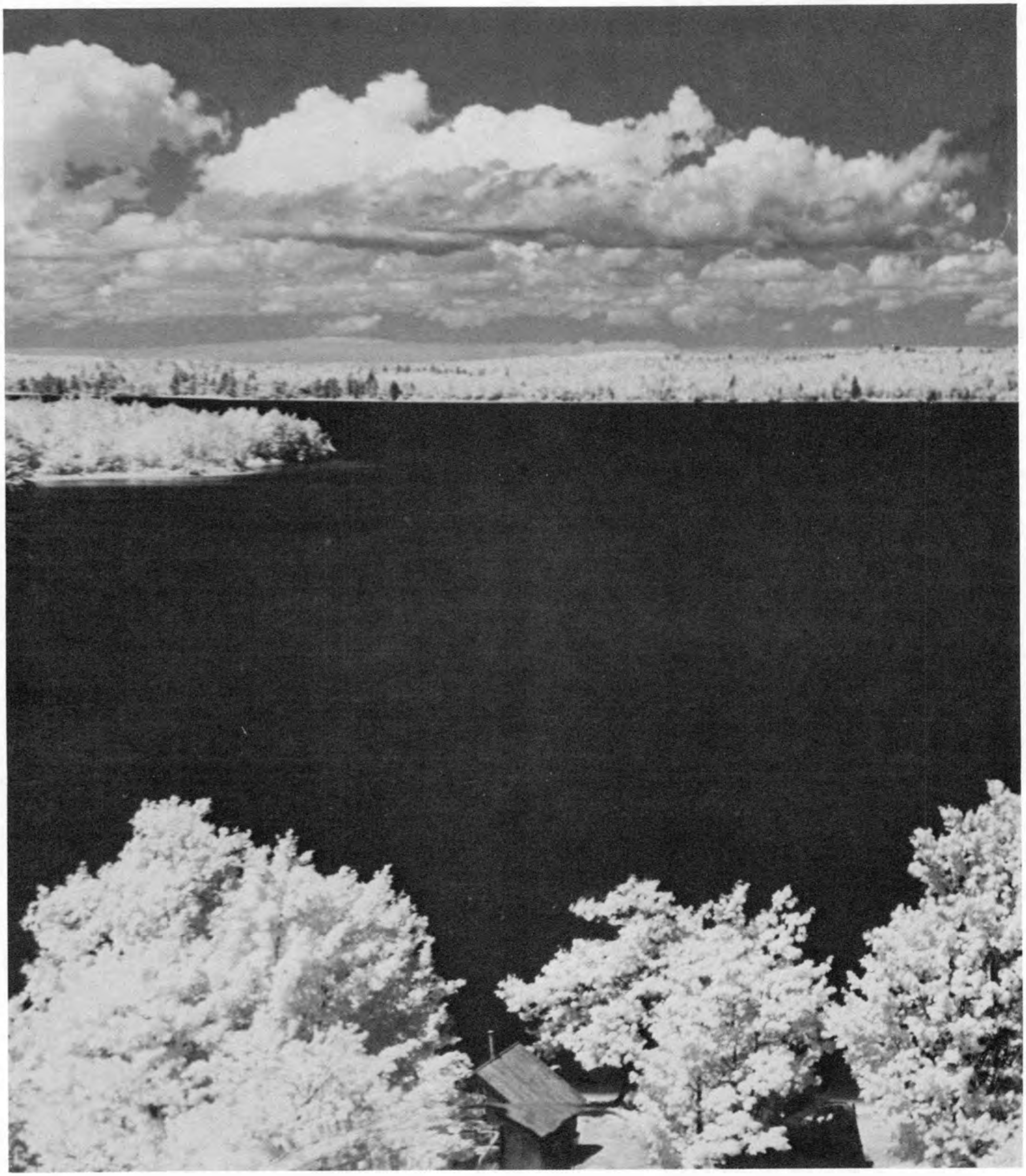

INTRODUCTION

The University of Michigan Biological Station occupies a position of distinction among biological institutions. It is of singular importance among biologists, for it was here that a large number of biologists received their first experience with field biology. A decade ago, when I first assembled a listing of the mailing addresses of former students and staff, I found scarcely an institution of higher learning in America without at least one faculty member who had studied at Douglas Lake. For large numbers of former students, the Biological Station experience was the most important formative event of their college careers. Former students occupy positions of great distinction throughout the world in government, industry and academia. Their contributions to our knowledge of the biosphere are enormous and their influence on other scholars as amplified through their teaching has been immense. Beyond that, large numbers of individuals who had the good fortune to take classes at the Biological Station have had their lives enriched through a sharpened ability to understand and appreciate the incredible beauty of the natural world.

An excellent history of the Biological Station was written by LaRue (1944). Further elaboration of the history is contained, as reminiscences by former administrators, professors, and students, in the Semicentennial Celebration Proceedings of the University of Michigan Biological Station, June 16-19, 1959. Here, I shall highlight some of the early history, a goodly amount recorded for the first time, and then describe developments of the most recent 25 years.

The importance of the Biological Station is as great or greater today than it ever was as the human species continues to exploit and degrade the global ecosystem. The necessity for a thorough understanding of natural and disturbed ecosystems is increasingly urgent. Notwithstanding the great advances being made in molecular biology and in genetic engineering, the necessity to understand thoroughly the biological composition, form, and function of the world in which we live, remains of paramount importance. Failure to balance this understanding against the advances of technology can only lead to human catastrophe. The Biological Station today continues its central role with educating each class of young disciples of biology and of promoting the scholarship of knowledge concerning all aspects of the living world. The University of Michigan must never withdraw from this obligation.

David M. Gates,
Editor

South Fishtail Bay, Douglas Lake by infrared.

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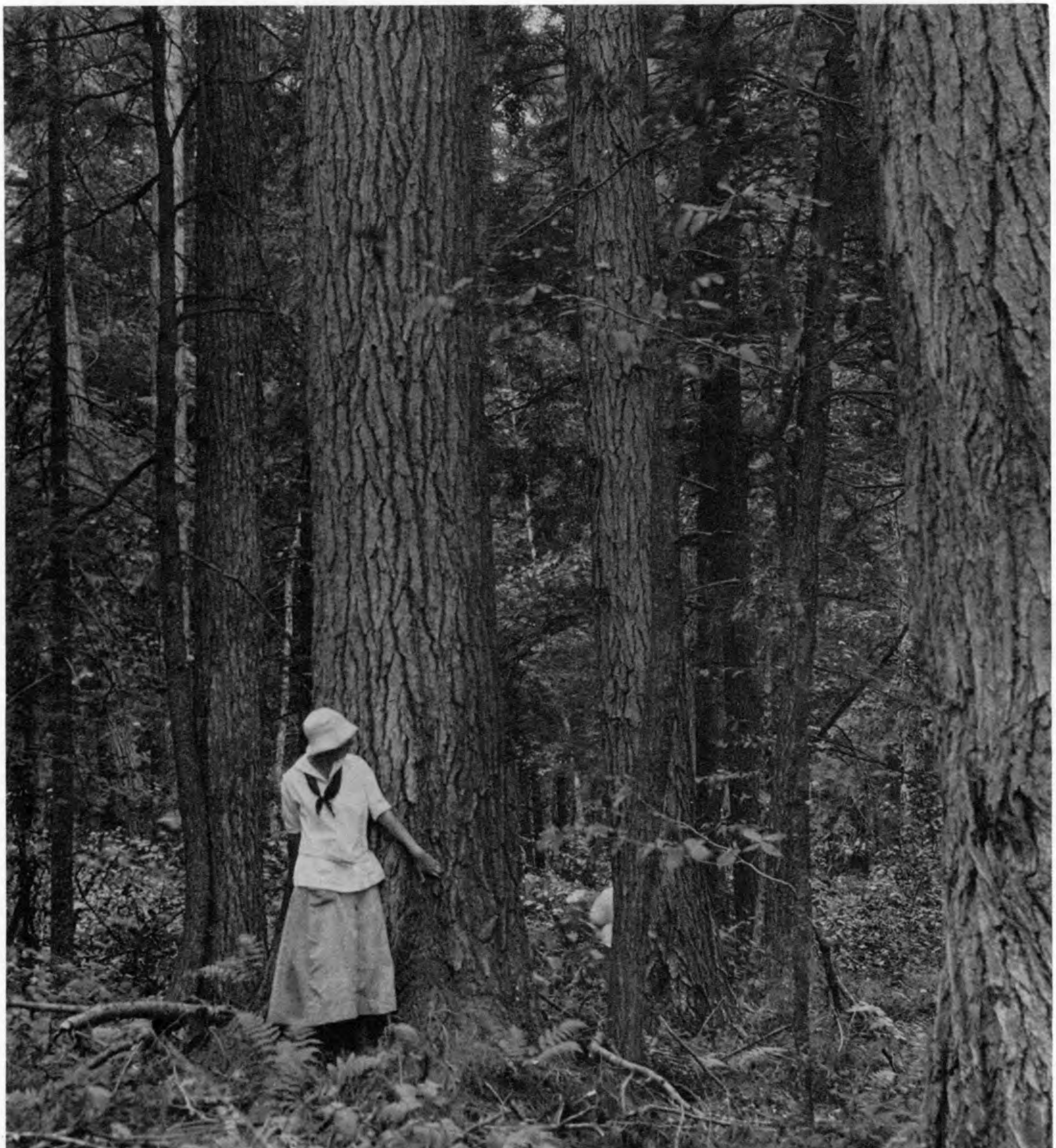


SEVENTY-FIVE YEARS

PRE-STATION HISTORY

The glaciers left behind in northern Michigan a landscape of moraines, drumlins, sand dunes, bogs, streams, outwash plains, and scoured rocks upon which a deciduous and coniferous forest established itself during the last several thousand years. The region around Douglas Lake was occupied by Ottawa Indians at the time of arrival by Europeans. These Indians were descended from a people of the late Woodland culture that in turn had emerged from the Hopewellian culture that earlier dominated much of eastern North America. Nearby, the large Chippewa tribal group occupied much of western Ontario and were first encountered by Europeans at Sault Saint Marie in 1622.

The primeval forests of the Douglas Lake region were comprised of trees of great size. As settlement of the region occurred it was no wonder that these trees were attractive to those who desired to exploit the resource. The first sawmill was established in Cheboygan in 1846 and 1 million board feet was shipped to Chicago that year. By 1867, 4 million board feet went out and 35 million by 1872. By 1890, timber was being brought to Cheboygan from Canada to keep the mills going. The lands occupied by the Station today had not been cut when a Mr. Pells and a Colonel Bogardus entered the scene.

Charles Bogardus was born in Cayuga County, New York, on March 28, 1841. A colonel during the Civil War, he was wounded twice and captured by the enemy. He retired from the army immediately after the war and married Hannah, the daughter of William H. Pells, a dealer in lands in western New York state. He then went into business with his father-in-law in New York state. Mr. Pells left New York in 1872 for Illinois, feeling that the opportunity for land development was much better there. Pells platted and developed the town of Paxton, Illinois, just north of Urbana. Colonel Bogardus was put in charge of the Mortgage and Loan Department of the bank in Paxton. Then in 1885 Bogardus was elected to the Illinois legislature and served until he came to Michigan in 1901.

As early as August 22, 1875, William Pells was buying more land for future operations, but now in northern Michigan rather than in Illinois. Mr. Pells purchased over 27,000 acres of timber lands in Emmet and Cheboygan counties between 1875 and 1885. The land agent for the Grand Rapids and Indiana railroad was impressed by Mr. Pells and when the line was extended to Mackinaw City from Petoskey, he named the village of Pellston after him. Mr. Pells died at Pellston on 25 June 1886. Colonel Bogardus and his wife inherited all the Illinois and Michigan properties after the death of Edgar Pells, the only son of William Pells.

Bogardus, 58, was then a successful businessman and politician in Illinois. He gave it all up to come to northern Michigan in 1901 to make his fortune in lumber. It was a bad decision. By 1913 he had lost

Margaret Gates (Mrs. F. C. Gates) in the Pellston Hardwoods, 1917.

it all — some 12 million dollars — in bad bank notes and receivers demands. But during the intervening 12 years he made Pellston bustle. He sold his holdings west of the railroad to Jackson and Tindle of Buffalo, New York. Being the largest manufacturer of cooperage stock and lumber in the world, they needed new timber lands. Charles Bogardus was the exact opposite of his father-in-law, Mr. Pells. Bogardus was "completely without insight, susceptible to flattery, easily taken in with others on the one hand, and refusing to take advice on the other" according to his grandson, Charles Zipfs.

By 1900, the largest timber operators were moving westward into Wisconsin, Minnesota, and the Northwest. Colonel Bogardus had no experience in the timber business. He decided to develop the lands on the east side of the railroad tracks in Pellston. He built the East Mill at the junction of the Maple River and Robinson Road to process the timber taken from between Burt and Douglas Lakes. This mill employed 75 to 100 men the year round and could handle from 20 to 30 thousand board feet of timber each day. In contrast, the Jackson and Tindle mill on the west branch of the Maple River had its own railroad, handled 75 thousand board feet of logs per day and had 300 to 400 men on the payroll in 1903.

Bogardus plunged into building the Cheboygan and Southern Railroad east from Pellston to the southern end of Douglas Lake and from there, northeast toward Cheboygan, a town with better shipping facilities than Petoskey. A three-track line was planned and the railroad grade was built from Pellston to near the south end of Douglas Lake. A railroad camp was established in two log buildings on South Fishtail

Loading logs, Jackson and Tindle Mill, Pellston, 1917.

Manville from the lake, 1917.

(South Ashton) Bay on Douglas Lake. In the years 1903 to 1907 Bogardus had financed, built, or acquired the Pellston Planing Mill and Lumber Company, the East Mill, the town of Lakewood, land north of Pellston between Van and Levering, various lumber camps, the Pellston Bank and Hotel, the Pellston Electric Company, the Cheboygan and Southern Railroad, and many homes and a company store for the workers. The Colonel established the Bogardus Land and Lumber Company in December 1905. Bogardus was overextended, timber was running out, and by 1912 bank examiners found the notes issued to the holding company (the Bogardus Land and Lumber Company) to be worthless.

THE EARLY YEARS

In June 1908, The University of Michigan was looking for a new site in northern Michigan for their summer civil engineering camp that had been located on Glen Lake. The University approached Colonel and Mrs. Bogardus for a lease for the summer of a site on Douglas Lake for $2,500. Instead, Bogardus offered the University 1,440 acres with a two-mile frontage on Douglas Lake as a permanent camp site, and it was accepted by the Board of Regents. The land was purchased at a price that made its transfer to the University in part a gift. Colonel Bogardus felt that its use should involve scientific work as well as engineering work. As a result, Dean Cooley of Engineering urged the establishment of a biological station. Professor Frederick C. Newcomb, Professor of Botany, visited the site and decided to recom-

Ladyville from the lake, about 1915.

Fire near UMBS, 1914.

mend to the Administration the founding of a biological station as an experiment. Professor Jacob E. Reighard, Professor of Zoology, was named the first director for the summer of 1909.

The original suggestion for the establishment of a biological station had occurred several years earlier. According to LaRue (1944):

> In the spring of the year 1900, Professor Jacob E. Reighard of the Department of Zoology appeared before the Board of Regents to discuss the establishment of a biological station on the Great Lakes, to be under University control, but maintained by the government. Apparently the project came to naught. The idea was not entirely abandoned by the University, however, for in October 1903, Professor John O. Reed included in his plan for the betterment of the Summer Session a suggestion that a biological station be established at some suitable place on the lakes of Michigan, "for the study of Botany and Zoology, and for accommodation of persons desiring to do advanced work in these lines." But again no immediate action resulted.

The land upon which the engineering camp known as Camp Davis and the Biological Station were established was not particularly attractive since it had been ravaged by the ax and blackened by fires. Nearby, around Bryants, west of Pellston and north of North Fishtail Bay on Douglas Lake, were some fine stands of virgin timber. When the engineering camp and the Biological Station were established, they occupied adjacent land along the shore of South Fishtail Bay, sometimes referred to as South Ashton Bay, of Douglas Lake. Camp Davis was located close to the west end of the bay, the more favorable site and more protected from the winds of summer. The Biological Station was to the east and more exposed to the prevailing wind.

During the first session, in addition to the Director, the Biological Station staff was made up of Professor George P. Burns, botanist,

(above) Tent living, 1918; *(right)* Log Lab, 1909.

and Miss Francis Dunbar and Mr. Fred A. Loew as assistants. The women's camp of three tents was on the hill near the mess tents, and the men's camp was just west of the Log Lab, one of the two log buildings left over from the logging days. This laboratory had no windows at first but was lighted through long slits on either side where the logs had been removed. There was no shed for the aquaria, and the students pumped the water by hand. There were 14 students and of these, 10 were women. Six of the students were graduates and eight were teachers. Three courses were given in botany and three in zoology. One research paper was published concerning the abatement of the black-fly pest. At the close of the first session, each student wrote a letter to the Director, giving an opinion of the Station and suggestions for improvement. These letters were so enthusiastic that, after reading them, the Regents decided to continue the experiment.

During the second session (1910), the Station was in the charge of Dr. A. S. Pearse, acting as assistant director. Professor Raymond Pool, of the University of Nebraska, had charge of Botany and was assisted by Mr. Loew. Mr. N. H. Stewart gave the course in vertebrate zoology and Miss Lucie Harmon acted as assistant. Twenty-three students were in attendance, but no list of these is available. Ten of these were graduate students. The women's camp was moved from the hill to along the lakeshore east of Log Lab. A tent laboratory, an additional dining tent, and the launch Alexander Forbes were added. The launch, two scholarships, and an instructorship were gifts secured by Dr. Pearse. The courses of the previous year were repeated, and a teacher's course, a course on fungi, and a separate bird course were added. A daily paper was published, camping trips and evening lectures were introduced, religious services were held on Sunday morning, and a social function was provided on Saturday evening. Three pieces of research were published from the Station, and two others dealt in part with materials collected at the Station. After the second session, the success of the Station was unquestioned, and it was decided to continue the "experiment."

The third session (1911) was again in the charge of Professor Reighard. Professor H. A. Gleason had charge of botany and was assisted by Mr. Loew. Mr. H. B. Baker acted as assistant in zoology. Professor Frank Smith was added to the staff; he had charge of invertebrate zoology and was assisted by Mr. Paul S. Welch, who initiated the work in entomology. Mrs. Smith acted as women's advisor. Mr. Harry Clarke was employed as laborer. Two tents and the windmill, with its shed and tank, were added to the equipment. Frank C. Gates, a graduate student in botany and a research investigator with the Biological Survey of Michigan, helped erect the windmill. Twenty-two students attended the session. Fourteen were graduate students. There were nineteen women students and only three men. Two of these men were at the same time assistants. The teacher's course and that on fungi were discontinued while courses dealing

The 1911 camp group. Gleason, fifth from left, and Welch, second from right, in back row. Gates, fifth from right, and Reighard, far right, front row.

with entomology and molluscs were added. Fourteen pieces of research were undertaken during the session.

During the fourth session (1912) the staff was enlarged by the addition of Mr. John S. Dexter as assistant in ornithology and Professor A. W. Shull and Dr. Harper acted as research assistants. Miss Francis Dunbar became the assistant in zoology and Mrs. Anna Rhoades became the Dean of Women. The courses remained the same as the previous year, except that the course on molluscs was omitted. There were eighteen students, of whom eight were graduate students. An excellent launch, the Aquilina, was purchased and a new tent research laboratory was erected. A typewriter and a mimeographing machine were added.

Towards the end of the fourth summer session Professor Reighard (1912) wrote the following:

> The four years have shown a steady growth in equipment, in graduate students, in enthusiasm, and in research output. The location, although not selected by biologists, has on the whole proved to be good. It is doubtful whether so large a tract of uncultivated country so well adapted to the work is to be found elsewhere in southern Michigan. Still, the present location should not be thought of as final until the problem has been studied. The field of the station, more perhaps than any other station, is that of outdoor study. The living organism, in its natural environment, is the center of our interest. In this interest, the botanist has advanced further than the zoologist, but zoologists are hot on their trail; and it is the belief of the writer that the outdoor study of animal habits, with the new field of physiological animal geography, have a promising future. For these, the Station is peculiarly fitted. In their study, experimental methods are likely to be more and more employed. For this use, a well equipped laboratory building is needed and is the next great desideratum of the station. Research along physiological-ecological lines is the first and most important thing, and for that we need a staff with leisure for the work, and with competent graduate students to take up the problems as they develop. Next to that our function seems to be to get teachers into close and enthusiastic contact with the living out-of-doors. Nothing is more stimulating to teachers and students than to mold natural history work with a good seasoning of modern scientific method. We never lose our interest in living nature, and for teachers and students to be with it for a season in the open is an inspiration that should be contagious.

(above) Cabin construction about 1920; *(below)* The Aquilina coming out of storage from Houghton Hall, 1919.

It is interesting to note that the idea of emphasizing physiological ecology at the Station was a part of their philosophy as early as 1912. Further insight into the early ideas concerning the importance and relevance of the Biological Station is given in Appendix A in the address given by Dr. Gleason at the dedication of Houghton Hall in 1914. During the teens and twenties the engineers and biologists continued to develop their camps. The engineers erected prefabricated galvanized iron cabins and laboratories, while the biologists constructed wood frame buildings covered by board and tar paper. Nearly all of these units are still in use 60 years later and every indication is that they will continue in use for another 60 years. Originally the metal cabins cost about $125 each and the wooden cabins about $175 each — clearly the best buy of housing The University of Michigan ever made.

MOVE TO THE NEW CAMP

The teens and twenties was a period of great growth for the Biological Station. Professor Paul S. Welch in his address to the Semicentennial Anniversary audience described this period as the transition period. In 1927 Clarence T. Johnson, Director of Camp Davis, announced that the engineers wished to move the civil engineering camp to Wyoming. Most of their field work was for training engineers in surveying. The forest was growing up and getting in the way and it was becoming more difficult for the engineers to do their work at Douglas Lake. Following the 1928 summer session, Camp Davis was moved to Jackson Hole, Wyoming, where it still operates today but as the field camp for geology.

The departure of the engineers solved a dilemma faced by the biologists. During the autumn of 1927 University officials and professors had seriously considered moving the Station to Grapevine Point, a location just northwest of Camp Davis. Now with $75,000 appropriated for the move, the Biological Station was relocated within the engineering camp area and within the western most part of the "old" camp site. Ninety-nine buildings were moved. Wooden laboratory buildings from the "old" site became faculty houses in the "new" camp. The dining hall and administration building, the botany laboratory (now known as Gates and Newcomb Laboratories) and the large Zoology building (now identified as Welch, Eggleton, Ehlers, and LaRue Laboratories) were built during the autumn of 1929 and early summer of 1930.

Further details concerning the move to the "new" camp are given in LaRue's chapter entitled "Growth and Development of Plant and Program," in the Semicentennial Proceedings (1959).

Classroom buildings, 1932.

DIRECTORS

The Biological Station has had a series of distinguished directors (Table I). It is appropriate to include here a biographical sketch concerning each of these individuals.

Jacob E. Reighard (1909-1914)

The first Director was Professor Jacob E. Reighard who served from 1909 to 1914. He also held the directorship of the Zoological Laboratories and Museum of Zoology at Ann Arbor during later years. He was distinguished for his remarkable studies on the embryology and life-histories of fishes. He was quick to apply the results of basic research to commercial and sport fishing and promoted their use by the Institute for Fisheries Research of the Bureau of Fish and Wildlife Service. In 1913 and 1914, Reighard was Director by title but was not in residence at the Station. Henry Allan Gleason, Assistant Professor of Botany, was Acting Director.

Henry Allan Gleason (1915)

Following two years as the Acting Director of the Station, Professor Henry Allan Gleason was appointed Director for 1915. Gleason was then Assistant Professor of Botany at The University of Michigan. He helped to bring the Station through its critical initial years after which the permanency of the Station was assured. Dr. Gleason resigned from The University of Michigan in 1916 to join the staff of the New York Botanical Garden. He returned for the summer of 1923 to teach plant anatomy and for other summers in order to do research. Henry Allan Gleason was to become one of the greatest of American botanists, distinguishing himself in plant systematics, taxonomy, and ecology. His paper on the individualistic concept in ecol-

TABLE I
DIRECTORS

1909-1914	Jacob Reighard
1910	Arthur S. Pierce, *acting*
1913, 1914	Henry Allan Gleason, *acting*
1915	Henry Allan Gleason
1916	Otto C. Glaser
1917-1939	George R. LaRue
1925	Paul S. Welch, *acting*
1940-1966	Alfred H. Stockard
1967	Frederick K. Sparrow, *acting*
1968	Alexander H. Smith, deputy *acting*
1969-1971	Frederick K. Sparrow
1972-Present	David M. Gates


(left) Jacob Reighard; *(right)* Henry Allan Gleason.

(above) Otto C. Glaser, 1916; *(below)* George R. LaRue.

ogy is one of the classics of ecological literature.

Henry Allan Gleason was born on a farm in Illinois in 1882. He graduated from the University of Illinois and later received the Ph.D. degree from Columbia University. He died in 1975.

Otto Charles Glaser (1916)

The third Director of the Station was Otto Charles Glaser, Associate Professor of Zoology. He was Instructor in Zoology 1905-1908, Assistant Professor 1908-1912, Junior Professor 1912-1915, and Associate Professor 1915-1918 at which time he departed Michigan for Amherst College, Amherst, Massachusetts.

George R. LaRue (1917-1939)

The fourth Director of the Biological Station was George R. LaRue, Assistant Professor of Zoology — a man destined to have an enormous influence on the Biological Station. His reputation as a parasitologist of national and international recognition grew rapidly. A complex man of irascible and kindly personality, he was known at the Station as "The Governor." A tongue lashing from him was never to be forgotten. His methods, which worked well in the teens and twenties, would have produced a Station revolution in the 1960s.

George R. LaRue was born 1 January 1882 in "a small square four roomed house" located in Union Township, O'Brien County, Iowa. LaRue graduated from the Crete Academy (affiliated with Doane College) in 1907. In September 1907 he entered the University of Nebraska to work with Dr. H. B. Ward, head of the Department of Zoology. He was assigned to review a journal paper on cestode larvae. This began the direction of his lifetime research.

During LaRue's second year at Nebraska, he took courses in physiology and botany. He studied tapeworms from salamanders and did a master's degree thesis. Then he was invited by Dr. Ward to go on an expedition to Alaska during the summer of 1909 to study the parasites of salmon in Alaska. Dr. Ward was moving from the University of Nebraska to the University of Illinois upon his return from Alaska and George LaRue accompanied him with the intent of accomplishing a Ph.D. degree in zoology. At Urbana in zoology there was Professor Frank Smith and students Paul S. Welch, James E. Ackert, and W. W. Cort; each of these to play a role at the University of Michigan Biological Station several years later. The Illinois connection is a most significant and fascinating one in terms of the Biological Station, for here also were Henry Allan Gleason, A. G. Vestal, and Frank C. Gates. George R. LaRue received a Ph.D. from the University of Illinois in June 1911. His Ph.D. thesis was on the histogenesis of *Proteocephalus filaroides* from the amphibian *Ambystoma tigrinum.*

Dr. LaRue served as Instructor at the University of Illinois during the summers of 1910 and 1911. He taught a course in microtechniques. During the summer of 1910 he taught this course at the

The Alexander Forbes towing a class, 1928.

University of Illinois Biological Station at the Methodist Assembly Grounds at Quiver Lake, a flooded part of the Illinois River, north of Havana, Illinois. The Illinois Biological Station was only operated that summer and never again. Then LaRue was offered an instructorship in zoology at The University of Michigan by Professor Reighard at a salary of $1,200. In June 1912 Dr. and Mrs. LaRue took the train to Michigan where George LaRue was to serve as a temporary scientific investigator for the old U.S. Bureau of Fisheries at the University of Michigan Biological Station on Douglas Lake. When they got off the train at Pellston, they found Professor and Mrs. Frank Smith of the University of Illinois on the depot platform. The two couples then went by automobile to Bryant's Resort on Douglas Lake and by launch, the Alexander Forbes, to the Biological Station. When they arrived at the Station they found that their tent had not been erected and so their first order of business was to build a tent platform and put up a tent. The summer of 1912 was a busy one, so much so that the LaRues did not once get to town until the end of the summer on the return trip to Ann Arbor. Several years were spent in Ann Arbor, both winter and summer, where George R. LaRue was heavily laden with the duties of teaching and administration in the Zoology Department.

In the autumn of 1916 Professor Reighard asked LaRue if he would accept the directorship of the Biological Station, a position then being vacated by Dr. Otto Glaser who was Director only one year. In June 1917 Professor Clarence Johnston, Director of Camp Davis, invited LaRue to ride in his car to the Station. They left at 6:00 a.m. the first day and drove the Model T Ford for two full days, spending the night in Cadillac. They had supper the second day in Pellston and arrived at the Station that evening. The summer of 1917 was a busy one for LaRue who was directing the Station and carrying on research. His research interests shifted from cestodes to trematodes that summer.

When LaRue assumed the Directorship of the Station he strove to make it a better place for instruction and research in field biology. With the realization that during the first few years an undue amount of time and energy was being spent on the act of living, he set about changing that in order to make the job of teaching and research more effective. The engineers had been replacing tents with metal cabins during the teens, and now in 1920 the Biological Station acquired five wooden cabins covered with tar paper. Almost every summer after that until 1927 or 1928 additional cabins were built. The summer of 1928 was spent in making plans to move onto the site of Camp Davis. In the spring of 1929 Drs. Welch, LaRue, and the Assistant Superintendent of Buildings and Grounds Department, Mr. Ward Davenport, went to the Station to make a final plan for the layout of new buildings, streets, laboratories, and sewer system. Construction at Camp Davis went on during the summer of 1929 and that winter the Biological Station buildings were all removed from the "old camp" and put on skids to pull them into place in the "new camp." The present and permanent configuration of the Biological Station was then accomplished.

George R. LaRue remained as Director through the summer of 1939. Professor LaRue continued to teach in Ann Arbor until his retirement in 1952. He spent the latter years of his life in Hyattsville, Maryland because of an affiliation with the Department of Agriculture. Clara Marshall LaRue died October 28, 1957 and George R. LaRue August 3, 1967.

Alfred H. Stockard (1940-1966)

Alfred H. Stockard was named fifth Director of the Station upon unanimous recommendation of the faculty and served as Director from 1940 through 1966. He was very knowledgeable about the Station, having served as Administrative Manager to the Director, under the title of Secretary, from 1931 to 1939. A Professor of Zoology in the University, he was highly regarded as a superlative teacher and a considerate administrator. His course in Comparative Anatomy, taken by most pre-med students at Michigan, was rigorous, challenging, and entertaining. To this day one hears from former students of their fond memories of this inspiring teacher. Under Stockard's management the Station weathered the difficult World War II era and entered the post-war growth period ready to accept the great flood of veterans returning to campus following their years of service.

Stockard was responsible for the modernization of many of the Station facilities, the Director's residence at ES27 in 1940, the construction of a new library in 1949, the Lakeside Laboratory and Dormitory in 1966. His untimely death November 1966 denied the Station his managerial talents. The Lakeside Laboratory was dedicated to his memory in 1972 as the Alfred H. Stockard Lakeside Laboratory.

(left to right) Alfred H. Stockard; Frederick K. Sparrow; David M. Gates.

Frederick K. Sparrow (1967-1971)

Frederick K. Sparrow was to become the sixth Director of the Biological Station having served as Acting Director in 1967 and 1968. He was Director for the summers 1969, 1970, and 1971. During the 1968 summer session, Professor Alexander Smith served as Deputy Acting Director during Dr. Sparrow's sabbatical leave. Fred Sparrow was Professor of Botany at The University of Michigan from 1936 to 1972 at which time he became Professor Emeritus. He taught courses in aquatic fungi, aquatic flowering plants, and algae at the Biological Station 1939, 1948, 1950, and 1952 through 1966. Professor Sparrow was a world authority in his field of fresh water and marine fungi. He served as President of the Mycological Society of America and President of the American Academy of Arts, Science, and Letters. He received the Russel Award of The University of Michigan in 1943 and the Merit Award of the Botanical Society of America in 1968. He was elected as President of the 2nd International Mycological Congress in 1975. Fred and Nan Sparrow did a great deal during a short span of years to transform the Biological Station into an egalitarian society of close knit people. Fred often said that he was a "caretaker Director" and that his main goal was to keep the place going until a successor could be found. Frederick K. Sparrow was born May 11, 1903 in Washington, D.C., and passed away October 1975 in Ann Arbor, Michigan.

David M. Gates (1972-Present)

David M. Gates was appointed Director of the Biological Station in September 1971 and Professor of Botany in The University of Michigan the same year. He had been Director of the Missouri Botanical Garden and Professor of Botany, Washington University, St. Louis, Missouri, from 1965 to 1971. Previously he had been Professor of Natural History at the University of Colorado and a member of the research staff of the Institute of Arctic and Alpine Research. After receiving his Ph.D. in physics from The University of Michigan in 1948, he taught physics at the University of Denver until 1955. He was Scientific Director of the London Branch of the Office of Naval Research, American Embassy, London, England 1955 to 1957. He was a staff member of the Radio Propagation Laboratory, National Bureau of Standards, Boulder, Colorado from 1957 to 1964. His fields of expertise include atmospheric physics, biometeorology, and biophysical ecology. He received the Outstanding Achievement Award in Bioclimatology of the American Meteorological Society in 1971, the Gold Seal Award of the National Council of State Garden Clubs in 1971, the Distinguished Achievement Award of the American Institute of Biological Sciences in 1975, and the Distinguished Professor Achievement Award of The University of Michigan in 1982. He is a member of the Board of Directors of the Detroit Edison Corporation and of several foundations.

(above) The Totem Pole, 1918), *(right)* Log Lab and Aquarium from the lake, about 1915.

LABORATORY BUILDINGS

Log Lab and Hotel J. B.

Early laboratory facilities were housed in two log buildings near the shore of south Fishtail Bay. These buildings were built as a part of the railroad camp set up by Bogardus when he was constructing a railroad right-of-way to connect his sawmill on the Maple River with the Michigan Central Railroad at Cheboygan. The building closest to the lake, that came to be called "Log Lab," had served as the cook shack and dining room for the crew. The second log building, farther from the lake, had been the bunkhouse, and was to be designated "Hotel J. B.," because Professor J. B. Davis had slept one night in it.

Log Lab was without windows when Professors Reighard and Burns arrived at Douglas Lake in 1909. Windows were shipped from Ann Arbor and installed during the first session, which was delayed by the late arrival of supplies and the plague of black flies. Tables and shelves were installed to make Log Lab useful as a research laboratory. Hotel J. B. was used as a storage building by Camp Davis, the engineering camp, for the first three years. Then in 1912, this building was fitted with shelves and tables and made into a research laboratory. Assigned space in it were Reighard, Smith, Gleason, Harper, Welch, Shull, and LaRue. Its occupants, though thankful for the research space, also had to deal with such matters as sand blowing in between the logs. In addition to the two log laboratory buildings there was a tent to the left of Log Lab as one faced the lake where classes in systematic botany and entomology met. The aquarium shelter stood to the right of the Log Lab as did also the windmill.

Houghton Hall

The first permanent research building was built in 1914 on the lake front in the "Old Camp." It was named Houghton Hall in honor of Douglass Houghton, the first State Geologist and Professor of Geology at The University of Michigan. This building was used for research space during summers and as a boat house and tent storage during the winter. It had double doors on the lake side through which the launches could be pushed on rails from the lake side into the interior.

(top to bottom) Houghton Hall, 1915; Alfred H. Stockard Lakeside Laboratory, 1983; Residence Hall, 1974.

During the winter of 1929-30 this building was moved on skids to its present location near Upper Drive among the classroom buildings. For many years it was the office and research space for the entomologists.

At the time of the dedication of Houghton Hall on July 4, 1914, Henry Allan Gleason was Acting Director of the Station. His remarks on that occasion captured the mission of the Station as a field facility:

> Years ago, our botanists and zoologists, like Douglass Houghton, were field scientists. They studied and knew the plants and animals of their own vicinity, and through their combined, painstaking, and long-continued efforts the flora and fauna of our country have been discovered, described, and published to the world. But in more recent times, with increasing density of population, science has moved indoors, and we have produced a race of scientists who are as complete strangers to the field as their predecessors were to the laboratory. We have taught the anatomy of the frog to students who never saw him by his native ponds; we have shown the pollen tubes of flowers to students who never saw an insect engaged in the act of pollination; we have discussed adaptations with students who never saw the wonderful mechanism or the brilliant colors of an orchid in the bog. But again, these times are changing, and the group of biological stations now scattered across the continent from Washington to Maine, on the seashore, in the mountains, and by the lakes, bears evidence that the reign of the closet biologist is over. . . . Research is just as integral a part of the work of the station as is the instruction. We have here research workers of all kinds, from the student who is just beginning his first problem in fear and trembling, half frightened at the very word research, to the chronic investigator whose mind is one immense question mark, who investigates all day and dreams of new species all night. Call him a genius if he is your friend, call him a crank if he is not, but investigate he will and investigate he must. Give such a man no tools but his fingers, and no laboratory but the lake shore, and he will keep right on with his research. But every sort of research is favored by good facilities, and in this light and roomy building we have one of the best possible incentives to productive study.

The full text of Dr. Gleason's remarks is contained in Appendix A.

Alfred H. Stockard Lakeside Laboratory

During the 1960s the National Science Foundation had scientists on their staff who were concerned about the viability of field stations. They established a program for funding research facilities at biological field stations. In 1963, with encouragement from the University Administration, the Director, Alfred H. Stockard, prepared a proposal for the National Science Foundation and designed a new research laboratory for the Station. This was funded in 1964 at $500,000 by NSF, and the Lakeside Laboratory was completed by the autumn of 1966 and first occupied in the summer of 1967. The building was dedicated in honor of Alfred H. Stockard during the summer of 1972.

Dormitory

As a condition in the contract awarding funds for the Lakeside Laboratory, the National Science Foundation required the state of Michigan to provide funds for winterized living quarters at the Station. The dormitory building was completed in June 1966 at a cost of $250,000.

DINING HALLS

During the summers of 1909, 1910, and 1911 the biologists took their meals with the engineers in the dining tent located on top of the hill dubbed as "delicatessen heights." A mess tent was purchased in 1912 and set up near the lake shore at the east end of the Biological Station. This tent or its successor served until about 1924 when a wooden building was built. This building served well until the Biological Station moved onto the Camp Davis site for the summer of 1930. A new dining hall of steel frame and galvanized sheet iron was constructed during the winter of 1929 to 1930. The lower story was of concrete and housed the administrative offices. This dining hall was always extremely noisy since it lacked any acoustical ceiling or walls. After World War II it became necessary to have two sittings for dinner and lunch-time sitting became impossibly crowded. A new dining hall was of the highest priority during the years of high enrollment.

A new dining hall was constructed beginning in August 1975. It was completed in June 1976. It was funded entirely by private gifts of a total cost of $340,000. Major contributors included The Kresge Foundation, The Dow Foundation, The McGregor Foundation, and The Elizabeth E. Kennedy Fund.

(above top) The Mess Tent, 1923; *(above bottom)* The Mess Hall, 1927; *(right top)* The Mess Hall, 1932; *(right bottom)* The Dining Hall, 1976.

(*below*) Renovated Ladyville cabin, 1976; (*right*) Investigator housing, 1981.

TABLE II
CONSTRUCTION

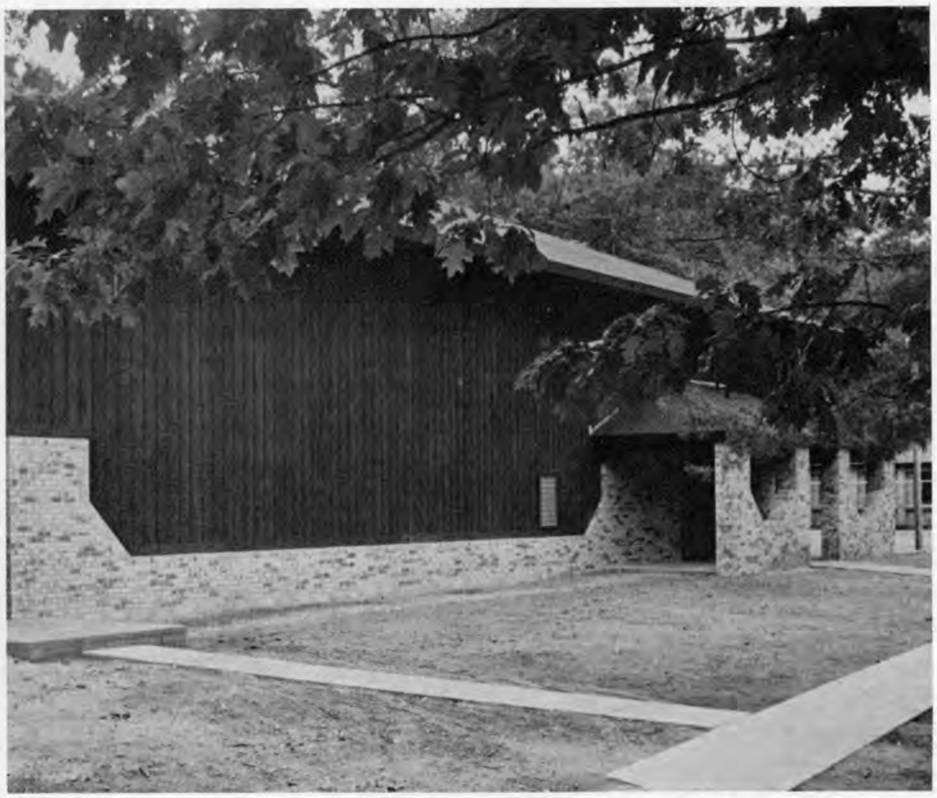
1966	Alfred H. Stockard Lakeside Laboratory
1966	Dormitory
1971	Cabin 48
1972	Scientist Residence
1974	Director's Cabin ES50
1975	Hilltop House I
1976	Hilltop House II
1973-1978	Renovation Faculty Cabins
1976	Dining Hall
1977	Student Cabins ES 7, 9, 11
1979-1980	Student Cabins ES 8, 10, 12, 14, 16, 18
1981-1982	Investigator Housing Renovation (11 cabins)
1981	Resident Investigator Cabins UDE 2 & 3
1981	Frederick K. Sparrow Classroom
1983	Lecture Hall

CONSTRUCTION

Significant construction accomplished at the Biological Station during the last 25 years is listed in Table II. Much of this renovation and construction has been financed by private gifts. The investigator housing renovation and the new resident investigator cabins at Upper Drive East 2 and 3 were funded by the National Science Foundation and by a small grant from the College of Literature, Science, and the Arts at the University. All construction done during the 1970s and 1980s, except for the dining hall, has been done by the staff of the Station.

During the 1970s the curriculum of the Station had reached 16 courses each summer. There were not a sufficient number of classrooms and there were no modern classrooms suitable for courses having unusual equipment or facility requirements. Using funds derived from clearing timber from some of the property, a splendid double classroom building was built from June 1980 to June 1981 in the gravel pit behind the Pettingill and Reighard laboratories. It has approximately 2,688 ft^2 of space. The building was dedicated in honor of Frederick K. Sparrow, a former Director and Professor of Botany. The west end of the building includes five darkrooms and is designed to accommodate the class in field photography. The east end has a modern laboratory designed for teaching physiological ecology.

In March 1983 the Clubhouse that had served for so many years as a central meeting hall for the Station was demolished. We have many wonderful memories relating to the Clubhouse, but Station activities



(above top) The Club House, 1979; *(above bottom)* Lecture Hall, 1983; *(right)* Lecture Hall, 1984.

had far surpassed its capacity and usefulness. A new lecture hall of 6,600 ft^2 was designed by Charles Wesley Lane of Ann Arbor. He donated all of his time and services to the project. The auditorium will seat 260 people and the upstairs seminar room will seat 50 or more. The lecture hall was built for $200,000 by our own staff under the supervision of Patrick Cunningham. Many individuals contributed funds to this project and also major foundations and corporations. A list of the donors is given elsewhere in this anniversary volume. The lecture hall was enclosed by midsummer and, although unfinished, it was used in August 1983 for the Diamond Jubilee event. The staff, the architect, and all concerned with the project must be recognized for the splendid job they did and for having the building in useful form in such short order. It was a major achievement. All of the interior finishing was done during the autumn of 1983 and the winter and spring of 1984.

STAFF

The success of an institution is the result of many people working together. It is appropriate to place into the historical record the names of some of the people who have contributed significantly to the success of the Biological Station during its 75 years of operation. There is always the danger of omitting someone who may have been overlooked. Apologies are offered to anyone who might have been inadvertently omitted.

TABLE III
DEAN OF WOMEN —

1910	Lucie Harmon
1911	Dora S. Smith
1912	Anna M. Rhoades
1913-1917	Marion D. Ellis
1918	Dorothy H. Simons
1919, 1920	Margaret T. Gates
1921	Lois S. Ehlers
1922, 1923	Margaret T. Gates
1924-1930	Grace W. Nichols
1931-1934	Jewel F. Stockard
1935-1941	Odina B. Olson
1942-1946	Ella M. Heinke
1947	Odina B. Olson
1948-1951	Grace C. Hooper
1952	Catherine W. Sturm
1953	Leigh Van Ansdall
1954, 1955	Marie A. Whiting
1956, 1957	Harriett C. Beach
1958-1961	Pat Barron
1962	Prudence Potter
1963, 1964	Lucille L. Vollmer
1965	Jane S. Emerson
1966, 1967	Martha Stockard Ebeling
1968	Catharine H. Bromley
1969-Present	Olive N. Williams

Secretary — Administrative Manager

During the period 1931 to 1939 Alfred H. Stockard had served in the position of Secretary by assisting the Director with many administrative duties. After Professor Stockard became Director there is no record of who may have occupied this position. Then William Fennell served as an Assistant to the Director 1965 through 1969. He was followed by Gary Williams in the position for the summers of 1970 and 1971. In September 1971 Markley W. Paddock joined the Biological Station staff as Administrative Manager, a full-time appointment, under Director Gates. Gary Williams then served as Administrative Associate during the summers of 1972 through 1976. Mark Paddock's contributions to the Station have been enormous and his work is recognized in the dedication section of this volume (page 67).

Dean of Women

The position of Dean of Women, now called Social Director, is a crucial one for the smooth operation of the summer session. The Social Director is responsible for assigning people to tables in the dining room, for seeing that guests are assigned to appropriate cabins and that they have an allocated seat in the dining hall, for designing the Saturday evening entertainment, and in general for expediting social matters. Those individuals who have served in this position over the years are listed in Table III.

GUSSIE WILLIAMS —
SOCIAL DIRECTOR

Gary and Gussie Williams, 1983.

The Biological Station has long had many people of unusual talent and of splendid personality helping with its administration. Among the finest of these is Gussie Williams who has been the Social Director (previously known as the Dean of Women) for 16 summers. Gussie has endeared herself to all who have known her at UMBS. The assignment of seating arrangements in the dining hall, the accommodation of guests in housing and at meals, and the orchestration of many social events during the summer are among her responsibilities. Beyond that, she assumes a critical role with maintaining a fine esprit de corps among the 250 people living in close cooperative fashion for two months. We shall always be grateful to Gussie for her magnificent dedication to this complex and difficult task, for not only does she do the regular work expected, but she spends countless hours during evenings and weekends helping all who need her attention.

Gussie Williams is the wife of Gary Williams, Professor of Photography at UMBS and Science Department Chairman and Biology Instructor at Glenbard North High School, Carol Stream, Illinois. Gussie was born as Olive Nordstrum at Garden Grove, Iowa July 26, 1936. She grew up on a farm there and attended school in Garden Grove. She earned a B.A. degree in music from Central College, Pella, Iowa in 1958. She married Gary, her childhood sweetheart, in 1957. They have three sons: Kevin, Brian, and Eric. Gussie earned an M.S. degree in Elementary Education from Northern Illinois University at DeKalb in 1981. For the past 13 years she has been teaching elementary school music in the Benjamin School District near Chicago, Illinois. She is an active participant in the First United Methodist Church where she sings with the Chancel Choir. She and Gary Williams' first summer at the Biological Station was 1963.

Our most sincere thanks go to Gussie Williams for her dedicated service to the Biological Station.

Superintendents

The Biological Station has had a year-around Superintendent living on the property since 1930. Those occupying this position are listed in Table IV. An Assistant Superintendent was added to the year around staff about 1966. This position was occupied by Eugene Andrejewski until 1972. Since 1978 Charles A. (Tony) Sutterly has served as Assistant Superintendent. Patrick J. Cunningham has served as Carpenter and Construction Superintendent since 1973.

Storekeeper

During summers only there has been a person responsible for supplies and equipment, a position referred to as Custodian and then as Storekeeper. Francis "Ma" Dunbar was a very notable, influential personality of the early years of the Station and occupied this position from 1909 through 1917. Hubert P. Kelsey (1925 to 1934) was a great camp personality and one who spanned the years before and after the move from the "old" to the "new" camp. He worked during the winter as a secretary and general assistant to Dr. LaRue in Ann Arbor. During the autumn of 1929 Dr. LaRue left Hubert Kelsey in charge of the dining room and laboratory construction during the move to the "new" camp. Hubert Kelsey was an English major at The University of Michigan and later distinguished himself as Associate Editor of Merriam Webster, Inc., publisher of Webster's dictionary.

Resident Biologist

The year-around position of Resident Biologist was established in 1972. The growth of research activities at all times of the year, the heightened need to maintain equipment in good order and the necessity for improved recordkeeping of all the scientific endeavors at the Station, including better land management, dictated the necessity to

TABLE IV
SUPERINTENDENTS

1930-1940	Britt B. Riggs
1941-1944	Bert Passeno
1945-1973	Clem Bur
1974-Present	Willard L. Sakcriska

TABLE V
LIBRARIANS

1922	Roy Tasker
1923	Arthur Curtis
1924	Nelson Keeler
1925-1927	Alice Crosby
1928-1932	Elizabeth Nation
1933	Donald Ameel
1934, 1935	Dorothy Malcolm
1936	Henriette Zezula
1937-1942	Henrietta (Mrs. Donald) Ameel
1943	Katherine (Mrs. Wayne) Porter
1945-1964	Veo G. Foster
1954	Layton Murphy (co-librarian)
1965-1972	Virginia W. Tibbals
1973-1975	Donald M. Munro

TABLE VI
HARRY W. HANN
LECTURE IN
ORNITHOLOGY

1971	William L. Thompson
1972	William E. Southern
1973	Douglas A. James
1974	Joseph J. Hickey
1975	Vance A. Tucker
1976	Glenn E. Woolfendon
1979	William Keeton
1980	Harold Mayfield
1981	Gary L. Nuechterlein
1983	Douglas Mock

have a year-around Resident Biologist. This position was occupied by Ole Lundin 1972-75, by Jack E. Stockwell 1976-78, and by Robert Vande Kopple 1979 to the present time.

Librarians

The Biological Station library contains about 10,000 volumes and a large number of research reprints. For many years the Natural Sciences librarian at The University of Michigan spent summers at the Biological Station. Table V lists the people who have served as Librarian until the tradition was discontinued in 1975.

Doctors

During the early years the Biological Station shared a doctor with Camp Davis. A nurse was in residence instead of a doctor during the period 1922 to 1927. Various doctors served in residence at the Station until Dr. William Brace began a long tenure from 1933 to 1955. Dr. Park W. Willis (1956 to 1959), Glenn O. Lease (1960, 1961), and Lucille Kuchera (1965 to 1969) and then the University changed over to having a nurse in residence. During recent years, Marie Boda, a nurse living in Pellston has attended to the Station clientele twice a day.

LECTURESHIPS

The establishment of endowed lectureships at the Station has been a very significant development to ensure that distinguished outside speakers may be brought in during the summer.

Harry W. Hann Lecture in Ornithology

The generosity of two former students, Jean McColl Batts (1947) and Henry Lewis Batts, Jr. (1942, 1947), endowed an annual lectureship in memory of Harry W. Hann, Professor of Ornithology in The University of Michigan. Those who have delivered this lecture since its establishment in 1971 are listed in Table VI.

Eleanor and Sewall Pettingill Lecture in Natural History

Following the retirement of Professor Olin Sewall Pettingill in 1974 after 35 summers as a Professor and one summer as a student, friends and former students contributed to an endowment fund in honor of Eleanor and Sewall Pettingill. Since a lectureship in ornithology already existed, it was decided to make this one broadly based as an annual lecture in natural history. Those who have delivered this address are listed in Table VII.

Cultural Lecture Series

Upon completion of the new lecture hall it was decided to endow a lecture series devoted to various cultural events including topics in the biological sciences. These events will be attractive to a broad audience including residents on Douglas and Burt Lakes and to other people in the region.

TABLE VII
ELEANOR AND SEWALL PETTINGILL LECTURE IN NATURAL HISTORY

1977	Olin Sewall Pettingill
1978	Ruth Patrick
1979	Eugenie Clark
1980	Gene E. Likens
1981	Durward L. Allen
1982	Frank A. Pitelka
1983	Ronald O. Kapp

(above) The Winter Ecology class, 1972; *(right)* Field research, Gwen Bennet, 1975.

WINTER ECOLOGY COURSES

Beginning in the winter of 1973-74 a course in Winter Ecology was taught at the Station for five years. Dr. John Gannon, Resident Scientist and Dr. Arlan Edgar of Alma College led these courses. At the time it was the only such course given by a major field station in America.

NATURALIST ECOLOGIST PROGRAM

The Andrew W. Mellon Foundation made a substantial grant to the Biological Station in 1980 and again in 1983 to fund the support of students and faculty for advanced training as field naturalists and ecologists. In funding this unique program the Mellon Foundation has recognized the Biological Station is the finest of its kind and the appropriate place to establish such a program. With this grant, a group of highly selected graduate and undergraduate students are supported for a summer's study at the Station. The grant supports one or two faculty and four or five full-time research investigators for a period of two months or longer. It also supports a year-around program director-in-residence at the Station. Dr. Claudia Jolls has served in this capacity.

The most significant characteristic of this program is that the students, research investigators, faculty, and project director spend a lot of time interacting in the field, laboratory, and seminars. Each student is required to take one course and to conduct a research study.

Whitney Sharp taking lake water sample, 1975.

RESEARCH

The research record of the Station is an illustrious and voluminous one dating from 1909. A reasonably complete bibliography for the first 50 years of Station activity was published in the Semi-Centennial Proceedings. The research publications for the years 1960 through 1983 are listed in Appendix E.

It will be difficult to select for mention certain pieces of research without serious omission of other significant research contributions. Certainly the limnological class work and research during the earlier years contributed significantly to the publication of Professor Paul S. Welch's *Limnology* in 1935 and *Limnological Methods* in 1948, two of the most important textbooks in the field at the time. The many years of research and class projects by Professor Frank C. Gates resulted in his book *Field Manual of Plant Ecology,* the first of its kind in North America. Professor William W. Cort's research on schistosome dermatitis, known as swimmer's itch, lead to a thorough understanding of the life cycle for the first time. Every bit as important, however, were the considerable number of students trained by Cort in parasitology; students who years later became many of the leading parasitologists fighting the plague of human schistosomiasis throughout the tropical world. The research by Professor Charles W. Creaser on the invasion of the upper Great Lakes by the Atlantic smelt and the sea lamprey was notable and prognostic. Professor Herbert B. Hungerford was a world authority of aquatic hemiptera and in particular of the genus *Notonecta.* Professor Henry Allan Gleason's many summers at the Station shaped his ideas in plant ecology and contributed to his notable 1926 paper on the individualistic concept of the plant association. The contributions by UMBS faculty to our understanding of the flora and fauna of northern Michigan are of great significance. Professors George E. Nichols and Williams C. Steere on the bryophytes of the region, Professor George R. LaRue on tapeworms and trematodes, and Professor Olin Sewall Pettingill, Jr. on the birds. Professors Frank C. Gates and John H. Ehlers published some of the earliest lists of the higher plants of the Douglas Lake region.

Recent decades have brought forth new treatises concerning the flora of the region with Professors Howard Crum's and Lewis Anderson's *Mosses of Eastern North America,* Professor Crum's *Mosses of the Great Lakes Forest,* and Professor Edward Voss's *Michigan Flora.* Professor John Cairns has been a prolific publisher during recent decades and has made highly significant contributions to our understanding of stressed ecosystems. In particular he has originated techniques for the biological monitoring of aquatic habitats, techniques that are being used throughout the world today.

Dr. David Gates has initiated a continuing research program concerning the carbon budget of the mixed species deciduous forest at the Station. This study is leading to a better understanding of the role of forests in the global balance of atmospheric carbon dioxide. It is also allowing us to gain a better understanding of forest succession and particularly how the forest may respond to climate change. Dr. Thomas Jurik was in residence at the Station during 1981 to 1983 on this project and Dr. George Briggs joined the staff in 1983. Some of the succession studies are based on the long-term study plots established by Frank C. Gates in the 1930s and by Authur Cooper in the 1960s. In total the Station has 90 plots or subplots in the forest that have been carefully studied over many years.

RANN Project

In the early 1970s the Station initiated a series of research projects concerning the quality of the lakes of the region under the support of the National Science Foundation through the program "Research Applied to National Needs" called RANN. Dr. John Gannon joined the Station's staff in 1972 and directed this program for six years. Much of this research had significant impact on water quality management of lakes throughout northern Michigan. The Station continued to receive grants for water quality research for several years after the RANN program had terminated.

Aquatic research, Diane Albright, 1976.


Getting the lake pH, Fran DeLisle, 1975.

Project CLEAR

As a direct result of the Northern Michigan Environmental Research Program, a series of student projects entitled Project CLEAR (Community Lakes Environmental Awareness and Research) took place during the summers of 1977-81. Each summer teams of advanced students selected a specific northern Michigan lake and its basin for water quality assessment. These efforts included work in aquatic, terrestrial, and social research culminating in an environmental assessment and a lake management program for a particular lake and lake basin. The students involved lakeshore property owners' associations and appropriate state and local agencies in their projects.

U.S. National Park Service Cooperative Projects

The Biological Station cooperated with the National Park Service on a series of studies in both Sleeping Bear National Lakeshore and Pictured Rocks National Lakeshore. Projects included: Natural History Surveys of Sleeping Bear and Pictured Rocks National Lakeshores, a Limnological Investigation of Florence Lake on South Manitou Island, a Study of the Lower Platte River, Winter Ecology of the Red Fox on South Manitou Island, Vegetation and Flora of North and South Manitou Islands, Vegetation and Flora of the Mainland Portion, Sleeping Bear National Lakeshore.

Biological Station Publication Series

In the early 1970s we began to issue several series of reports to provide information about land, water, and the people of the northern Michigan region. There are four separate series:

Technical Report Series — Eleven issued
Educational Report Series — Four issued
Lakeland Report Series — Fourteen issued
Lake Profilies — Four issued

ENDOWMENTS AND BEQUESTS

The University of Michigan is becoming increasingly dependent upon private funds to augment inadequate levels of state support. Paralleling this development have been enormous increases in tuition in recent years which have made the University a very costly institution for students. Therefore, it has become imperative for the Biological Station to find funding which will be available to support students with grant-in-aid money for the summer and to support professorships for summer teaching and research. Several such endowments have been established and efforts continue to develop other funding sources.

Margaret T. and Frank C. Gates Scholarship Fund

An endowment fund for student support was established in 1978 in honor of Professor and Mrs. Frank C. Gates for their long and many contributions to the Biological Station. Frank Gates taught plant ecology at the Station from 1915 through 1954. His first summer at the Station was 1911 when he was working for the Michigan Biological Survey. Margaret Thompson Gates (1915 to 1954) was Dean of Women (1919 to 1923) and Assistant Librarian (1925 to 1932 and 1935 to 1938).

Henry Allan Gleason Scholarship

Andrew M. Gleason, Professor of Mathematics at Harvard University and son of H. A. Gleason, established a scholarship fund with an initial endowment given in 1981. It is intended that the interest from this endowment be used each year to support a student engaged in field research at the Station each summer. Preference is to be given to students of ecology. Henry Allan Gleason taught field botany and plant ecology at the Station in 1911 to 1914 and plant anatomy in 1923. He was Acting Director of the Station in 1913 and 1914 and Director in 1915.

The Vaden and Maxine Miles Professorship of Ornithology

In 1983 Maxine Smith Miles (1935, 1936, 1938) initiated an endowment for a professorship in ornithology at the Station. Dr. Vaden W. Miles received his Ph.D. in physics at The University of Michigan in 1947. He was Professor of Physics at Wayne State University from 1948 to 1970.

Charles and Hulda Creaser Bequest

A bequest of $97,000 came to the Station in 1971 from the estate of Charles and Hulda Creaser. Professor Charles W. Creaser, Professor of Zoology at Wayne State University, taught ichthyology at the Biological Station from 1925 through 1961. Funds from this bequest were used for modernizing the physical plant of the Station and for the purchase of important pieces of land contiguous with the main holdings of the Station adjacent to Douglas Lake.

NATIONAL MEETINGS

The Biological Station provides an excellent intimate setting for professional meetings of moderate size. Many local and state groups meet often at the Station and are too numerous to list here. National meetings held at the Biological Station during the last 10 years are listed in Table VIII.

TABLE VIII
NATIONAL MEETINGS HELD AT UMBS

1973	Biophysical Ecology Symposium
1974	Wilson Society
1974	National Science Board
1976	American Institute of Biological Sciences Executive Committee
1975, 76, 77	Ecology-Meteorology Workshops — DOE
1979	International Diatom Society
1976, 77, 79, 81	Toxicity Workshops
1982	Organization of Biological Field Stations

INSTRUCTION

The most distinctive feature of the Biological Station has been its academic program and its enormous influence on the careers of thousands of biologists and others. LaRue (1944) reviewed the history of courses at the Station during the first few decades. Until the 1950s there was considerable stability of faculty with the same professors returning to the Station each summer. Since then there has been a combination of frequent turnover and some long-term stability on a regular summer basis or on an alternate summer schedule. Financial exigencies brought on by severe budget cuts in 1982 and 1983 are creating considerable instability for the teaching program. Fewer experienced faculty are returning and more younger people with frequent turnover are being appointed to the summer faculty. It is our hope that the future will see a return to more stability and somewhat increased seniority to the faculty.

REFERENCES

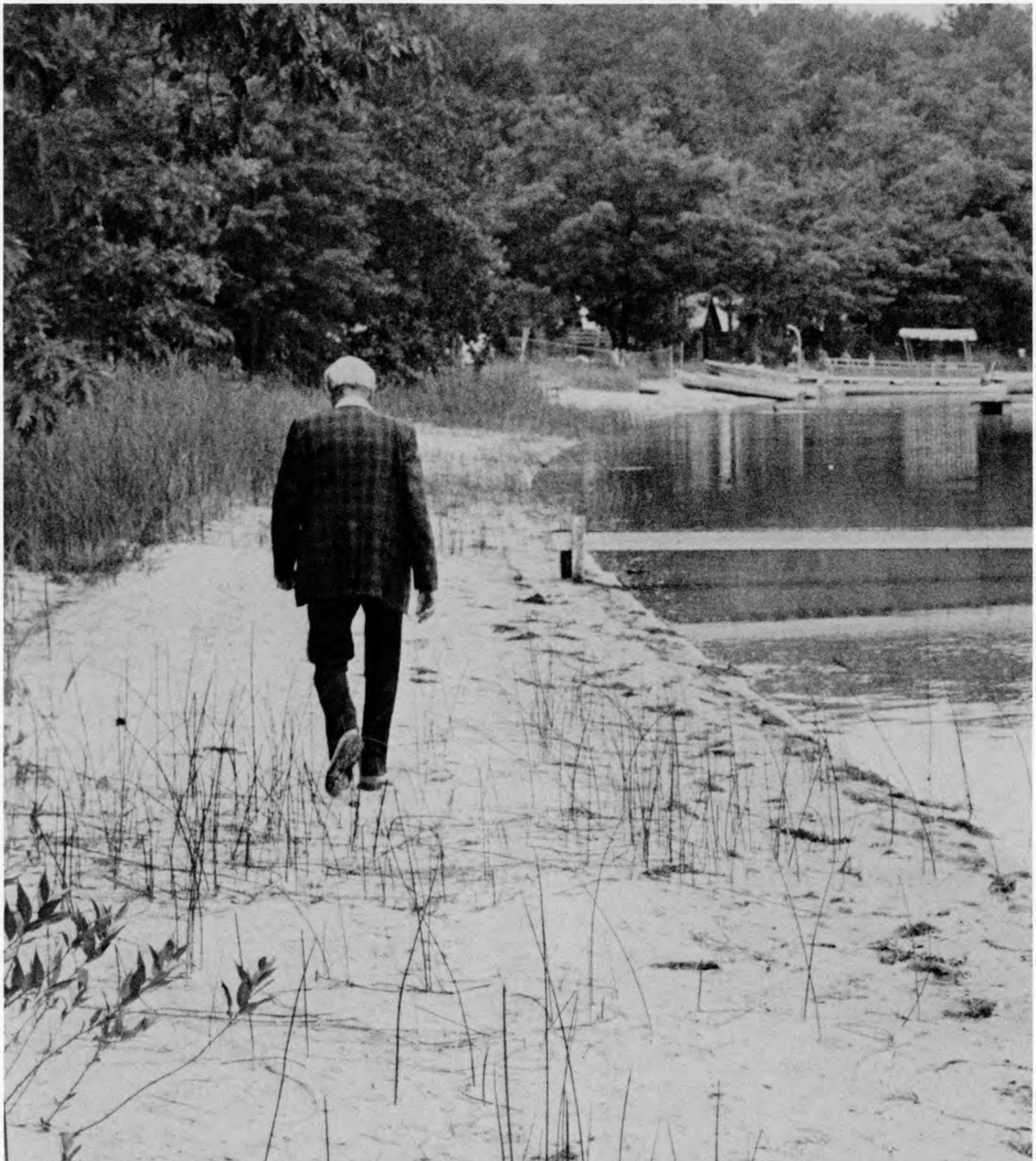
LaRue, G.R. 1944. The Biological Station. The University of Michigan — An Encyclopedic Survey. Wilfred B. Shaw, Ed. U. of M. Press, Ann Arbor 761-769.

Reighard, J. 1912. History of the Douglas Lake Biological Station. The Biological Bulletin (Faculty Number) *4,* No. 7, 1-6.

Semicentennial Celebration Proceedings The University of Michigan Biological Station. June 16-19, 1959. Pellston, Mich.

1. Professors C. D. La Rue, F. C. Gates, and G. R. LaRue about 1935; 2. Class transport, about 1936; 3. Reighard teaching swimming, 1909; 4. Prof. Eggleton's classroom, 1961; 5. The "Engineer's Launch" hauls a class, 1946; 6. At the B Street dock, 1934.

1. Professor and Mrs. H. A. Gleason, 1914; 2. A class leaving the loading dock, about 1928; 3. Up the Pellston Hill, 1927; 4. Aquilina and Houghton Hall, about 1919; 5. Volleyball, 1961.



THE DIAMOND JUBILEE

BIOLOGICAL STATION, DOUGLAS LAKE, MICHIGAN, AUGUST 17-21, 1983

The intense loyalty of former students and faculty of the Biological Station was demonstrated by the 360 individuals who came to celebrate the Diamond Jubilee marking 75 summers of Station history. Bug camp was literally "full as a tick." All cabins were fully occupied and many people camped or stayed in campers. All who came seemed to fulfill their expectations of a rewarding experience. Old haunts and field sites were revisited, boat rides were taken; classrooms, library, and cabins were inspected; and countless friends were seen again. People never ceased talking, it seemed, for four days. The program was leisurely and relaxed, although everyone seemed to be short of time. There were four talks given:

Biological Station History and Photographs — David M. Gates
Botanical Beachcombers and Explorers: Early Exploration in the Straits Area — Edward Voss
Changes in the Terrestrial Ecosystems Over 75 Years — Winfield Fairchild
Changes in the Aquatic Ecosystems Over 75 Years — Claudia Jolls.

A highlight of the Jubilee and a sentimental journey was Olin Sewall Pettingill's presentation of his narrated film "Tip O' the Mitten," a show he filmed at the Station in the early 1950s. A standing ovation was given to Sewall and richly deserved it was indeed.

Prior to the showing of the film, the audience heard remarks by Paul Brown, Regent from Petoskey; Bill Frye, Provost and Vice President for Academic Affairs; and Michael Martin, Chairman, Division of Biological Sciences.

Their remarks conveyed tacit support for the Station and indicated an important place for it within the future fabric of The University of Michigan, but their enthusiasm fell far short of the level of excitement and support felt by the audience for the Station.

Field trips to old familiar places (Lake Shore Drive, Smith's Fen, Bryant's Bog, Wilderness State Park, Carp Creek, Maple River and Colonial Point) punctuated the formal program and the early morning bird breakfast with Sewall Pettingill was particularly popular. A fun night was enjoyed by all as awards were given for those who came the farthest, those who were the oldest, those with the most summers at camp, those couples who met at UMBS, and for other significant achievements.

Gary Williams, Professor of Photography at the Station, capped all events with a sound and light slide presentation of the Station's 75 years in a manner that left few dry eyes. All who came would not have missed it for anything.

Library Dedicated

Saturday morning was eventful. Foremost was the dedication of the Library Building to the memory of George R. LaRue in recognition of his long years of service at the Biological Station. All four of his children were present: John LaRue, Helen Hazelton, Julia Meighan and

The shoreline and Sewall Pettingill, 1983.

(above) The Library, 1962; *(right)* D.M. Gates and John La Rue mounting the plaque.

Charlotte Butler. A plaque enscribed with the signature of George R. LaRue was mounted over the front door of the library. Also dedicated were three of the classroom buildings, named in recognition of Charles Creaser (ichthyology), John Ehlers (plant systematics), and Carl LaRue (plant anatomy), all longtime professors at the Station.

Congratulatory Messages

Congratulatory messages were received from a number of former students and faculty:

"I greatly regret not being able to be at Douglas Lake for your 75th anniversary. My summer there in 1946 was a unique experience that I shall never forget." *James D. Watson, Director, Cold Spring Harbor and Nobel Laureate.*

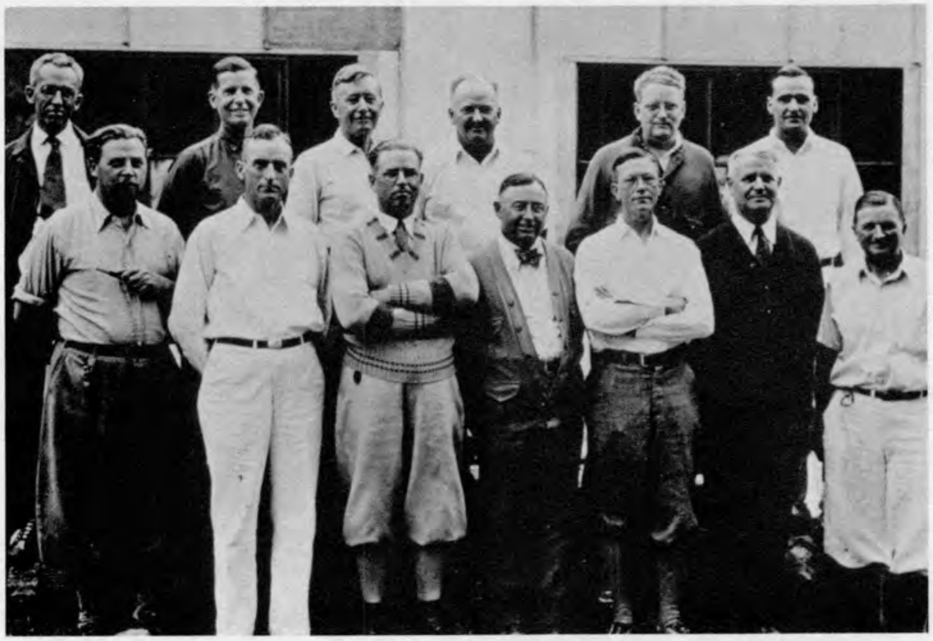
"Congratulations on the 75th birthday of the Station. My own summer there in 1949 made a tremendous difference to me in my development as a scientist. It gave me the first glimpse of the possibility that one could pursue serious experimental biology without losing sight of the whole organism in its natural surroundings. For that lesson, we will continue to depend on biological field stations." *Donald Kennedy, President, Stanford University.*

"It is a pleasure to join alumni extending felicitations on the occasion of the 75th anniversary of the Biological Station. It is hard to realize that my three most happy and productive summers at Douglas Lake occurred almost 50 years ago. At that time my exposure to the cadre of distinguished parasitologists then in residence, namely, LaRue, Cort and Thomas, was instrumental in patterning my scientific interests and career." *Thomas H. Weller, M.D., Richard Pearson Strong Professor of Tropical Medicine, Harvard University, and Nobel Laureate.*

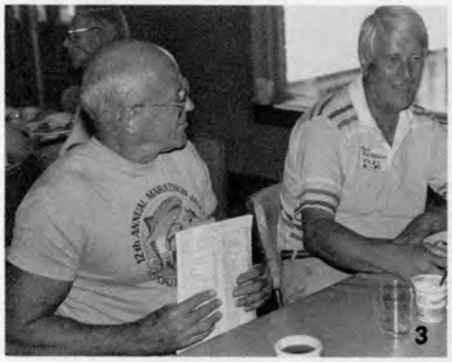
"The summer of 1927 I had my first graduate studies at the University of Michigan Biological Station. I learned more botany in my two months there than in any other equal period." *Elbert L. Little, Jr. Retired, U.S. Forest Service.*

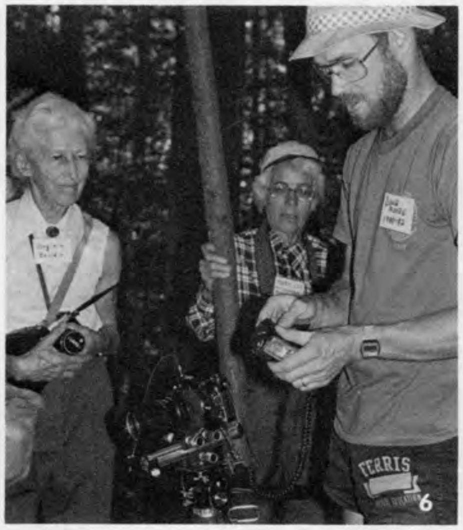
"We spent many scientifically rewarding years at the "Bug Camp" and are very proud of the Station as well as the work that has been carried on there over the years. May the coming years see the Station exerting an even greater influence than in the past on the training of young biologists and advancing our knowledge of biology as a field for research." *Alexander and Helen Smith, University of Michigan.*

"Future generations of "bug campers" have much to thank you for in insuring the future of a place where far more than the average number of biologists have been inspired to greatness. I am continually reminded of the power of UMBS when I go to professional meetings and I regularly run into former students from UMBS." *C. Richard Tracy, Associate Professor, Colorado State University.*



(left to right) Professors Blanchard, C. D. LaRue, Thomas, Welch, Ehlers, Eggleton, Gates, G. R. LaRue, Hungerford, Creaser, Cort, Stockard, Nichols, about 1936.

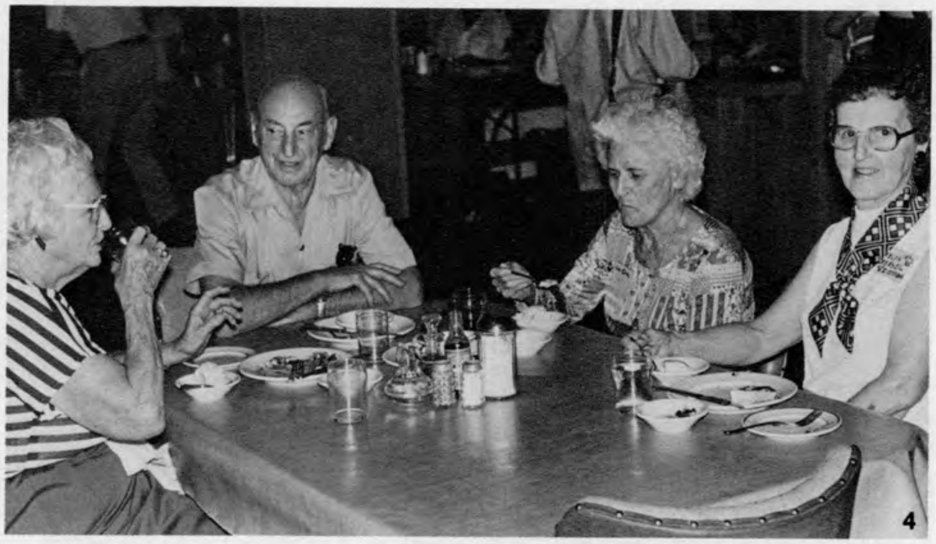


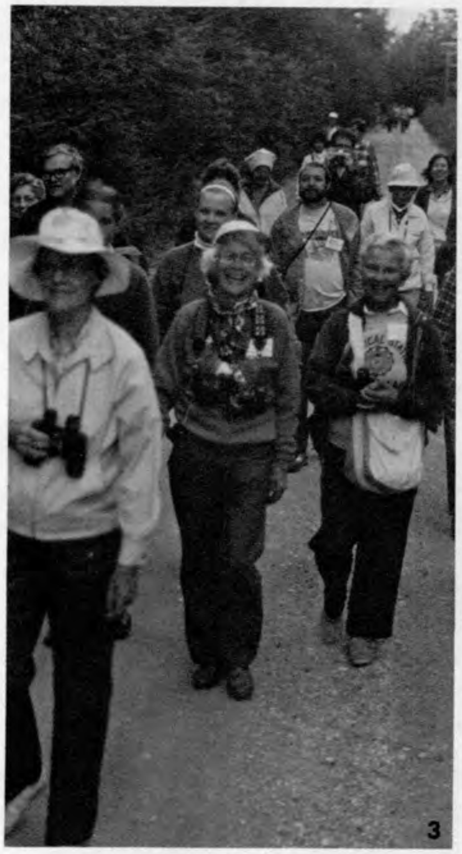


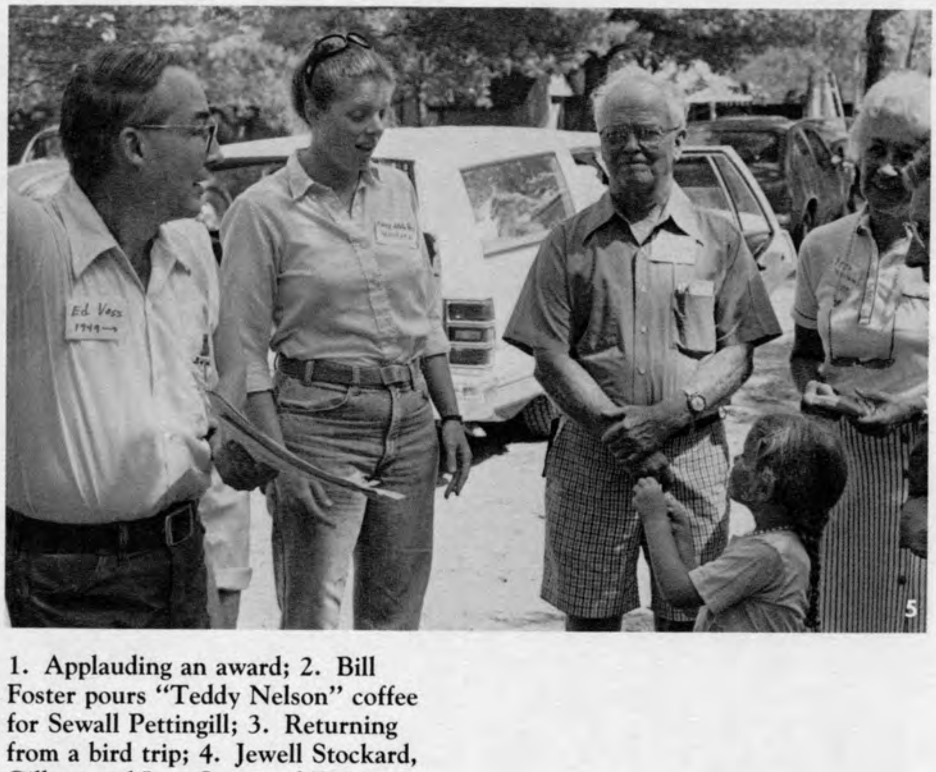
1. Marian Gates, Lois Jotter Cutter, D. M. Gates, and Mary Lou McConnell Brown; 2. Gussie Williams, Bonnie Edgar, and Jean Cooper; 3. Bill Fennel and Bob Paterson; 4. Lilian Nagel and Anne Fuller; 5. John Hawkinson, Helen Prockiw Varner, June Wilcox, Peggy MacQueen Hawkinson, Sewall Pettingill, and Harry Wilcox; 6. Virginia Bailey, Mary Lou McConnell Brown, and Doug Moore; 7. Arlan Edgar and Irene Crum.

1. Martha Hohn Friedlander and Bill Anderson; 2. P. B. Hofslund, Gene Goellner, Millie Seltzer, and Ruth Godwin Goellner; 3. Evelyn and Jack Sharp, Peg Feigley, and Lilian Nagel; 4. Marian Gates, Bob Campbell, David Gates, Dorothy Campbell; 5. Returning from a tour of the lake.

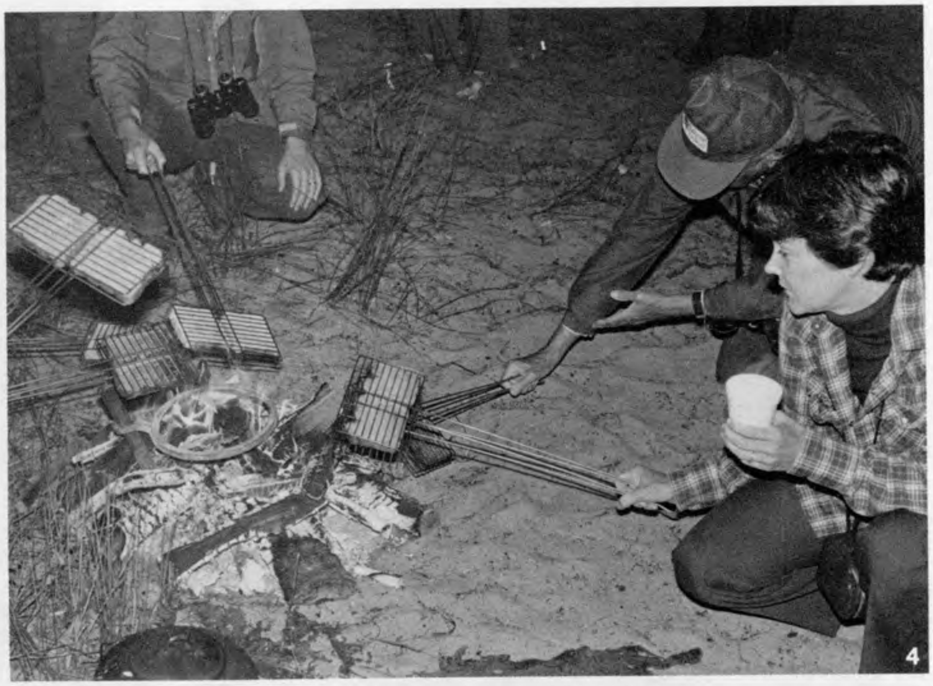
1. Jewell Stockard and Clem Bur; 2. Laura Hubbs and Gladys Eggleton; 3. The audience; 4. Polly Yocum Fairchild, Art Gold, Doug Farr, Dikran Kashkashian, Mo Gold, Mike Tilchin, Mark Paddock, Win Fairchild; 5. Nan Sparrow and Jewell Stockard.



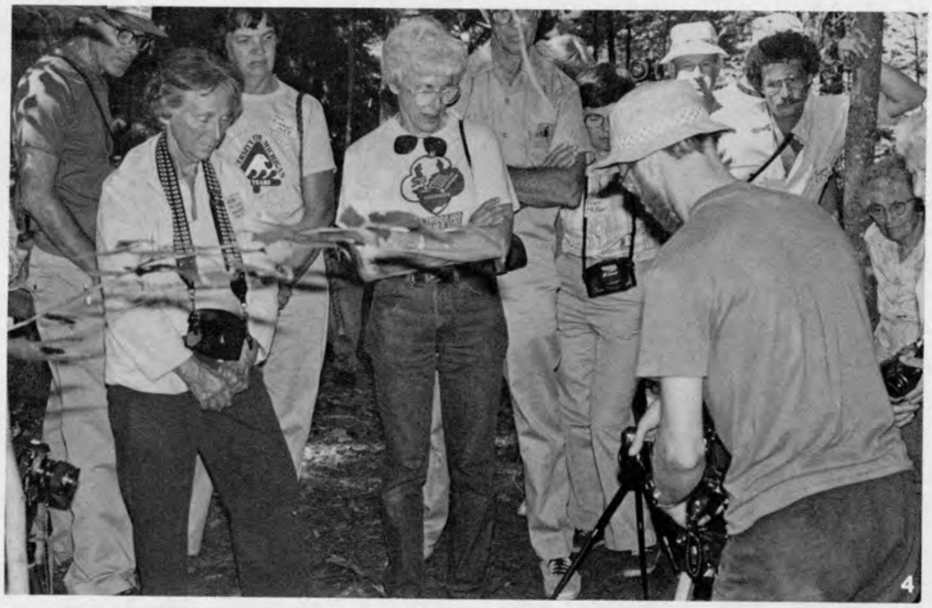




1. Applauding an award; 2. Bill Foster pours "Teddy Nelson" coffee for Sewall Pettingill; 3. Returning from a bird trip; 4. Jewell Stockard, Gilbert and Lou Otto, and Evie Steidtmann; 5. Ed Voss, Nancy White Paul, Howard and Beth Williams.

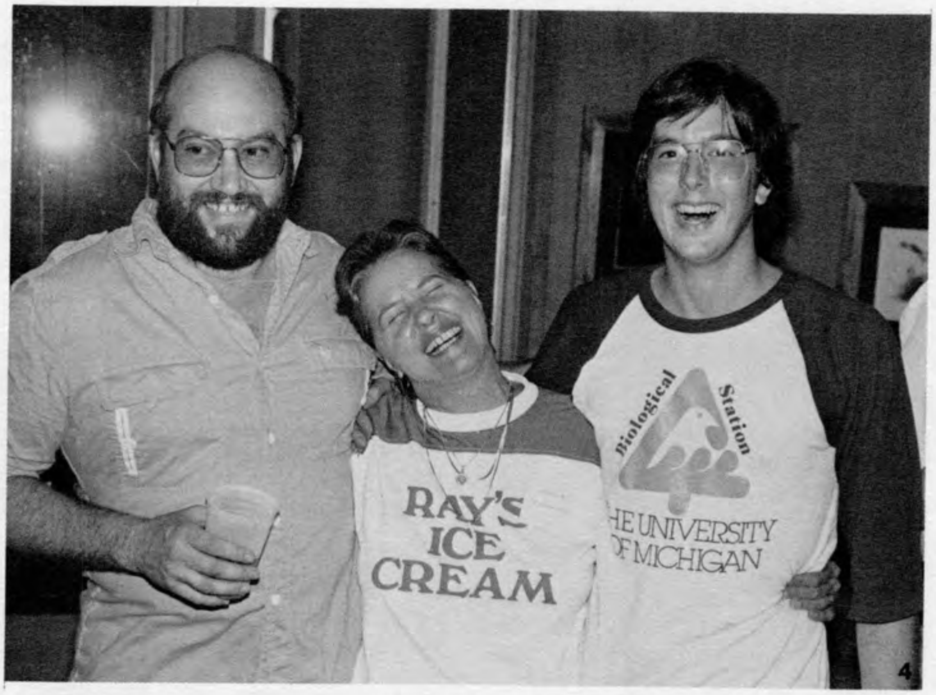


1. Peggy MacQueen Hawkinson and Sewall Pettingill; 2. Sewall Pettingill and David Gates; 3. (?) and Veo Foster; 4. The Ornithologists' Breakfast; 5. Harve Blankespoor, Gussie Williams, Henry Van Der Schalie, and Robert Miller.



1. Bill Anderson and Marilyn Gates; 2. Bill Foster, John Glover, David Baker, Craig Bennett, and Doug Alexander; 3. Millie Seltzer (center) and friends; 4. Watching Doug Moore demonstrate camera equipment; 5. Marion Nichols Arnold and Marian Gates; 6. Rex Lowe, M. C. Sewall Pettingill, Jewell Stockard, and David Gates — most summers award.

1. Claudia Jolls, Polly Fairchild, Jack and Betty Young, and news reporter; 2. Marian Gates, Dorothy and Bill Steere; 3. Nan Sparrow, Clem Bur, and Ed Voss; 4. Robert Lea, Jr.; 5. Edith Hurst, Ed Voss, Phyllis Eggelton White, Nancy White Paul, and Tot Breher.; 6. John Funk, (?), Eleanor Funk, and Robert Miller.



1. Conrad Yocum and Bill Steere; 2. Paul and Lynn Kilburn; 3. Eleanor and John Funk; 4. Mike Sliva, Bobbie Flexner, and Morris Flexner; 5. Mary Martha Nichols Bierwaltes; 6. Allan Gleason.

(top) Camp Kids, 1931: left to right, Peggy Cort, Jack Young, Charlotte LaRue, Andrew Gleason, Barbara Young, Helen Cort, Julia LaRue, Evie Steidtmann, Dorothy Cort, Bob Young; front row, Margaret Gates, Beth O'Roke, David Gates.
(middle) Camp Kids, 1932: left to right, Margaret Gates, David Gates, Char LaRue, Evie Steidtmann, Julia LaRue, Ann Welch, Charlotte LaRue, Frances Stockard, Dorothy Cort, Mary Stockard, Peggy Cort, Barbara Young.
(bottom) Camp Kids, 1983: left to right, front row, Grace Nichols Rhodes, Julia LaRue Meighan, Evie Steidtmann, Charlotte LaRue Butler, Helen LaRue Hazelton; middle row, John LaRue, Marion Nichols Arnold, Peggy Cort Olivier, Helen Cort Brackett, George Nichols, Jr.; back row, David Gates, Dorothy Blanchard, Grace Blanchard Iverson, Mary Martha Nichols Beierwaltes, Jack Young, Allan Gleason.

LECTURES

A 75-YEAR HISTORY OF AQUATIC RESEARCH AT THE UNIVERSITY OF MICHIGAN BIOLOGICAL STATION

by G. Winfield Fairchild

Win Fairchild

Faculty, students, and independent investigators at the Biological Station have, since its founding in 1909, been concerned with a broad range of aquatic research, largely reflecting the diversity of habitats and organisms available for study. For example, a large variety of lake types are in close proximity of the Station and are visited regularly by a number of classes. Local streams are similarly abundant. The entire drainage of Carp Creek lies on Station land, and the Maple River, that transports water from the west end of Douglas Lake to Burt Lake, is also used frequently by classes and researchers. Most published work at the Station has been directed, however, toward understanding Douglas Lake and its surrounding wetlands, and it is that body of research I would like to review. This review will consist of three parts. First, I would like to summarize the evidence for vegetational succession in local wetlands. Second, I will give an overview of major areas of research on Douglas Lake, emphasizing the evidence for long-term changes in its trophic status. And finally, I will direct a few concluding remarks toward the present status and future possibilities of aquatic research at the Station.

In preparing this presentation I have attempted to summarize a wide range of information, much of it outside my own areas of research. The assistance of a number of people who kindly provided slides and information is gratefully acknowledged. I wish in particular to mention Dr. N. Andresen, Dr. D. Chandler, Dr. J.E. Gannon, Dr. R. Glover, Dr. N. Miller, Dr. C. Schwintzer, and Dr. C.L. Smith.

EVIDENCE FOR VEGETATIONAL SUCCESSION IN LOCAL WETLANDS

A major concern of early investigators was the vegetational mapping and classification of bogs and fens near the Station (Sigler and Woolett 1926, Goe *et al.* 1927, Dean and Coburn 1927, Jewell and Brown 1929, Gates 1942, Bevis *et al.* 1960). More recently, many of these early studies have been reexamined and complemented with measurements of water chemistry and plankton composition (Schwintzer 1978a, 1978b, 1979, 1981, Plafkin *et al.* 1980, Henebry *et al.* 1981, Schwintzer and Tomberlin 1982).

One major effect of this work has been an adjustment in our thinking concerning the rates of ecological succession in wetland communities. Prevalent theory has viewed vegetational succession in wetlands as a gradual species replacement process, in which early colonizing species accumulate organic matter and otherwise modify their habitat, thus promoting the establishment of later taxa. The wetland is eventually transformed in this manner to an upland climax community.

Schwintzer's work with Bryant's Bog (Schwintzer and Williams 1974, Schwintzer 1978) clearly disputes this theory. Drawing from earlier work (Potzger 1932, Coburn *et al.* 1933), she has put together a cogent picture of very slow directional change, reversed frequently by high water levels and the consequent destruction of encroaching woody vegetation (e.g., *Nemopanthus, Ilex, Larix, Picea*) such as occurred in the early 1970s.

Sanger and Gannon (1979), who similarly drew upon earlier studies of Smith's Fen (Woolett *et al.* 1925, Johns 1966), also found that vegetational change had occurred over time. Floral changes were again associated, not with a gradual species replacement process, but with periodic disturbances. A major fire in 1916 grounded the then floating *Sphagnum* mat, permitting the establishment of willows. The abandonment of a local farm precipitated the decline in the late 1930s of the large stands of *Typha* that once existed there. Most notably, fluctuating water levels have caused the alternating advance and retreat of stands of *Carex lasiocarpa* stands that now surround the open water. Vegetational changes in Smith's Fen thus support Schwintzer's contention that our wetlands are going to be around far longer than was once thought, and that changes which do occur are more typically cyclical and are the result of external (allogenic) forces than being unidirectional and biotic (autogenic) in nature. The addition in 1983 of a new course in the Ecology of Peatlands provides much promise for continued research in this area.

THE LIMNOLOGY AND BIOTA OF DOUGLAS LAKE

Geologic History and Physicochemical Features

Douglas Lake is a moderately large lake, with a surface area of 15.2 km^2, a maximum length of 6.1 km, and a maximum depth of 28 m. The lake is unusual in having 7 distinct depressions, separated by extensive shoals. Scott (1921), in his book *The Inland Lakes of Michigan,* concluded that these depressions were of glacial origin. A large irregular block of ice or perhaps a cluster of ice blocks were presumably separated from a retreating tongue of the last continental glacier. The ice blocks were buried under glacial debris, as evidenced by the coarse sand that surrounds Douglas Lake today, and when they eventually melted, left "kettle"-like depressions in their stead. Subsequent variations in water supplied by the glacier were associated with changes in the size and shape of Douglas Lake. Two high water stages are particularly distinguishable from the land forms which surround the lake. The first sediments deposited in the various depressions, primarily a pink clay of low organic content (Wilson 1945), reflect cold water, oligotrophic conditions characteristic of the period when Douglas Lake was part of glacial Lake Algonquin. More recently, what was once a deep lake of low productivity has become a much shallower, moderately eutrophic lake as shown by the black, highly organic sediments of more recent origin. Stoermer (1977), in work based upon diatom analyses of Wilson's earlier core samples, has suggested that the lake has in fact been stably eutrophic for as much as 8000 years.

Sediment accumulation in the depressions of Douglas Lake is influenced both by the settling of planktonic organisms from the water column, and by the influx of materials from nearshore areas. A number of studies have demonstrated the importance of wind-driven currents in sorting and transporting sediments. Major currents (Gannon and Fee 1970) typically originate from the northwest end of the lake. Under such winds, this water passes over Big Shoal, entering South Fishtail Bay and forming a large clockwise eddy that leaves the bay through a deep channel just to the east of Grapevine Point (Gannon and Brubaker 1969). Surface waters entering North Fishtail Bay (Tallman 1975) leave the bay via a deep channel just west of East Point. These currents can develop considerable erosional force, as shown by the boulder fields with their stream-like biota located in particularly wave-swept portions of the lake (e.g., Grapevine Point). These currents also have contributed to the formation of recurved spits and their eventual enclosure as beach pools along the shore. This process of beach pool formation has been especially well documented at Sedge Point by Gates (1948) and by subsequent student projects.

The hard water of Douglas Lake reflects the strong influence of a large, calcareous watershed. Chemical features of the well-mixed surface waters of the epilimnion, that extends to a depth of approximately 10 m, have been shown to be similar throughout the lake. Waters of the hypolimnion are in contrast to this and are isolated in the 7 depressions of the lake and exhibit unique features according to basin location and morphometry. Early papers concerning this "depression individuality" (Welch 1927, 1944; Welch and Eggleton 1932, 1935) have together summarized 26 summers of data for the lake (between 1911 and 1943) and provided a strong conceptual base for later ecological studies.

Only more recently have detailed nutrient data been available for the lake, made possible by the construction of Stockard Laboratory and the acquisition of equipment for our present chem lab. The analysis of the nutrient limitation to algal growth in Douglas Lake was begun by C. Schelske and E. Stoermer using phytoplankton during the early 1970s and, more recently, has been clarified using periphyton by Fairchild and Lowe (1983).

Biotic Communities

The large majority of papers on Douglas Lake have addressed taxonomic and ecological questions concerning its biota. The few comments I will make serve only to point to the extensive information available for particular groups.

Eggleton (1952) has estimated that 76% of the lake's surface area is underlain by "littoral" sediments less than 9 m in depth. Much of the work on benthic invertebrates associated with the sediments has involved the littoral zone (Cobb 1915, Smith 1916, Eggleton 1931, Moore 1939, Moffett 1943, Hoffman 1940, Neel 1948, Berg 1950, Cole 1953, Lyman 1956, Cort *et al.* 1960, Clampitt 1970, 1972, 1973, 1975), revealing both the high species diversity of these shoal and nearshore communities and the importance of water movements to their distributional ecology. Studies of benthic invertebrates of deeper water in the 7 depressions (Eggleton 1931, 1934, Roth 1967) have described much simpler communities, adapted to the cold, oxygen poor water and flocculent sediments of the profundal zone.

Distributional studies of aquatic vascular plants in the lake (Haynes and Hellquist 1978, Gates 1948, Bromley 1967, Williams 1970, J.A. Weber 1972) have emphasized adaptations for growth and dispersal as a function of their physicochemical environments. Algal communities attached to these plants have been examined by Young (1945) and Fairchild and Lowe (1983).

In contrast to the extensive work available for benthic invertebrates and plants, studies of the plankton have been few. Papers by Tucker (1957) and Saunders *et al.* (1962) have addressed the growth and diversity of the phytoplankton, while Campbell (1941) and Fuller *et al.* (1977) have examined the community composition and population dynamics of rotifers in the lake.

Reighard's (1915) early reconnaissance of the fishes of Douglas Lake has received little subsequent comprehensive study. Papers by Weller (1938) and Rodeheffer (1939, 1941, 1945, 1946) have addressed the behavior and distribution of selected species.

A large volume of literature exists in addition concerning the fungal and animal parasites of Douglas Lake. These and other references may be located by those interested from the Station's bibliography.

EVIDENCE FOR TROPHIC CHANGE IN DOUGLAS LAKE

Lakes, like wetlands, undergo a form of geological succession over time. Basins gradually fill with sediments, and productivity typically increases. The process is commonly termed eutrophication. Rates of such change are typically slow and usually difficult to detect. Human disturbances of a lake's watershed can, by adding critical nutrients to the lake, also produce changes in productivity. Such "cultural" eutrophication is often perceived over relatively short periods of time. With the availability of limnological information for Douglas Lake over much of this century, it is not surprising that aquatic researchers here have at times addressed this question of trophic change. Three such studies are summarized here.

Sediment Coring as Evidence of Watershed Disturbance

When the Biological Station was first founded in 1909, the surrounding land had been dramatically altered through lumbering, which apparently occurred principally during winter 1879-1880, and subsequent fires which lasted until 1920. As Paul Welch suggested 25 years ago, it was thus logical for early research to turn to Douglas Lake as an environment apparently not affected by this devastation. The analysis of diatoms in a 176 cm sediment core taken from South

Fishtail Bay (Andresen 1976), however, suggests that changes in lake water quality did in fact occur during the logging era, as evidenced by the decreased species diversity of the diatom community and by the increased abundance of warm water, eutrophic indicator species, especially *Melosira granulata*. More recent sediments showed a subsequent stabilization of the diatom community. Andresen interpreted the changes as being the result of increased nutrient run-off from the land owing primarily to the remineralization of bound nutrients by fires which swept the area. Increased nutrient retention apparently ensued within the watershed during secondary terrestrial succession. Slight increases in trophic status since the 1940s, when rapid recreational (cottage) development occurred at the west end of the lake, are also suggested by an increase in eurytopic species in the uppermost 12-16 cm of the sediments.

The Hypolimnetic Oxygen Deficit (1911 to 1964)

Oxygen content in the bottom waters, or hypolimnion, of a lake during mid-summer is dependent upon the amounts of organic material settling from above, and upon the degradation of these materials, largely by bacterial respiration. Accordingly, the greater the production of organic matter, the greater the sedimentation rate and consequent oxygen consumption as decomposition proceeds. The rates of hypolimnetic oxygen depletion (HOD) can thus be utilized as an index of lake productivity. For example, Lind (1978) hypothesized that the basins close to the cottage development at the west end of Douglas Lake should experience increased algal growth and consequently greater hypolimnetic oxygen depletion. His comparison of Fairy Island, Grapevine Point, and South Fishtail Bay depressions revealed an unexpectedly high oxygen depletion rate in South Fishtail Bay, which he attributed to its protection from wind action and its cul-de-sac location within the lake. Bazin and Saunders (1971) examined the HOD for South Fishtail Bay beginning with data from Welch in 1911 and ending with unpublished data of Chandler and Saunders in 1964. Apparent from their study is considerable year-to-year variation in the HOD estimates, but a significant ($p<.05$) trend toward an increasing rate of oxygen depletion during the 54-year time interval. The authors interpreted this trend as evidence of slow eutrophication in the lake. Available information for net primary production that shows a 2-3 fold increase from 1959 (Saunders *et al.* 1962) to 1970-1971 (Lind 1978) appears to support this view. Likewise, the comparison of total rotifer densities in the lake in 1938 (Campbell 1941) with densities in South Fishtail Bay three decades later (Fuller *et al.* 1977) has suggested approximately 4-fold increases in herbivorous zooplankton abundance, again supporting the contention of increases in lake productivity. In contrast, available nutrient and other chemical data during the past 75 years (Pratt and Cairns 1983) provide no evidence of significant change in the lake trophic state.

Protozoan Colonization Patterns (1969 to 1982)

Artificial substrates, when placed in a lake, are gradually colonized by an assortment of protozoan species that immigrate from already existing surfaces in the lake. Cairns *et al.* (1979) have shown that both the rate of increase in numbers of species (G) and the equilibrium species number that can exist stably on the new substrates (S_{eq}) are enhanced in response to eutrophication. Pratt and Cairns (1983) have examined colonization patterns for protozoans in Douglas Lake from 1969 to 1982. No consistent trends in either G or S_{eq} were found, and the authors interpreted their results as indicating trophic stability in the lake during this time interval.

Evidence addressing the question of trophic change in Douglas Lake is thus incomplete and somewhat contradictory. Cultural eutrophication in the lake was apparently most pronounced during the logging era. Gradual changes in productivity may also have occurred during the development of the west end of the lake, but no published evidence exists for changes in water quality during the recent past. Much remains to be learned.

CONCLUDING REMARKS

Facilities such as the University of Michigan Biological Station are perhaps uniquely suited for the development of large quantities of research data, obtained over many years and by many authors, all directly or indirectly aimed at understanding the intricacies of a single ecological system. Douglas Lake has historically been such a habitat, and numerous authors have examined the lake or its biota. This is in one sense impressive. Many of the papers briefly mentioned here have been influential in expanding the perimeters of our understanding in limnology and aquatic ecology. Considerable satisfaction can likewise be derived in the slow accumulation of knowledge by single individuals associated with the Station for long periods of time. A synopsis of aquatic research during the past 75 years is at the same time frustrating, however, in its revelation of a myriad of comparatively isolated research efforts, designed along conceptual lines to which the lake as an ecological entity has been incidental. One is struck with the analogy of a large puzzle of many individual pieces, at a stage in its completion where relatively few of the pieces have been joined to form a discernible picture. Studies of vegetational succession in Bryant's Bog and Smith's Fen, examination of the physical processes governing the distribution of sediments and benthic organisms of Douglas Lake, the examination of physicochemical and biological data to infer "depression individuality" and lake trophic state represent unusual instances where the information of early studies has been integrated with later research.

The Station staff can help to facilitate the integration of research on the lake and adjacent water bodies. First, the Station is in the process of collating published information as well as student papers in a form cross-indexed according to topic and thus easily accessible to future researchers. The presence of a permanent staff member interested in aquatics and available as a source of ideas and information was begun in 1972 with the arrival of Dr. John Gannon. Dr. Gannon's presence was critical to the gathering of year-round information on Douglas Lake and to the organizing of a comprehensive research effort on water quality in this region. Dr. Gannon remained at the Station for 6 years and was succeeded by Dr. Ned Grossnickle between 1979 and 1982, but no aquatics staff member has been in residence at the Station since that time. The accumulation of knowledge is a process that feeds upon itself. As the available data base and research facilities of the Station become increasingly recognized, the future of aquatic research here cannot help but be bright.

REFERENCES

All the references prior to 1959 are contained in the Station bibliography published with the Semicentennial Proceedings in 1959. All references of the last 25 years are to be found in the Station bibliography contained in this volume.

CHANGES IN THE UPLAND FORESTS OF THE DOUGLAS LAKE REGION OVER THE PAST 75 YEARS

by Claudia L. Jolls

Claudia Jolls

When Dave Gates suggested I prepare a talk describing changes in the terrestrial ecosystems in the Douglas Lake region, my excitement was surpassed only by the cold grip of fear which seized me. As a plant ecologist, I was exhilarated at the thought of reviewing and synthesizing the literature. After a cursory review of the list of 1,700 Station publications, my exhilaration changed to trepidation, and after a more extensive review of 58 publications, dealing just with changes in terrestrial vascular flowering plants, my excitement and trepidation turned to exhaustion.

The most overwhelming aspects I encountered during my preparation for this talk were (1) the dramatic changes that have occurred in our vicinity during the past 75 years and (2) the vast amount of work, both published and unpublished, documenting these changes. Douglas Lake is unique in having a rich, extensive, and well-documented history, gained while fulfilling our mission of teaching and research in field biology.

Thus, I was left with 1,700 publications, 114 courses, 150 faculty, several hundred researchers, and 7,000 students, most of whom did independent projects for their courses. The compilation of all this information has been tackled in earnest through the efforts centered around the Station's list of publications, our archives, copies of student papers, and, most recently, the Gazetteer and our efforts with data management. The accumulation of this information has taken 75 years and I was beginning to feel that its synthesis would take an additional 75.

I had a title: "Changes in the Terrestrial Ecosystems Over 75 Years"; the words in the title connote several concepts and ideas. The word "changes" implies the process of succession. The phrase "terrestrial ecosystems" suggests those extensive plant communities that control to some degree the other organisms inhabiting them. The most conspicuous of the plant communities is the forest and our research history for this community, particularly the upland forest, is richest. I have deferred to my colleague, Win Fairchild, for a discussion of the wetlands and have opted to ignore the dunes and shoreline vegetation. My thirty years of life give me a very myopic perspective given that much of our forest is at least 70 years old; even one of our youngest communities, the 1980 burn, has a tenure at UMBS longer than mine. My caveat is I have overlooked some very important contributions. Although my views have undergone considerable evolution as the result of discussion with my colleagues, they are nonetheless my views and interpretation of others' work. I will attempt to illustrate some of the changes in this area during the past 75 years using selected studies and generalizations from many efforts, only some of which I can acknowledge in this discussion.

SUCCESSION

Succession is defined as a progressive, directional, and predictable or nonrandom process of change in species composition in a given area, generally accompanied by changes in diversity, productivity, and biomass. Some schools of thought conclude that this process yields a steady, self-perpetuating state termed climax, however, others feel climax is an academic state that is never realized.

Views of succession have changed. The earliest considerations, championed by F.E. Clements (1916, 1936), viewed succession as a community-level process. The community was considered an organism and succession was its life cycle. Transitions in a given area were believed to be replacement of one community by another rather than a continuous process of replacement of species. Changes mediated by the early successional species were to their own detriment, paving the way for later successional species. Clements viewed succession as a progression toward a homogeneous species composition or monoclimax, independent of initial site and vegetation composition.

Ecologists have argued whether a climax community is unique and predictable for a given regional climate or whether each region is characterized by a mosaic of climax types (the polyclimax of Whittaker 1953, 1973). This is a very important view, given the diversity of habitats in the Douglas Lake region. The most recent embellishments on traditional views of succession have trended away from the Clementsian view of a community-level process to greater emphasis on population-level interactions. These views emphasize the life histories of individual species, the role of disturbance in shaping communities and the strong influence of random events (West *et al.* 1981). Both schools of thought are represented by Station research.

There are several methods of documenting succession, all represented by studies at UMBS. These methods include: (1) single measures of one plot through time, (2) observations on nearby plots of different successional ages, (3) analysis of historical and pre-historical records, (4) experimental manipulations, and (5) mathematical modeling.

The present-day vegetation patterns and the faunal communities dependent on the primary producers are a reflection of the vegetation here prior to 1909 and the forces which shaped it. These initial vegetation patterns were shaped by glaciation, climate, and soils, as well as by internally and externally caused disturbance following initial establishment. I will begin by describing the forest the settlers saw, the impact of human settlement (or dissettlement as you will see) and the resultant changes that have been monitored at UMBS during the past 75 years.

The present-day landscape was released from glaciers 10,000-12,000 years (Gold, Gannon, and Paddock 1979) and sometime after 11,400 years ago plants re-entered Cheboygan county (Kilburn 1957). Even after the final retreat of the ice, fluctuating lake levels shaped the landscape around Douglas Lake. Pleistocene Lake Algonquin connected Burt, Douglas, and Mullett Lakes at an elevation of

225 m above sea level 11,000 to 8,000 year ago. Much of UMBS was under Lake Algonquin, except for the highlands. Lake Nipissing existed 4,000 to 3,500 years ago at a level of 189 m above sea level and combined Lakes Superior, Huron, and Michigan. Despite its large size, it affected only small areas in the region around Douglas Lake (Spurr and Zumberge 1956). Thus, near UMBS, various areas have been exposed to vegetation for different lengths of time. Areas above Lake Algonquin, that is areas now above 225 m, have been exposed since ice retreat, approximately 11,000 years. Areas between 189 m and 225 m, below Lake Algonquin and above Lake Nipissing, have been exposed for 8,000 years, while areas below 189 m have only been free of ice and water for 3,500-4,000 years.

Topography and soils are two factors which determine plant distributions. Glaciation has produced a diversity of topographic regions and soil types in the UMBS region. These include erosion resistant ridges on the lakeshore such as Roberts (Bentley), Ingleside, and Grapevine Points. The effects of glaciation also include the deposition of moderate- to heavy-textured till, coarse-textured outwash sands and gravels, and lake bed deposits.

After the Pleistocene, temperate mesic plant species began their migration northward from their southern glacial refuges. Davis (1981) documented the arrival of various tree species in the Great Lakes region based on pollen stratigraphy of cores from north central and eastern United States lakes. Jack pine arrived 10,500-11,000 years ago, along with white pine and oak. Hemlock arrived 500 to 1,000 years later. Beech, the most recent arrival, is first seen in the pollen record between 5,000 and 6,000 years ago.

Pollen profiles and plant macrofossils also help us document the post-glacial vegetation of this region, most notably work by Sears (1942), Wilson and Potzger (1943), Deevey (1949), Benninghoff and his students (1960), Farrand, Zahner and Benninghoff (1969), Miller and Benninghoff (1969), Andresen (1976), and Futyma (1982). These profiles record a transition from boreal conifers to deciduous tree genera. Initially, spruce was dominant, with small amounts of pine and fir. This spruce dominance was followed by an increase in pine pollen and the first appearance of birch, oak, and tamarck, then by hemlock, beech, and maple. After this pine dominance, conifers decreased to 50% with a concomitant rise in hemlock, birch, oaks, and beech.

THE FOREST THE SETTLERS SAW

Land survey records also are a powerful tool used to reconstruct the presettlement forest. Between 1840 and 1855, before the earliest settlers had arrived, the General Land Office Survey took place in Cheboygan County. In 1957, Paul Kilburn interpreted these land survey records. Using site reconnaissance of the existing vegetation and soil types, Kilburn constructed a presettlement vegetation map, documented successional trends in the post-settlement vegetation and proposed future trends. In order for the surveyors to locate and map section and township corners, the distances and directions to two or four trees were recorded, as well as tree species and diameter at breast height (DBH). These so-called witness or bearing trees give us a glimpse of part of the presettlement forest.

Little disturbance characterized the presettlement forest except for that created by native peoples. No lumbering occurred prior to 1840 and little cutting had taken place by 1855. Fire probably occurred only once per century in the presettlement forest. Based on the presence of fire scars, Kilburn concluded that only five major fires had occurred in Cheboygan County during the lifetime of the trees present in 1957. These fires occurred primarily in dry woodlands dominated by pine.

Kilburn (1957, 1060, 1961) recognized several types of presettlement forest. On organic soils, the swamp forest was composed of cedar, and to a lesser degree tamarack, or spruce and fir. The northern hardwood forest occurred on the better soils, well-drained loams, silt loams, clay loams, and some mesic sandy loams. On such sites, sugar maple dominated with some basswood, yellow birch, and elm. On drier sandy loams, beech abundance rose to 50% or shared dominance on loamy sands with hemlock. Lastly, Kilburn recognized the pine woodland, dominated by jack, red, and white pine, with lesser representation of hemlock, bigtooth aspen, white oak, red oak, paper birch, and beech.

From 1841 to 1871, the federal government offered land for $1.25 per acre to encourage the extension of the railroad into the forests (O'Neil 1977 cites Inglis 1898). Although labeled "swamp," this was valuable pineland in our area. Due to high yield, much land was cruised, purchased, and set to the axe.

In 1845, Cheboygan County saw its first settler (Voss 1956). By 1870, these numbers exceeded 2,000 and in 1910, the county population peaked at 17,872. By 1900, more than 20% of the county existed as farmlands, mostly situated on loamy soils (Kilburn 1957). Thus, the northern hardwoods were more affected by human settlement.

Human settlement also had a drastic impact on the terrestrial fauna of this area. According to O'Neil (1977), in 1875, 160 acres of land were awarded to Civil War veterans. After a rugged winter in this area, the homesteaders were met by the arrival of millions of passenger pigeons, returning to nest. Colonies were reported to be 30 miles long and three to four miles wide, particularly near Cross Village and Petoskey. The story of the uncontrolled slaughter is well-documented and by 1898, Michigan's last passenger pigeon was gone (Schorger 1955).

The years between 1840 and 1900 were the heyday of Michigan lumbering (O'Neil 1977). Between 1847 and 1872, lumbering increased rapidly; six mills were operating in Cheboygan by 1872 (Voss

1956). "Pine went first," as Voss (1956) recounts. In general, trees between 15 and 30 inches DBH, from 70 to 160 years old were cut, but smaller trees were lumbered as well (O'Neil 1977). By 1880, all the better pine was gone from Douglas Lake and Pellston. Between 1880 and 1900, most lumbering operations involved only small-scale salvaging.

In addition to white and red pine for lumber, hemlock was taken for its bark for the extraction of tannins. By 1900, the conifers were gone and attention turned to the high-grade hardwoods: ash, elm, maple, birch, cedar, spruce, and smaller pines. In 1902, the Tyndall-Jackson Mill at Pellston began to lumber the hardwoods west of town. As J. G. Inglis reported in his 1898 *Handbook for Travelers: Northern Michigan* (cf. O'Neil 1977):

> For miles and miles this desolate wilderness of stumps stretches on either side with gaunt bare pine 'stubs' sprinkled among them and decaying logs scattered in wild confusion everywhere. The stubby undergrowth of oak and poplar adds to rather than relieves the desolateness.

The period between 1880 and 1920 was a time of constant fires (Kilburn 1957). Due either to farmers clearing the land or to transients (depending on whether you ask a farmer or a visitor), major fires occurred in 1892, 1901, 1911, and 1923, according to Frank C. Gates. From his examination of fire scars, Kilburn (1957) reported nine fires in 43 years, or a fire at least once every four to five years. These frequent fires kept aspen and other timber down and stimulated the huckleberries and blueberries.

Human impact, trapping, logging, and agriculture also shaped the faunal patterns of distribution and abundance. The fur trade dominated Indian-white relations during the seventeenth and eighteenth centuries. Even at this early date, O'Neil (1977) reported that the incoming settlers were pushing out the Indians and destroying the forest. Gates, Clarke, and Harris (1983) summarized changes in wildlife of the Great Lakes states; these changes probably parallel abundance patterns of animals which occurred here in northern Michigan. Gates, Clarke, and Harris concluded that early trapping did not exterminate any wildlife species, however, it did deplete populations of wolverine, fisher, marten, otter, and beaver, the mainstay of the trapping industry. Beavers created frequent forest clearings, elevated water tables and made ponds as catchments for meltwater and eroding soils. The drastic decline in beaver populations must have produced dramatic environmental changes.

The landscape opened with farming and the subsequent growth of aspen. Logging, clearing, and subsequent fires radically changed the microclimates as well as the landscape. Soil and air temperatures increased, and water content of the soils decreased, producing drastic shifts in bird and mammal populations.

By 1900, large mammals (moose, bison, elk) had disappeared due to exploitation by humans for food and fur in addition to habitat changes.

Systematic hunting exterminated puma and timberwolf. Black bears were nearly extinguished by the 1920s and 30s, but made a comeback; they are now considered common. Some furbearing mammals having a high population growth (muskrat and mink) survived the logging era, but those with a strongly cyclic and low recruitment rate (marten, fisher, lynx, and beaver) became scarce (Gates, Clarke, and Harris 1983).

Lumbering had opened the forest, improving range conditions for deer. After an initial increase, deer populations plummeted to a minimum in 1890 due to rampant fires and uncontrolled hunting. The advent of fire control in the 1930s produced an explosion in deer herd numbers. Overbrowsing stunted reproduction of white pine, cedar, hemlock, and yellow birch, favorite foods of deer. As the forest opened, the range of many vertebrates extended northward, improving conditions for the ruffed grouse, sharp-tailed grouse, and prairie chicken (Gates, Clarke, and Harris 1983). The thirteen-lined ground squirrel greatly increased in numbers as hardwoods became established.

Harper (1918) and Gleason (1923) gave vivid accounts of the plant associations during the early years of the Station. On the dry uplands, Harper recognized three communities dependent upon the moisture-holding capacity of the soil: (1) hardwoods and hemlock on the mesic sites, (2) white and red pine on intermediate sites, and (3) jack pine on the driest sites. Harper recognized red and white pine as the dominant tree species before the appearance of the lumbermen and hypothesized that, given enough time for the accumulation of humus, the pine forests on the sandy upland might be succeeded by hardwoods. Although Harper recognized a second type of succession in our region resulting from fire, he felt that the hardwoods were rarely burned, as Kilburn concluded some 39 years later. Harper (1918, p. 32) summarized the impact of lumbering on the vegetation as follows:

> . . . the 'pernicious activities' of the lumbermen a few decades ago removed the greater part of these two valuable pines (red and white), and the ground formerly occupied by them has now a low scrubby growth of birch and aspen, which is burned too often for the white pine to reestablish itself, though the red pine is making some headway.

Gleason's eloquent account in 1923 of his botanical observations in northern Michigan recognized the unique nature of the transition forest. He described this so-called tension zone forest as an army of deciduous trees from the south meeting an army of coniferous trees from the north. Gleason blamed the lumbermen for the demise of this unique forest community (p. 273):

> The armies of both belligerent forces have been sadly decimated by a third and much more powerful force — man, armed with the axe, the circular saw, and the railroad.

Gleason recounts that after lumbering around Douglas Lake, the land was a "jungle of brush heaps . . . dense thickets of aspen, birch, and pin cherry with an almost continuous ground cover of bracken fern." He saw extensive white pine regeneration and growth where a seed source remained and blamed careless fire for the failure of white pine to replace aspen. These fires were frequent; he counted 12 fires in one day during a drive of seven miles. Of the 3,000 acres the Station owned in 1923, Gleason knew of only two small areas that had escaped fire and saw the old aspen trees being replaced by what he called "a thrifty growth of healthy pines" (p. 275).

Gleason recognized that aspen germination was favored by fire. He felt that the pine, if protected from fire, could replace the aspen since the poplars are relatively short-lived trees. He speculated that the demise of many aspen after 25 years could be due to the poverty of the sandy soils, crowding, or water stress. The work of Barnes (1966) and his students illustrated the fire-adaptedness of this "phoenix tree" in terms of germination characteristics, its stimulated suckering following fire and rapid growth rates. Perhaps what Gleason did not know at the time was that *Hypoxylon* canker is responsible for the relatively rapid death of certain genetically susceptible clones. We now know that many aspen stands on Station property are approaching 80 years of age and may persist even longer.

In 1960, Kilburn summarized the effect of settlement on the original vegetation of the Biological Station as follows: Between 1850 and 1900, pine and hemlock were logged on the upland sandy soils. For 40 years after the original lumbering, fires were frequent, eliminating most of the small pine and practically all of the hemlock. With fire control in the '20s, second growth forests of bigtooth aspen dominated. The logging removed red pine to the advantage of jack pine which in the face of fire protection gave way to oaks. Kilburn (1960) felt that, given natural restocking of seedlings, the pines would return, with a slower return of hemlock due to the scarcity of seed. In the pine-oak forest type, fire merely damaged the oaks, so large oaks dominated in 1957, but Kilburn hypothesized that pines would take at least 200 years to return.

PERMANENT PLOTS

Between 1911 and 1954, Frank C. Gates studied forest succession in the Douglas Lake region. From 1923 to 1954, he and his plant ecology classes made yearly surveys of areas that had experienced fires. He clearcut and burned three adjacent plots in 1936, 1948, and 1954; a fourth burn was added by UMBS researchers in August 1980. In 1938, Gates, W. F. Ramsdell, and L. R. Schoemann set up seven fifty-year forest plots to initiate a study of succession on different soil types (Duncan and Varner 1938). Every plant over one meter in height was mapped in these 0.1 acre plots. Subplots were sampled for herbaceous understory and woody species under one meter in height were noted as well. Under the initiative of Ramsdell in 1934 and S. H. Spurr in

1956, a set of permanent plots was established and monitored to study the effects of thinning and other management on many tree species and forested communities. These permanent plots: aspen sets, natural burns, experimental burns, fifty-year plots, and forestry treatment plots, are the jewels in the crown of the Biological Station. They allow us to approach the study of succession using three methods: the analysis of (1) stands of different ages sampled at one point in time, (2) a stand or series of stands measured through time, and (3) communities that are manipulated to experimentally test certain hypotheses about succession. I would like to use several studies which utilized these UMBS permanent plots to illustrate patterns of vegetation change in our region since 1936.

Scheiner and Teeri (1981) analyzed Gates' data that lay dormant for many years following his death. They found successional trends, based on species occurrence, similar to those reported earlier by Whitford (1901) and Gates (1930). Bigtooth aspen dominated in the early years following fire, becoming replaced by white pine and red maple, with a gradual increase in the diversity of species. Scheiner and Teeri hypothesized that this course of succession may be very different from that which produced the primeval woodland or that which occurred immediately following this destruction.

Cooper (1981) took another approach to the analysis of some of the permanent plot data. He concluded that once significant aspen mortality begins to occur, as it has in the seventy-year-old forests at UMBS, aspen standing crop peaks and productivity begins to decline. Standing crop and net annual production of pine and oak-maple woodland, however, increase. Cooper hypothesized that within the next two decades production increases will be confined entirely to pine and oak-maple. The species dominance will shift. Where pines are well stocked, they will become dominant. In areas where pines are rare, oaks and maples will reign for an unpredictable period of time before pines finally assume dominance. In areas where pines, oaks, and maples are scarce, we are likely to see small patches of aspen dominance.

Sharik, Heinen, and Fenster, with the assistance of recent plant ecology classes, have recensused the burn plots and asked mechanistic questions about white pine regeneration. For all tree species, they observed a constant recruitment into the lower strata and an increase in recruitment over time into the upper levels of the canopy. They observed that it took about 15 years for the 1936 burn to be invaded by white pine, compared to only three to five years for initial establishment in the 1948 and 1956 burns. Interestingly, the 1936 and 1948 burns were invaded in about the same calendar years, 1951-53. Aging of the white pines in the surrounding forest indicated that they were probably reaching reproductive maturity at about this time. Their studies support earlier predictions that logging or comparable forms of disturbance and fire must occur in moderately-aged stands of reproducing white pine for this species to persist. More frequent fires result in reversion to aspen, while less frequent fire may lead to dominance by hardwoods, at least on better sites, a trend seen during the past ten years by Sakai, Roberts, and Jolls (1984). The pines of Hartwick Pines State Park, Grayling, just south of Douglas Lake, are becoming Hartwick Maples, and are an example of this reversion to hardwood without disturbance.

CHANGES IN BIRD POPULATIONS SINCE 1928

The Biological Station is unique in having permanent census areas for birds set up by Sewall Pettingill and Douglas James in 1947 and a small mammal trapping grid established by John Douglas in the late '70s. Pettingill (1974) recounts some of the changes in local birdlife during the maturation of the second-growth forest. In 1928, Common Nighthawks, Hermit Thrushes, Rufous-sided Towhees, Black-billed Cuckoos, and Brown Thrashers were common. Today, they are rare and can be found only in cleared areas. The loss of open areas also reduced or eliminated the Eastern Kingbird and Mourning Dove. However, the maturation of pines and shade trees has attracted the Pine Warbler and the Warbling Vireo. Due to other changes, such as the use of pesticides, loss of nest sites, and fluctuating water levels, Pettingill noted a sharp reduction in almost all diurnal birds of prey, the Eastern Bluebird, and shorebirds.

Several species, however, are new to the region: the Mockingbird, Brewer's Blackbird, and the Dickcissel. Still others such as the chimney swift, purple martin, robin, and blue jay have taken advantage of the new habitats created by humans (Gates, Clarke, and Harris 1983).

CONCLUSIONS

Mark Roberts, formerly of Duke University, now at University of New Brunswick, used much of the permanent plot data and extensive site reconnaissance as part of his dissertation (1983) to evaluate the successional trends of this region and to offer some insights into successional mechanisms. He concluded that succession is influenced not only by soil type, time, disturbance, and what was there, but also by biotic forces, such as the life history properties of species (their mode of growth, reproduction, longevity) and even browsing and insect defoliation. The extant forces shaping our forests are as heterogeneous as the forces that shaped them: glaciation, soils, lumbering, fire, human settlement, and the composition of the ancestral forests. On drier sites, we can expect young stands of bigtooth aspen, black cherry, red maple, red oak, and serviceberry to give way to red and white pine, red oak, and paper birch. Some semblance of the presettlement forest will return; however, with fire suppression, we will not see the jack pine return to its original dominance on the poorest sites. Due to a lack of seed from its fire sensitivity, we can expect a distinct scarcity of hemlock compared with presettlement communities.

On the more mesic sites, Roberts hypothesized that aspens will yield to resprouting hardwoods, such as beaked hazelnut and cherries. These pioneers will then be succeeded by sugar maple, beech, basswood, white ash, red oak, red maple, and paper birch. However, due to decimation by the introduced Dutch Elm disease, we will not see the American Elm.

We can conclude that contrary to the earlier views of succession as a community by community replacement process, succession in this area appears to be a continuous replacement of species. There is considerable overlap of early and late successional species which results in a gradual shift from pioneer to climax species over time. Succession is not the neat, orderly process Clements and others envisioned. We can predict that the eventual dominants on dry-mesic sites will be pines, on mesic-sites — hardwoods, and on wet-mesic sites — cedar and balsam fir. Recent work by Sakai and Sulak (1984) confirm earlier hypotheses (Duncan and Varner 1938, Gates 1942) that white cedar, black spruce, and balsam fir would continue to dominate wet, organic soils. The current composition of their site was controlled by species present at the time of establishment, over fifty years ago. Sakai and Sulak, however, did find that localized disturbances such as storms can dramatically alter stand composition.

There is still some doubt as to whether we will ever again see the forest primeval; however, as I have tried to illustrate, we are not sure what it was. We can be sure that the extant forests will exhibit the same heterogeneity characteristic of not only the ancestral forests, but also the forces which shaped them.

Our properties need two things: management and protection. To some extent, we should promote the growth of aspen, restocking of pines, and establishment of open areas to maintain faunal diversity and to maintain the heterogeneity of communities we need for teaching and research. This management is in its incipient stages, largely through the efforts of Robert Vande Kopple with the Land Plan, Dikran Kashkashian, Tom and Heidi van't Hof with the Gazetteer, and Polly Fairchild with data management efforts. We are attempting to inventory what we have in terms of teaching and research resources and to make them accessible. We will continue to monitor our permanent plots, perhaps establish new study plots, and execute experiments to help unravel the processes of community change. However, we must consider past, present, and future uses of our resources: permanent plots, research sites, class use, timber sales, public access, and recreational use.

Not only should our land be managed thoughtfully and perhaps conservatively, it also should be protected in the face of increasing human impact: development, recreation, biocides, acid rain, and increasing carbon dioxide levels. The question we face is how much should be protected and from what.

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LITERATURE CITED

Andresen, N.A. 1976. Recent diatoms from Douglas Lake, Cheboygan County, Michigan. Dissertation, University of Michigan, Ann Arbor.

Barnes, B.V. 1966. The clonal growth habit of American aspens. Ecology 47: 439-47.

Benninghoff, W.S. 1960. Pollen spectra from bryophytic polsters, Inverness Mud Lake Bog, Cheboygan County, Michigan. Papers of the Michigan Academy of Science, Arts and Letters 45: 41-60.

Clements, F.E. 1916. Plant succession: an analysis of the development of vegetation. Carnegie Institute of Washington Publ. No. 242. Washington, DC: Carnegie Institute of Washington.

Clements, F.E. 1936. Nature and structure of climax. Journal of Ecology 24: 252-84.

Cooper, A.W. 1981. Above-ground biomass accumulation and net primary production during the first 70 years of succession in *Populus grandidentata* stands on poor sites in northern Michigan. p. 339-60. In: D.C. West, H.H. Shugart and D.B. Botkin, eds. Forest Succession: Concepts and Applications. New York: Springer-Verlag.

Davis, M.B. 1981. Quarternary history and the stability of forest communities. p. 132-53. In: D.C. West, H.H. Shugart and D.B. Botkin, eds. Forest Succession: Concepts and Applications. New York: Springer-Verlag.

Deevey, E.S., Jr. 1949. Biogeography of the Pleistocene. Geological Society of America Bulletin 60: 1315-1416.

Futyma, R.P. 1982. Postglacial vegetation of eastern upper Michigan. Dissertation, University of Michigan, Ann Arbor.

Duncan, D.P. and R.W. Varner, 1938. Experiment designed to show the relationship between soil and changes in the vegetational cover. University of Michigan Biological Station, unpubl. ms.

Farrand, W.R., R. Zahner and W.S. Benninghoff. 1969. Cary-Port Huron interstade: evidence from a buried bryophyte bed, Cheboygan County, Michigan. Geological Society of America Special Paper 123 (INQUA Volume): 249-62.

Gates, D.M., C.H.D. Clarke and J.T. Harris. 1983. Wildlife in a changing environment. p. 52-80. In: Susan Flader, ed. The Great Lakes Forest: An Environmental and Social History. Minneapolis, Minnesota: The University of Minnesota Press in association with the Forest Historical Society, Inc., Santa Cruz, California.

Gates, F.C. 1930. Aspen association in northern lower Michigan. Botanical Gazette 90: 233-59.

Gates, F.C. 1942. The bogs of northern lower Michigan. Ecological Monographs 12: 214-54.

Gleason, H.A. 1923. Botanical observations in northern Michigan. Journal of the New York Botanical Garden 24: 273-83.

Gold, A., J. Gannon and M.W. Paddock, Jr. 1976?. Douglas Lake profile. A report for the National Science Foundation, LSP76-84559. 4 p. Available from: The University of Michigan Biological Station, Pellston, Michigan 49769.
Harper, R.M. 1918. The plant population of northern lower Michigan and its environment. Bulletin of the Torrey Botanical Club 45: 23-42.
Inglis, J.G. 1898. Handbook for Travelers: Northern Michigan. Petoskey, Michigan: George E. Sprang. Grand Rapids, Michigan: Black Letter Press Reprint, 1973.
Kilburn, P.D. 1957. Historical development and structure of the aspen, jack pine and oak vegetation types on sandy soils in northern lower Michigan. Dissertation, University of Michigan, Ann Arbor.
Kilburn, P.D. 1960. Effect of settlement on the vegetation of the University of Michigan Biological Station. Papers of the Michigan Academy of Science, Arts and Letters (1959) 45:77-81.
Miller, N.G. and W.S. Benninghoff. 1969. Plant fossils from a Cary-Port Huron interstade deposit and their paleoecological interpretation. Geological Society of America Special Paper 123 (INQUA Volume): 225-48.
O'Neil, W.S. 1977. This Land and Man: A Historical Look at the Use of Land and Natural Resources in the Inland Water Route Region of Northern Lower Michigan. 21 p. Informational Report No. 3. Available from: The University of Michigan Biological Station, Pellston, Michigan 49769.
Pettingill, O.S. 1974. Ornithology at the University of Michigan Biological Station and the Birds of the Region. Special Publication No. 1. 118 p. Available from Kalamazoo Nature Center, 7000 North Westnedge, Kalamazoo, Michigan 49007.
Roberts, M.R. 1983. Variability and mechanisms of secondary forest succession in the aspen ecosystems of northern lower Michigan. Dissertation, Duke University, Durham, North Carolina.
Sakai, A.K., M.R. Roberts and C.L. Jolls. 1984. Successional changes in a mature aspen forest in northern lower Michigan: 1974-1981. American Midland Naturalist. in press.
Sakai, A.K. and J.H. Sulak. 1984. Four decades of secondary succession in two lowland permanent plots in northern lower Michigan. American Midland Naturalist. in press.
Scheiner, S.M. and J.A. Teeri. 1981. A 53-year record of forest succession following fire in northern lower Michigan. Michigan Botanist 20: 3-14.
Schorger, A.W. 1955. The Passenger Pigeon, Its Natural History and Extinction. Madison, Wisconsin: University of Wisconsin Press.
Sears, P.B. 1942. Forest sequences in the north central states. Botanical Gazette 103: 751-61.
Spurr, S.H. and J.H. Zumberge. 1956. Late Pelistocene features of Cheboygan and Emmet counties, Michigan. American Journal of Science 254: 96-109.
Voss, E.G. 1956. A history of floristics in the Douglas Lake region (Emmet and Cheboygan counties), Michigan, with an account of rejected records. Denison University, Journal of the Scientific Laboratories 44: 16-75.
West, D.C., H.H. Shugart and D.B. Botkin, eds. 1981. Introduction. p. 1-6. In: Forest Succession: Concepts and Applications. New York: Springer-Verlag.
Whitford, H.N. 1901. The genetic development of the forests of northern Michigan: a study in physiographic ecology. Botanical Gazette 31: 289-325.
Whittaker, R.H. 1953. A consideration of climax theory: the climax as a population and pattern. Ecological Monographs 23: 41:78.
Whittaker, R.H. 1973. Climax concepts and recognition. Handbook of Vegetation Science 8: 137-54.
Wilson, I.T. and J.E.T. Potzger. 1943. Pollen study of sediments from Douglas Lake, Cheboygan County and Middle Fish Lake, Montmorency County, Michigan. Indiana Academy of Science Proceedings 52: 87-92.

DEDICATION

Mark Paddock

MARK W. PADDOCK

This anniversary volume is dedicated to Mark W. Paddock, whose devotion and contributions have been enormously important to the Station's programs. Mark has been Assistant to the Director and Administrative Manager since 1971. He has been "keeping the store" on a daily basis, summer and winter, while David Gates engaged himself in teaching, research, fund-raising, and in many professional outside activities. Mark has originated many important ideas with respect to the Station's programs and has seen to their implementation. It is not easy for outsiders to appreciate the enormous contribution Mark has made to the Station. The position he holds is unsung and often unrewarded. Therefore, this volume is dedicated to this outstanding individual.

Markley William Paddock was born in Clinton, Iowa, November 2, 1928. His family had settled there in about 1860. He had a treasured boyhood since he truly lived the life of a Huck Finn on the nearby Mississippi River. As Mark himself says, "Most parents were deathly afraid of the river with its fast current, muddy water, and deep holes, and prohibited their children to be on it. Mine were not and I was able to spend huge amounts of time 'down on the river.' " Mark had an old flat bottomed rowboat for exploring the river and fishing. He hunted along its banks and woods and swam off its sand bars. These experiences generated a strong interest in natural history. His home was full of books and his parents were voracious readers. So all the ingredients were there for Mark, his older brother David and younger sister Nancy to go on to college after high school; the first generation on either side of the family to do so. However, for Mark the Army was to delay this for a period of two years which he spent with a field artillery battalion in Nara, Japan.

Mark did his undergraduate studies at the University of Colorado receiving a B.A. degree in geography in 1952. There he entered graduate school in geography following a summer as a park ranger for the U.S. National Park Service at Rocky Mountain National Park, Grand Lake, Colorado. It was only natural that Professor John Marr, ecologist and Director of the Institute of Arctic and Alpine Research, should recognize this young man as suitable for a research assistantship in ecology. He was placed in charge of maintaining and collecting climatological field data from stations situated along a transect on Niwot Ridge above Boulder. The stations ran from 7,000 to 12,300 feet altitude. It was rugged duty maintaining the higher elevation stations through the winter. Mark has many hair-raising stories to tell of "whiteouts" around an army weasel with rocky precipices nearby. The climatological data gathered during these and later years formed the basis for a series of important publications entitled "Data on Mountain Environments, Front Range, Colorado."

Mark departed from Colorado in 1954 to become a special student in wildlife management at Iowa State University and a research assistant with the Agricultural Research Service, USDA. Here he worked with agronomists and geneticists doing crop breeding. Then in 1955 Mark left Iowa to become a game biologist with the Idaho Fish and Game Department. For two years he had responsibility for research and management of big game in a 10-county area of central Idaho.

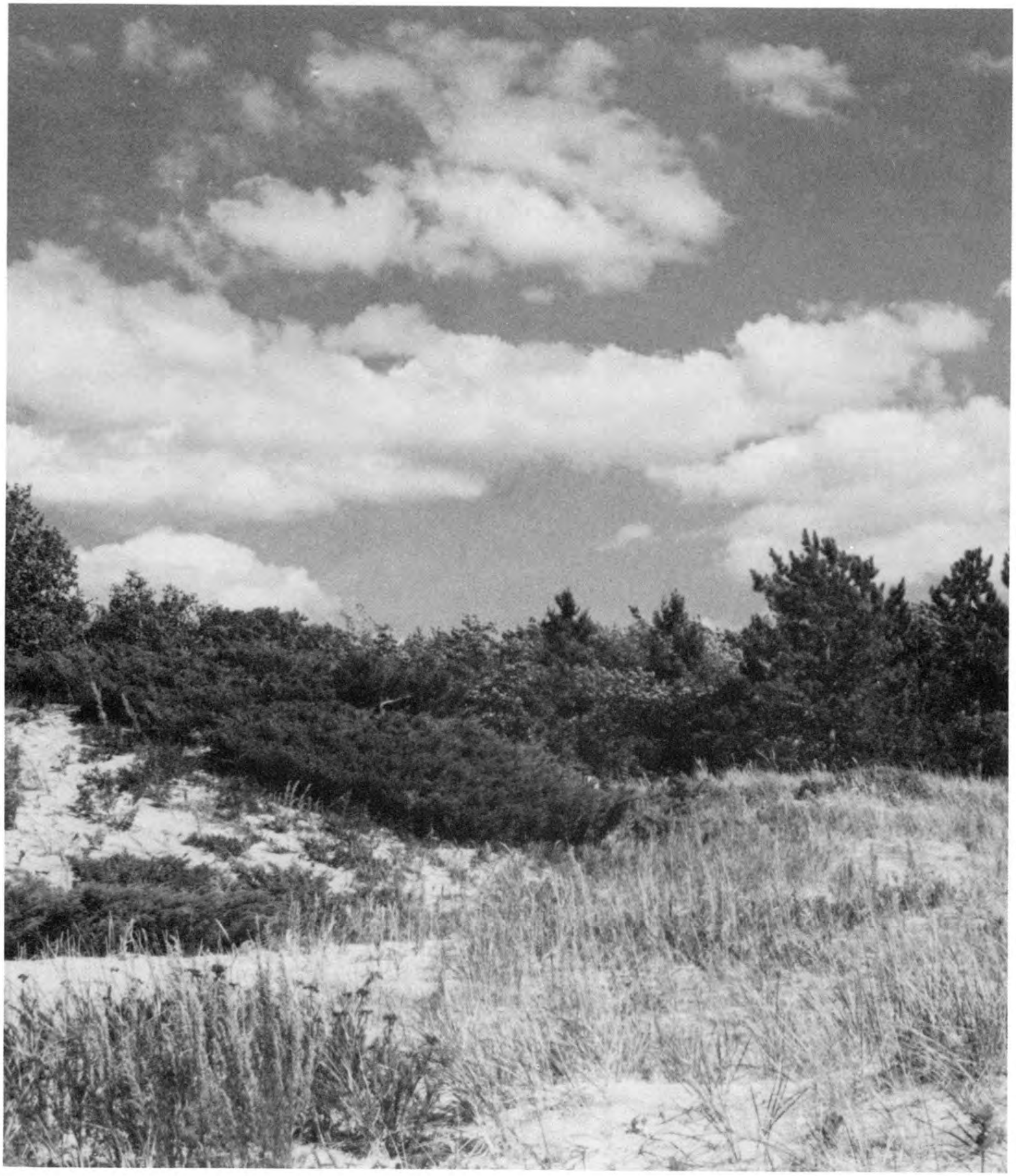
However, the urge to continue his graduate studies took him back to the University of Colorado in 1957 where once again he was a research assistant to Dr. John Marr in the Institute of Arctic and Alpine Research. He advanced through various positions to Chief of Operations and Facilities and to Assistant to the Director. The Institute attracted outstanding ecologists from around the world and Mark had a close working relationship with many of these including Dr. Eilif Dahl of Norway, Dr. Alexander Watt of Cambridge, England, Dr. William S. Osburn, now of the U.S. Department of Energy, and Dr. Robert Crocker of Australia. David Gates became associated full time with the Institute of Arctic and Alpine Research in 1964 and there he met Mark, who by then completed all requirements of the Ph.D. degree except a dissertation.

When David Gates was offered the Directorship of the Missouri Botanical Garden in 1965, he insisted on selecting his own assistant. Considering the remarkable background possessed by Mark in geography, agriculture, wildlife management, and ecology as well as in administration, he naturally turned to Mark to go to St. Louis as his assistant. The job was a difficult one since at that time the Missouri Botanical Garden was in serious trouble with large budget deficits and poor morale and community relations. During six years at MBG, Mark gained an enormous amount of experience with all aspects of administration, public relations, and fund raising. He also became heavily involved with the environmental movement of those years and was one of the founders of the St. Louis Coalition for the Environment — still an effective, active organization in that region.

In 1971 David Gates was asked to assume the directorship of the University of Michigan Biological Station. It was only natural that he turned once again to Mark to accompany him on another new venture. Here was another great challenge. In spite of the environmental excitement of the 1960s and the demand for ecologists, the Biological Station had been falling behind. The physical plant was old and inadequate, except for the splendid new Lakeside Laboratory and the Dormitory built by Alfred Stockard in 1966. Student enrollment was down and no research was being done on a year-around basis. It is a different story today and much of the success for the new vitality of the Biological Station is due to Mark and Ruth Paddock.

Mark met Ruth Knuths at the University of Colorado just a month before they each graduated in 1952. She was an art major from Ames, Iowa. They share a great fondness for the natural world and hiking, camping, skiing, canoeing, biking, and gardening. Mark and Ruth were married in June 1953. Their children Mark (1956), Todd

(1961) and Meredith (1962) share their parents' love for the outdoors and sports. Since coming to Michigan the Biological Station has been Mark's life as well as Ruth's and the children's. This family has devoted itself to the Biological Station. Ruth has put in countless hours as a volunteer doing many chores that needed to be done and tasks for which there were no funds. Mark, Todd, and Meredith each worked both on the work crew and/or the kitchen staff for four or five summers and Todd attended classes for three summers. Only those who have lived at the Biological Station can fully appreciate what this kind of devotion really means. It means a summer program that runs efficiently and effectively. It means a community of people who blend together and whose problems are resolved by those of experience like Mark and Ruth. It means money saved; it means students educated, and it means a happy community of people with fond memories.



APPENDIXES

APPENDIX A

Speech given by Acting Director, Henry Allan Gleason on the occasion of the dedication of the Houghton Laboratory July 4, 1914.

The first naturalist of the young state of Michigan, eighty years ago was Douglas Houghton. His chief interest was in geology, and he was the first official state geologist. In this capacity, he made known much of the mineral wealth of the state, particularly the rich copper deposits of the upper peninsula, where the city of Houghton is named in his honor. Like most other early naturalists, his scientific studies were not confined to one field, and besides his work in geology he was actively interested in both zoology and botany. Of his zoological work I can say nothing. In his botanical work, he added many species to the then little known flora of Michigan, and several species of plants were named in his honor by Torrey and Gray. One of these, both sedges, Carex Hougtonii and Cyperus Houghtonii, are both found at the present time in the near vicinty of the Biological Station. Besides the city of Houghton, Houghton Lake, the second in size in the state, bears his name, and on the campus at Ann Arbor an old monument, weathered by the storms of half a century, has an inscription to his memory. It has seemed entirely fitting that this laboratory should also commemorate his name and work and we have accordingly named it the Houghton Laboratory.

The erection of this building marks an epoch in the history of the Biological Station, and its importance is shown in at least three ways.

For five years past the University has dealt generously with us. For each student registered at the Station during these five years the state has spent $115. Most of this money, however, has been used for salaries, for current expenses, and for various small articles of equipment, and practically none has been used for any equipment of a permanent nature. At the close of our work last year, one hundred dollars would cover all the property of a permanent nature, which could not be moved away from this place on short notice, or discarded without much loss. In this building you see the first piece of permanent equipment which the University has ever given us. This means much to us. It means that we have been tried and not found wanting; that the administration of the University believes that its Biological Station is a useful part of the University whole; and that we may look forward to the continuation of the Station for an indefinite length of time.

Years ago, our botanists and zoologists, like Douglas Houghton, were field scientists. They studied and knew the plants and animals of their own vicinity, and through their combined, painstaking, and long-continued efforts the flora and fauna of our country have been discovered, described, and published to the world. But in more recent times, with increasing density of population, science has moved indoors, and we have produced a race of scientists who are as complete strangers to the field as their predecessors were to the laboratory. We have taught the anatomy of the frog to students who never saw him by his native ponds; we have shown the pollen tubes of flowers to students who never saw an insect engaged in the act of pollination; we have discussed adaptations with students who never saw the wonderful mechanism or the brilliant colors of an orchid in the bog. But again these times are changing, and the group of biological stations now scattered across the continent from Washington to Maine, on the seashore, in the mountains, and by the lakes, bears evidence that the reign of the closet biologist is over. For five years past the University of Michigan has done its share, under adverse circumstances, in teaching field biology at this station, and this new building, trebling its working space, and more than trebling its conveniences, must aid in corresponding proportion its teaching efficiency.

A year ago Acting Dean Kraus, in his report on the Biological Station to the regents of the University, recommended that this building be provided, so that "the work of instruction and research may be carried on under more favorable conditions." Research is just as integral a part of the work of the station as is the instruction. We have here research workers of all kinds, from the student who is just beginning his first problem in fear and trembling, half frightened at the very word research, to the chronic investigator whose mind is one immense question mark, who investigates all day and dreams of new species all night. Call him a genius if he is your friend, call him a crank if he is not, but investigate he will and investigate he must. Give such a man no tools but his fingers, and no laboratory but the lake shore, and he will keep right on with his research. But every sort of research is favored by good facilities, and in this light and roomy building we have one of the best possible incentives to productive study.

Long experience has shown that the best instruction is given by those who are simultaneously engaged in research; and that the best research is accomplished by those who devote a part of their time also to teaching. This building serves both purposes, and we take pride this evening in opening to the cause of biological instruction and biological research the Houghton Laboratory of the Michigan Biological Station.

APPENDIX B

Courses Taught from 1909-1983

BOTANY, ECOLOGY, FORESTRY, and PHOTOGRAPHY

1. Teachers Courses in Ecology
   Burns 09.
2. Identification of Trees and Shrubs
   Burns 09.
3. Botanical Survey of Bogardus Camp Region
   Burns 09.
5. Systematic Botany
   Pool 10; Gleason 11-14; F. Gates 15, 44; Ehlers 16-38; Steere 39-43, 45-47; McVaugh 48, 49; Wood 50, 51, 53; Shinners 52; Clover 54, 56-66; Wagner 55; Voss 67-69, 71-74; Thieret 75, 76; Snider 76.
6. Advanced Systematic Botany
   F. Gates 15; Ehlers 16-32, 34, 36.
7. Field and Forest Botany
   Pool 10; Gleason 11, 12, 14; Loew 11, 12; Whitford 13; McFarland 14, 15; Holman 16, 17.
8. Plant Ecology
   Gleason 13-15; F. Gates 15-42, 44-54; Phillips 55, 56, 58, 70, 71; Benninghoff 57, 61, 63, 66; Cantlon 59, 60, 62; Gilbert 65; Cooper 67-69, 71; Botkin 72, 74; Richardson 73; Kershaw 77; Teeri 78; Anderson 80; Edwards 81; Sharik 82, 83.
9. Advanced Ecology
   Nichols 26-30.
10. Plant Anatomy
    Gleason 15, 18, 23; Rogers 15; Holman 16, 17; Ehlers 18; Quick 19; Nichols 20-22; Seifriz 24; C.D. LaRue 25-51.
11. Ecological Plant Anatomy
    LaRue 26-35.
12. Fungi
    Pool 10; Shaffer 75, 77, 79, 81.
13. Lower Fungi
    Sparrow 48, 50, 52, 54, 63-65; Shaffer 73.
14. Higher Fungi
    A. H. Smith 46, 47, 49, 51, 53, 55, 57, 59, 61, 63, 65, 67, 69; Shaffer 62, 64, 66, 68, 71, 73.
15. Bryophytes
    Nichols 20-30, 32-38; Castle 31; Steere 39-42, 45, 46; Fulford 47-49, 51-53; Patterson 50; Sharp 54-57, 59-64; Crum 58, 65-72, 74, 76, 78, 80, 82; Vitt 71.
16. Advanced Bryophytes
    Steere 48; Fulford 49, 51.
17. Cryptogamic Botany
    Nichols 20-27.
18. Plant Geography
    Seifriz 24; C. D. LaRue 25-29.
19. Freshwater Phycology (Algae)
    Nichols 28-39; Prescott 40-47, 49; Patterson 50; G. M. Smith 51, 53, 54; Wagner 52; Blum 55; Sparrow 56-66; Paterson 67; Clemençon 68; Stoermer 69-73; Lowe 74-83.
20. Plant Tissue Culture & Experimental Morphology
    LaRue 36-42, 46, 49.
21. Tropical Economic Botany
    LaRue 42.
22. Floristic Botany
    LaRue 43; Prescott 43-45; Steere 43.
23. Aquatic Flowering Platns
    Ehlers 33, 35, 37, 38; Steere 39; Prescott 40-47, 49; Sparrow 48, 50, 52, 54, 56-62; Wood 51; Wagner 53; Blum 55; Voss 63-69, 71; Haynes 73, 75, 77.
25. Lichens
    Fulford 52-54; Sharp 55-57, 59-64; Crum 58, 65-72, 74, 79, 81, 83; Vitt 71.
26. Pteriodphytes & Gymnosperms
    Wagner 52, 53.
27. Morphology & Biology of Algae
    G. M. Smith 53,54.
28. Aquatic Fungi
    Sparrow 66; Paterson 67; Thiers 68.
29. Ecology of Phytoplankton
    Stoermer 69-73; Lowe 74.

30. Boreal Flora
Voss 67-74, 76-83.
31. Population Biology of Plants
Weller 81.
32. Biology of Peatlands
Crum 83; Miller 83.
35. Energy Exchange in Biosphere
D. Gates 64.
36. Physiological Ecology
Hill 69; D. Gates 70, 83; Yocum 70, 72; Dawson 71, 73; Tracy 74, 75, 77, 79; Weber 80; Christian 81; Schloss 81; Jurik 83.
37. Systems Ecology
Patten 73, 74.
38. Ecology of Insular Habits
Simberloff 74.
39. Winter Ecology
Edgar 73-75; Gannon 73-75; Foster 76; Bricker 77.
40. General Ecology
Sexton 83.
42. Field Biology for Science Teachers
Williams 77, 78.
43. Photography for Field Biologists
Williams 79-83.
45. Investigations in Silvics
Spurr 54-57; Barnes 58; Zahner 59-65, 67-71.
46. Soil-Plant Relationships
Zahner 72.
47. Dynamic Geology
Farrand 73.
48. Pleistocene Geology
Farrand 73, 74.
49. Soils and Their Development
Farrand 74.
50. Soils and Ecosystems (Biogeochemistry)
Boyle 75-80.

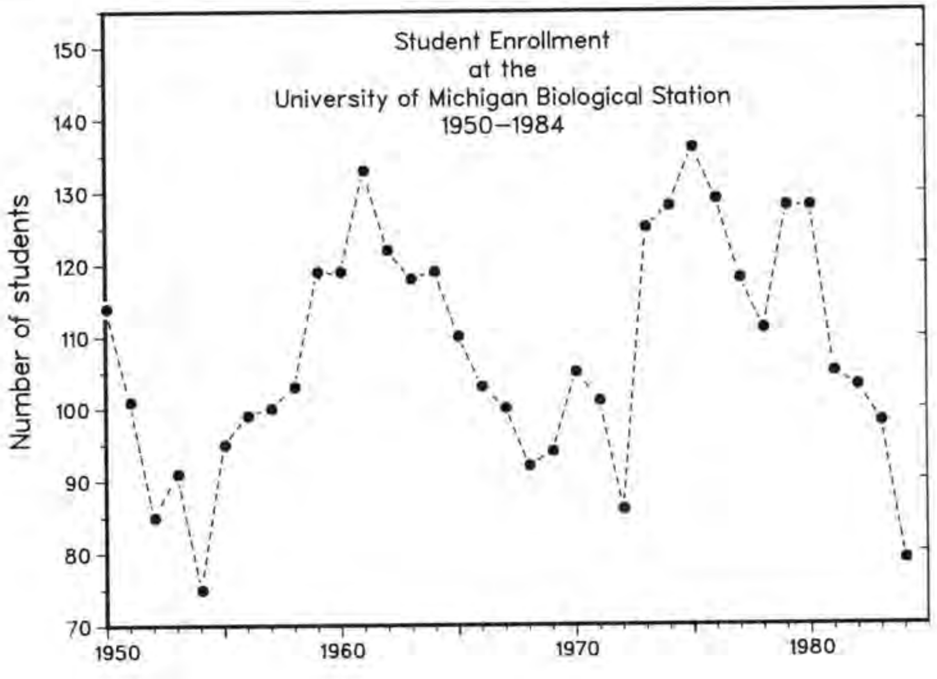
ZOOLOGY

1. Freshwater Biology
Reighard 09.
2. Natural History of Vertebrate Animals
Reighard 09, 11, 12; Stewart 10; Ellis 13-18; F. Smith 19-22; Creaser 43; Pettingill 43; Test 51-72.
3. Herpetology and Mammology
Harper 23, 24; Creaser 25-50.
4. Ecology of Terrestrial Vertebrates
Test 57-72; Sexton 75-77, 79, 81.
5. Systematic and Faunal Zoology
Reighard 11, 12; Smith 11, 12; Baker 11.
6. Zoology for Teachers
Pearse 10; Harmon 10.
7. Natural History of Invertebrates
Pearse 10; F. Smith 11-14; Hegner 15; Glaser 16; Koelz 17; Welch 18-22; Eggleton 33-63; Fennel 63; Burch 64; Edgar 65-73, 75; Covich 79.
8. Invertebrate Zoology
Welch 43; Thomas 43; Eggleton 43-45.
9. Biology of Birds
Smith 11, 12; Dexter 12; Ellis 13; Compton 13, 14; Wood 15; Strong 16, 17; Hussey 18; Stoner 19, 20; Metcalf 21; Blanchard 22-27, 29-37; Gross 28; Pettingill 38-45, 47-57, 59-74; Kendeigh 46, Tordoff 58; Southern 75-78; Ford 79, 80; Cuthbert 81-83.
10. Advanced Ornithology
Blanchard 23-27, 29-37; Gross 28; Pettingill 38-45, 47-51, 53-57, 59-70; Kendeigh 46; Emlen 52; Tordoff 58.
11. Biology of Insects
Smith 12; Welch 12, 13; Ellis 14-18; Stoner 19, 20; Metcalf 21; Matheson 22; Hungerford 23-27, 29-54; Kennedy 28; Fairchild 55, 56; Beer 57-69; Lloyd 71-73; Istock 74, 75; Barrows 77, 78; Cowan 81-83.
12. Natural History of Mollusks
Baker 11; van der Schalie 77.
13. General Zoology
Cort 15.
14. Biology of Fishes
Harper 23, 24; Creaser 25-61; Legault 62-67; Cavender 68-70; Norden 71, 72; Webb 73, 74; C. L. Smith 76, 78, 80, 82.
15. Limnology
Welch 23-50; Eggleton 31-33; Chandler 51-60; Frey 61; Saunders 62-64, 66; Main 65; Bachmann 67; Robertson 68.

69; Lind 70, 71, Gannon 72-75, 77; Kilham 76, 79; Fairchild 78, 81-83; Grossnickle 80.

16. Limnological Methods
    Eggleton 31, 32, 34, 36-38, 40, 42, 44, 46, 48; Hooper 49,51.
17. Great Lakes Limnology
    Schelske 70; Evans 79-82.
18. Oceanographic Field Methods
    Hough 70-74.
19. The Marine Environment
    Meadows 79, 80; Meyers 79, 80.
20. Helminthology
    Cort 27-45; Thomas 27-53; Beaver 58; Hendricks 58-68.
21. Biology of Parasites
    Cort 54, 55; Beaver 54-56; Hendricks 55, 66; Barrow 56, 57; DeGiusti 57; Wooton 58, 60-65, 67, 74; Lang 68-72; Blankespoor 76, 78, 80, 82.
22. Parasitological Methods
    Beaver 54, 55; Cort 54; Hendricks 55-57; Barrow 56, 57.
23. Tropical Biology
    Cort 42-44; Creaser 42-44; F. Gates 42; Hungerford 42, 43; LaRue 42-44; Steere 42, 43; Brace 42, 43; Eggleton 44; Prescott 44; Pettingill 44.
24. Medical Entomology and Human Parasitology
    Cort 43-45; Thomas 43-46; Hungerford 43-45; Otto 47.
25. Protozoology
    Otto 48-53; Barrow 58-63; Cairns 64-68.
26. Structure and Function of Freshwater Protozoan Communities
    Cairns 69, 70, 72; Yongue 75.
27. Biology (Ecology) of Stressed Ecosystems
    Cairns 73-83.
28. Zooplankton Ecology
    Gannon 76.
29. Animal Behavior
    Low 77, 79, 81, 83; Griswold 78, 80, 82.
30. Ecology of Streams and Rivers
    Berg 75, 76; White 79-83.
31. Evolutionary Ecology
    Janzen 75; Pullman 75; Carroll 75; Istock 78, 80.

APPENDIX C



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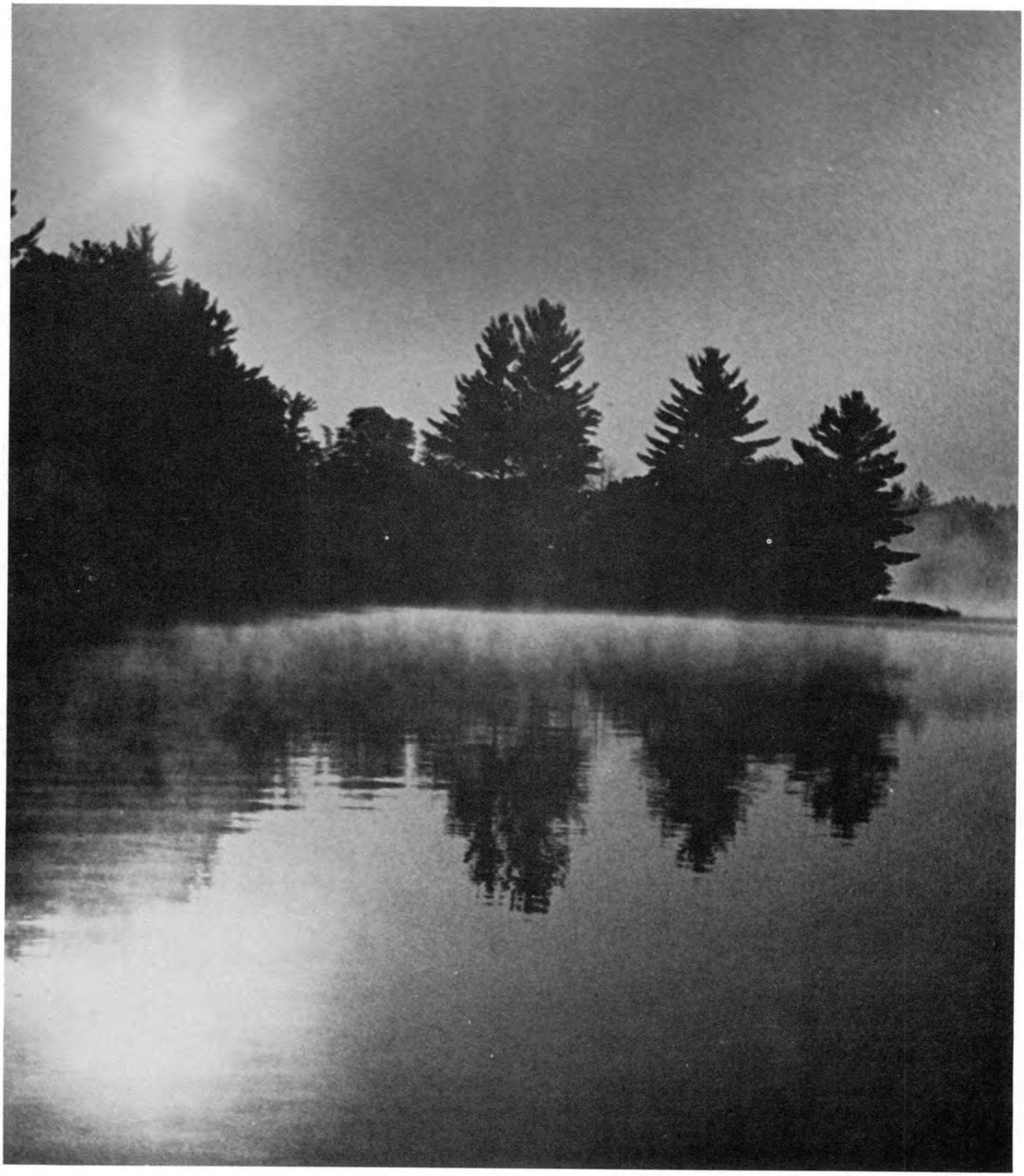

BIBLIOGRAPHY

PAPERS FROM THE BIOLOGICAL STATION OF THE UNIVERSITY OF MICHIGAN 1959 - 1983

Adams, Paul. 1980. Forest soil and site productivity considerations in intensive wood harvest systems in northern lower Michigan. Ph.D. Dissertation, University of Michigan, Ann Arbor, MI.

______. 1982. Estimating biomass in northern lower Michigan forest stands. Forest Ecol. and Mgt. 4:275-286.

Adams, Paul W. and James R. Boyle. 1979. Cation release from Michigan spodosols leached from aspen leaf extracts. Soil Sci. Soc. of Amer. J. 44:847-850.

______. 1980. Effects of fire on soil nutrients in clearcut and whole-tree harvest sites in central Michigan. Soil Sci. Soc. of Amer. J. 44:847-850.

______. 1982. The quantity and quality of nutrient cations in some Michigan spodosols. Soil Sci. Soc. of Amer. J. 133:383-389.

______. 1982. Soil fertility changes following clearcut and whole-tree harvesting and burning in central Michigan. Soil Sci. Soc. of Amer. J. 46:638-640.

Addicot, J.F. 1974. Predation and prey community structure: an experimental study of the effect of mosquito larvae on the protozoan communities of pitcher plants. Ecology 55:475-492.

Adkisson, Curtis. 1966. The nesting and behavior of Mocking Birds in northern lower Michigan. Jack-Pine Warbler 44:102-116.

Ae, Shigeru A. 1959. A study of hybrids in *Colias* (Lepidoptera, Pieridae). Evolution 13:64-88.

Ammirati, Joseph F. Jr. and Alexander H. Smith. 1972. Studies in the genus *Cortinarius;* II: Section Dermocybe, new and interesting species from Michigan. Mich. Bot. 11:13-25.

Anderson, Marlowe G. 1962. *Proterometra dickermani,* sp. nov. (Trematoda: Azygiidae). Trans. Amer. Micro. Soc. 81:279-280.

Anderson, M.G. and Florence M. Anderson. 1963. Life history of *Proterometra dickermani,* 1962. J. Parasitol. 49:275-280.

______. 1967. The life histories of *Proterometra albacauda* and *Proterometra septimae,* spp. n. (Trematoda: Azygiidae) and a redescription of *Proterometra catenaria* Smith, 1934. J. Parasitol. 53:31-37.

______. 1969. The establishment of *Proterometra sagittaria* Dickerman, 1946 in a new locality. J. Parasitol. 55:425.

______. 1969. Progenesis in *Proterometra sagitaria* Dickerman, 1946 (Trematoda: Azygiidae). J. Parasitol. 55:452.

Anderson, Roger C. and M.H. Beare. 1983. Breeding system and pollination ecology of *Trientalis borealis* (Primulaceae). Amer. J. Bot. 70:408-415.

Andresen, Norman A. 1976. Recent diatoms from Douglas Lake, Cheboygan County, Michigan. Ph.D. Dissertation, University of Michigan, Ann Arbor.

Andresen, N.A. and E.F. Stoermer. 1978. The diatoms of Douglas Lake: a preliminary list. The Mich. Bot. 17:49-54.

Annan, Ormsby. 1961. Observations on breeding behavior veeries in Michigan. Jack-Pine Warbler 39:62-71.

Bachmann, Marilyn D.D. 1964. Maternal behavior of the Redbacked Salamander, *Plethodon cinereus.* Ph.D. Dissertation, University of Michigan, Plubl. in microfilm. 64-12549.

Bakken, G.S. 1976. A heat transfer analysis of animals: unifying concepts and the application of metabolism chamber data to field ecology. J. Theor. Bio. 60:337-384.

______. 1976. An improved method for determining thermal conductance and equilibrium body temperature with cooling curve experiments. J. Thermal Bio. 1:169-175.

Bakken, George S. and David M. Gates. 1974a. Linearized heat transfer relations in biology. Science 83:967-977.

______. 1974b. Notes on "Heat Loss from a Newtonian Animal." J. Theor. Bio. 45:283-292.

______. 1975. Heat-transfer analysis of animals: some applications for field ecology, physiology, and evolution. *In:* D.M. Gates and R.B. Schmerl (eds.), Perspectives on Biophysical Ecology, Ecological Studies. Springer-Verlag, New York. pp. 225-290.

Bakken, Laura E. and G.S. Bakken. 1977. American Redstart feeding by artificial light. Auk 94:373-374.

Barnes, Burton V. 1959. Natural variations and clonal development of *Populus tremuloides* and *P. grandidentata* in northern lower Michigan. Ph.D. Dissertation, University of Michigan. Publ. in microfilm 59-4882. 334 pp.

______. 1961. Hybrid aspens in the lower peninsula of Michigan. Rhodora 63:755.

______. 1966. The clonal growth habit of American aspens. Ecology 47: 439-447.

______. 1969. Natural variations and delineation of clones of *Populus tremuloides* and *P. grandidentata* in northern lower Michigan. Silvea Genetica 18:130-142.

Barrow, James H. Jr. 1960. The distribution of a haplosporidian found in the liver of aquatic snails in the Great Lakes region. Papers Ohio Acad. Sci. 1:6-7.

______. 1960. Studies of *Haplosporidium* in fresh-water snails of Michigan. J. Protozool. 7: (suppl.)

______. 1961. Observations of a haplosporidian, *Haplosporidium pickfordi,* sp. nov. in freshwater snails. Trans. Amer. Micro. Soc. 80:319-329.

______. 1965. Observations on *Minchinia pickfordae* (Barrow 1961) found in snails of the Great Lakes region. Trans. Amer. Micro. Soc. 84:587-593.

Barrow, J.H., Jr. and James Hoy. 1960. Two new species of *Eimeria* from the common newt, *Notopthalmus viridescens.* J. Protozool. 7:217-221.

Barrow, J.H., Jr., N. Kelker, and H. Miller. 1968. The transmission of *Leucocytozoon simondi* to birds by *Simulium rugglesi* in northern Michigan. Amer. Midl. Nat. 79:197-204.

Barrow, J.H., Jr. and J.J. Stockton. 1960. The influences of temperature on the host-parasite relationships of several species of snakes infected with *Entamoeba invadens.* J. Protozool. 7:377-383.

Barrows, Edward M. 1978. Behavior at a nesting site and prey of *Crabro cribrellifer* (Hymenoptera: Sphecidae). Gt. Lakes Entomol. 11:175-176.

______. 1978. Male behavior in *Evagetes subanulatus* (Hymenoptera: Pompilidae). Gt. Lakes Entomol. 11:77-80.

______. 1979. Flower biology and arthropod associates of *Lilium philadelphicum.* Mich. Bot. 18:109-115.

______. 1979. Polistes wasps (Hymenoptera: Vespidae) show interference competition with other insects for Kermes scale insect (Homoptera: Kermesidae) secretions. Proc. Entomol. Soc. Wash. 81:570-575.

______. . *Cypridedium* flowers entrap adult *Thymelicus* (Leopidoptera: Hesperiidae) in northern Michigan. J. of the Lepidop.

Batac-Catalan, Z. and J. Cairns, Jr. 1977. The effects of thermal stress and sublethal concentration of chromates on the survival of *Daphnia pulex.* Kalikasan. Phil. J. Bio. 6:

Bazin, M. and G.W. Saunders. 1971. The hypolimnetic oxygen deficit as an index of eutrophication in Douglas Lake, Michigan. Michigan Acad. 3:91-106.

Beach, Neil W. 1960. A study of the planktonic rotifers of the Ocqueoc River system, Presque Isle County, Michigan. Ecol. Monogr. 30:339-357.

Beer, Robert E. 1963. Social parasitism in the *Tarsonemidae,* with description of a new species of tarsonemid mite involved. Ann. Entomol. Soc. Amer. 56:153-160.

Beeson, David R. 1982. Epiphytic diatom (Bacillariophyceae) community structure in a wetland continuum. M.S. Thesis. Bowling Green State Univ., Bowling Green, OH. 66 pp.

Beiswenger, Ronald E. 1972. Aggregative behavior of tadpoles of the American toad, *Bufo americanus* in Michigan. Ph.D. Dissertation, U. of Michigan, Ann Arbor. Publ. in microfilm.

Beiswenger, R.E. and F.H. Test. 1967. Effects of environmental temperature on movements of tadpoles of the American toad, *Bufo terrestris americanus.* Papers Mich. Acad. Sci., Arts, and Ltrs. 51:127-141.

Beitel, Joseph M. 1979. The clubmosses *Lycopodium sitchense* and *L. sabinifolium* in the upper Great Lakes region. Mich. Bot. 18:3-13.

Belanger, S.E. and S.R. Hogler. 1983. A comparison of five ageing techniques applied to walley *Stizostedion vitreum* in Burt Lake, Michigan. J. Great Lakes Res. 8:656-661.

Benninghoff, William S. 1960. Pollen spectra from bryophytic polsters, Inverness Mud lake Bog, Cheboygan County, Michigan. Papers Mich. Acad. Sci., Arts, and Ltrs. 45:41-60.

Benninghoff W.S. and K.J. Cramer. 1963. Phytosociological analysis of aspen communities on three site classes for *Populus grandidentata* in western Cheboygan County, Michigan. Vegetatio Acto Geobotanica 11:253-264.

Benninghoff, W.S. and A.I. Gebben. 1960. Phytosociological studies of some beech-maple stands in Michigan's lower peninsula. Papers Mich. Acad. Sci., Arts, and Ltrs. 45:83-91.

Bevis, Frederick B. 1960. Phytosociological study of Inverness Mud Lake Bog, Cheboygan County, Michigan. Papers Mich. Acad. Sci., Arts, and Ltrs. 45:61-75.

______. 1962. Corticolous bryophyte and lichen communities on beech (*Fagus grandifolia*) in northern Michigan. Mich. Bot. 1:37-42.

Bierman, V.J., Jr., D.M. Dolan, E.G. Stoermer, J.E. Gannon, and V.E. Smith. 1980. The development and calibration of a spatially simplified multi-class phytoplankton model for Saginaw Bay, Lake Huron. Great Lakes Basin Comm., Great Lakes Envir. Planning Study (GLEPS) Contr. No. 33. 126 pp.

Bigelow, Howard E. and Alexander H. Smith. 1969. The status of *Lepista:* a new section of *Clitocybe*. Brittonia 21:144-177.

Blanchard, F.N., M. Ruth Gilreath, and F.C. Blanchard. 1979. The Eastern Ring-neck snake (*Diadophis punctatus edwardsii*) in northern Michigan. (Reptilia, Serpentes, Colubridae). J. Herpetol. 13:377-402.

Blankespoor, Harvey D. 1980. Answers to 25 of the most frequently asked questions about swimmers' itch. Mich. Riparian 2:23.

______. 1980. Swimmers' itch in Michigan. Pamphlet 9 pp.

______. 1980. What you should know about swimmers' itch. Pamphlet 6 pp.

Bliss, Margaret. 1983. A comparative study of the two varieties of *Mimulus glabratus* (Scropulariaeae) in Michigan. M.S. Thesis. U. of Michigan, Ann Arbor, MI. 58 pp.

Blum, M.S. and A.L. Edgar. 1972. 4-Methyl-3-Heptanone: Identification and role in opilionid exocrine secretions. Insect Biochem. 1:181-188.

Blumer, Lawrence S. 1982. Parental care and reproductive ecology of the North American Catfish, *Ictalurus nebulosus*. Ph.D. Dissertation, U. of Michigan, Ann Arbor, MI.

Botkin, D.B., P.A. Jordan, A.S. Dominski, H.S. Lowendorf, and G.E. Hutchinson. 1973. Sodium dynamics in a northern ecosystem. Proc. Nati. Acad. Sci. 70:2745-2748.

Bradford, Laura S. 1970. Myxomycetes from Cheboygan and Emmet Counties, Michigan. Mich. Bot. 9:211-212.

Bricker, F.J. and J.E. Gannon. 1976. Limnological investigation of Hoop Lake — a northern Michigan bog. Michigan Acad. 9:25-42.

Bricker K.S., F.J. Bricker, and J.E. Gannon. 1976. Distribution and abundance of zooplankton in the U.S. waters of Lake St. Clair, 1973. J. Great Lakes Res. 2:256-271.

Bricker, Kathryn, J.E. Gannon, L.S. Roberts, and B.G. Torke. 1978. Observations on the ecology and distribution of free-living Ergasilidae (Copepoda, Cyclopoida). Crustaceana 35:313-317.

Briggs, N. Theodore. 1960. A comparison of *Leucocytozoon simondi* in Pekin and Muscovy ducklings. Proc. Helminthol. Soc. Wash. 27:151-156.

Bromley, Dennis D. 1967. Some observations on spreading of aquatic flowering plants in deep water of Douglas Lake, Michigan. Mich. Bot. 6:75-80.

Brooks, Travis E. and Donald J. Kowalski. 1963. A preliminary survey of the myxomycetes of Emmet and Cheboygan Counties. Papers Mich. Acad., Sci., Arts, and Ltrs. 48-131-133.

Browne, E.E. 1979. Stray food records from New York and Michigan snakes. Amer. Midl. Nat. 102:200-203.

Bundy, Dinah and C. Richard Tracy. 1977. Behavioral response of American toads (*Bufo americanus*) to stressful thermal and hydric environments. Herpetologica 33:455-458.

Cadle, Steven H. and N.E. Grossnickle. 1983. A study of a northern Michigan snowpack. Gen. Motors Res. Lab. Publ. GMR-4366, 32 pp.

Cadle, S.H., Jean Muhlbaier-Dasch, and N.E. Grossnickle. 1983. Northern Michigan snowpack — a study of acid stability and release. Gen. Motors Res. Lab. Publ. GMR-4275 ENV-149, 39 pp.

Cairns, John, Jr. 1969. The response of fresh-water protozoan communities to heat waste waters. Chesapeake Sci. 10:177-185.

______. 1969. Rate of species diversity restoration following stress in freshwater protozoan communities. U. Kansas Sci. Bull. 48:209-224.

______. 1973. Le maintien de l'equilibre dans les communatis protozoaires d'eau douce. Vth Intl. Cong. Protozool. Progress in Protozoology, Univ. de Clermont, VER-Sciences Exactes et Naturelles, 74 pp.

______. 1975. Crucial species, including man, within the biosphere. Naturwissenschaften 62:193-199.

______. 1976. The effects of substrate quality upon colonization by freshwater protozoans. Revista de Biologia 10:13-20.

______. 1978. The modification on inland waters. *In*: H.P. Brokaw (ed.) *Wildlife and America,* Council on Environmental Quality, Wash. D.C. pp. 146-162.

______. 1978. Summary, recommendations, and the future of reclaiming surface mines for fish and wildlife. *In:* D.E. Samuel, J.R. Stauffer, C.H. Hocutt, and T. Mason, Jr. (eds.) *Surface Mining and Fish/Wildlife Needs in the Eastern United States — 78/81.* Fish and Wildlife Service, Office of Biological Services, Wash. D.C. pp. 15-21.

______. 1978. Zooperiphyton as water quality indicators. (Physiological Soc. of Am. Symposium; Plankton and Periphyton as Water Quality Indicators). Trans. Amer. Micro. Soc. 99:44-49.

______. 1979. Ecological considerations in reclaiming surface mined lands. Minerals and the Environment 1(3):83-89.

______. 1980. Coping with point source discharges. Fisheries 5:5-8.

______. 1982. Predictive and reactive systems for aquatic ecosystem quality control. Scientific basis of Water-Resource Management, Geophysics Study Commission, Nat. Res. Council, Nat. Acad. Press, Washington, D.C. pp. 72-84.

______. 1982. Protozoan communities. *In*: A.T. Bull and A.R.K. Watkinson (eds.) *Microbial Interactions and Communities.* Academic Press, London pp. 47-111.

______. 1983. Regulating hazardous chemicals in aquatic environments. Environmental Affairs Law Review. In press.

______, T. Beamer, Sharon Churchill, and Jeanne Ruthven. 1971. Response of protozoans to detergent-enzymes. Hydrobio. 38:193-205.

______, H. Boatin, Jr., and W.H. Yongue, Jr. 1973. The protozoan colonization of polyurethane foam units anchored in the benthic area of Douglas Lake, Michigan. Trans. Amer. Micro. Soc. 92:648-656.

______. W.F. Calhoun, M.J. McGinniss, W. Straka. 1975. Aquatic organisms response to severe stress following acutely sublethal toxicant exposure. Water Res. Bull. 12:1233-1243.

______, M.L. Dahlberg, K.L. Dickson, Nancy Smith, and Wm. T. Waller. 1969. The relationship of fresh-water protozoan communities to the MacArthur-Wilson equilibrium model. American Nat. 103:439-454.

______ and Kenneth L. Dickson. 1970. Reduction and restoration of the number of fresh-water protozoan species following acute exposure to copper and zinc. Trans. Kansas Acad. Sci. 73:1-10.

______, K.L. Dickson, and A. Maki (eds.) 1978. Estimating the hazard of chemical substances to aquatic life. Spec. Tech. Publ. 657. Amer. Soc. for Testing and Materials. Philadelphia, PA 278 pp.

______, K.L. Dickson, and Wm. H. Yongue, Jr. 1971. The consequences of nonselective periodic removal of portions of fresh-water protozoan communities. Trans. Amer. Micro. Soc. 90:71-80.

______, Katherine M. Hart, and M.S. Henebry. 1980. The effects of a sublethal dose of copper sulfate on the colonization rate of fresh-water protozoan communities. Amer. Midl. Nat. 104:93-101.

______, and M.S. Henebry. 1892. Interactive and non-interactive microbial colonization processes. *In*: J. Cairns, Jr. (ed.) *Colonization Processes on Artificial Substrates.* Ann Arbor Sci. Publ. Inc. Ann Arbor, MI. 23-70

______, R.L. Kaesler, D.L. Kuhn, J.L. Plafkin, and W.H. Yongue, Jr. 1976. The influence of natural perturbation upon protozoan communities inhabiting artificial substrates. Trans. Amer. Micro. Soc. 95:646-653.

______, D.L. Kuhn, and J.L. Plafkin. 1979. Protozoan colonization of artificial substrates. *In*: R.L. Weitzel (ed.), *Methods and Measurements of Attached Microcommunities: A Review.* Amer. Soc. Testing and Materials. *STP* 609, Philadelphia, PA. pp. 34-57.

______, and D. Messenger. 1974. The effects of prior exposure to sublethal concentrations of toxicants upon the tolerance of snails to thermal shock. Arch. Hydrobiol. 74:441-447.

______, D. Messenger, and W.F. Calhoun, 1976. Invertebrate response to thermal shock following exposure to acutely sublethal concentrations of chemicals. Arch. Hydrobiol. 77:164-175.

______, and J.L. Plafkin. 1975. Response of protozoan communities exposed to chlorine stress. Arch. Protistenk. 117:47-53.

______, J.L. Plafkin, R.L. Kaesler, and R.L. Lowe. 1983. Early colonization patterns of diatoms and protozoans in twelve freshwater lakes. J. Protozool. 30:47-51.

______, J.L. Plafkin, W.H. Youngue, Jr., and R.L. Kaesler. 1976. Colonization of artificial substrates by protozoa: replicated samples. Arch. Prostistenk. 118:259-267.

______, and Jeanne Ruthven. 1970. Artificial microhabitate size and the number of colonizing protozoan species. Trans. Amer. Micro. Soc. 89:100-109.

Cairns, J. Jr., W.H. van der Schalie, and G.F. Westlake. 1975. The effects of lapsed time since feeding upon the toxicity of zinc to fish. Bull. Envir. Contam. & Toxicol. 13:269-274.

______, and William H. Yongue, Jr. 1965. A checklist of the protozoa of the Douglas Lake region, Michigan. Notes Natl. Acad. Nat. Sci. Phil. No. 383, 10 pp.

______, ______. 1968. The distribution of fresh-water protozoa on a relatively homogeneous substrate. Hydrobio. 31:65-72.

______, ______. 1970. An observation on protozoan communities in the bottom sediments of Lake Huron. Revista de Biologia 7:151-153.

______, ______. 1973. The effect of an influx of new species on the diversity of protozoan communities. Revista de Biologia 9:187-206.

______, ______. 1974. Protozoan colonization rates on artificial substrates suspended at different depths. Trans. Amer. Micro. Soc. 93:206-210.

______, ______. 1977. Factors affecting the number of species in freshwater protozoan communities. *In*: J. Cairns, Jr. (ed.). *Aquatic Microbial Communities,* Garland Publ. Inc., New York. pp. 257-304.

Cairns, J. Jr., W.H. Yongue Jr., and H. Boatin, Jr. 1973. Relationship between number of protozoan species and duration of habitat immersion. Revista de Biologia 9:35-42.

Cairns, J. Jr., W.H. Yongue Jr., and R.L. Kaesler. 1976. Qualitative differences in protozoan colonization of artificial substrates. Hydrobio. 51:233-238.

Cairns, J. Jr., W.H. Yongue Jr., and N. Smith. 1978. The influence of substrate quality upon colonization by freshwater protozoans. Revista de Biologia 10:1-11.

Cameron, Randall G. and David Troilo. 1982. Fly-mediated spore dispersal in *Splachnum ampullaceum* (Musci). Mich. Bot. 21:59-65.

Camin, Joseph H., W. Wayne Moss, J.H. Oliver, Jr., and G. Singer. 1967. Cloacaridae, a new family of Cheyletoid mites from the cloaca of aquatic turtles (Acari: Acariformes: Eleutherengona). J. Med. Entomol. 4:261-272.

Campbell, Ella O. 1969. *Marchantia polymorpha* in northern Michigan. Mich. Bot. 8:146-150.

______. 1970. Morphology of the fungal associations in three species of *Corallorhiza* in Michigan. Mich. Bot. 9:108-113.

______. 1971. Notes on the fungal association of two *Monotropa* species in Michigan. Mich. Bot. 10:63-67.

Carlson, Thomas J. 1979. The comparative ecology and frequencies of interspecific hybridization of Michigan woodferns. Mich. Bot. 18:47-56.

Carr, J.F., J.W. Moffett, and J.E. Gannon. 1973. Thermal characteristics of Lake Michigan, 1954-55. U.S. Bureau of Sport Fish. & Wildlife, Tech. Paper No. 69. 143 pp.

Chau, Robert. 1979. Conidial ultrastructure and taxonomic affinity of a fungal parasite of Sphagnum. Mich. Bot. 18:15-18.

Chernin, Eli. 1962. The unusual life-history of *Daubaylia potomaca* (Nematoda: Cephalobidae) in *Australorbis glabratus* and in certain other fresh-water snails. Parasitol. 52:459-481.

Chernin, E., H. Michelson, and D.L. Augustine. 1960. *Daubaylia potomaca,* a nematode parasite of *Helisoma trivolvis,* transmissible to *Australorbis glabratus.* J. Parasitol. 46:599-607.

Chopra, Narinder and A.J. Sharp. 1961. The occurrence of *Bryum coronatum* in Michigan. Bryologist 64:64-65.

Chrobak, Beverly and A.J. Sharp. 1965. A preliminary comparative study of asexual reproduction in *Dicranum flagellare* and *Dicranum montanum.* J. Hattori Bot. Lab. 28:122-128.

Clampitt, Philip T. 1970. Comparative ecology of the snails *Physa gyrina* and *Physa integra* (Basommatophora: Physidae). Malacol. 10:113-151.

______. 1970. The role of substratum and food in the distribution of the pulmonate snails of Douglas Lake. Amer. Zool. 10:325.

______. 1972. The biology of swimmer's itch. The Explorer 14:7-31.

______. 1972. Seasonal migrations and other movements in Douglas Lake pulmonate snails. Malacol. Rev. 5:11-12.

______. 1973. Substratum as a factor in the distribution of pulmonate snails in Douglas Lake, Michigan. Malacol. 12:379-399.

______. 1974. Seasonal migratory cycle and related movements of the fresh-water pulmonate snail, *Physa integra.* Amer. Midl. Nat. 92:275-300.
______. 1975. How fast is a snail's pace? Active and passive dispersal of *Physa integra* in Douglas Lake, Michigan. Malacol. Rev. 8:121.
Clemençon, Heinz. 1975. Ultrastructure of hymenial cells in two boletes. Beih. Nova Hedwigia 51:93-98.
Coffey-Flexner. Deborah. 1983. Interception and modification of acidic precipitation by Bigtooth Aspent forest canopies in northern lower Michigan. MS Thesis, School of Nat. Resources, University of Michigan. 207 pp.
Cook, David R. 1971. North American species of the genus *Hydrochoreutes* (Acarina: Pionidae). Michigan Entomol. 3:108-117.
Cort, W.W., K.L. Hussey, and D.J. Ameel. 1960. Studies on a microsporidian hyperparasite of strigeoid trematodes. I. Prevalence and effect on the parasitized larval trematode. J. Parasitol. 46:317-325.
______, ______, ______. 1960. Studies on a microsporidian hyperparasite of strigeoid trematodes. II. Experimental transmission. J. Parasitol. 46:327-336.
______, ______, ______. 1960. Seasonal fluctuations in larval trematode infections in *Stagnicola emarginata angulata* from Phragmites Flats on Douglas Lake. Proc. Helminthol. Soc. Wash. 27:11-13.
Coutlee, Ellen L. 1963. Maintenance behavior in the American Goldfinch (*Spinus tristis*). Wilson Bull. 75:342-357.
______. 1967. Agnostic behavior of the American Goldfinch. Wilson Bull. 79:89-109.
Coy, Kathleen B., Harvey D. Blankespoor, and Martin J. Ulmer. 1977. Recruitment of digenetic trematodes using caged snails. NSF (Undergraduate Research Participation) Grant #SPI-76-83612. 24 pp.
______, ______, ______. 1982. Recruitment of digenetic trematodes using caged snails. J. Parasitol. 68:496-500.
Crandall, B.J. 1969. Morphology and development of branches in the leafy *Hepaticae.* Beih. Nova Hedwigia 30: 261 pp.
Crum, Howard A. 1964. Mosses of the Douglas Lake region of Michigan. Mich. Bot. 3:3-12, 48-64.
______. 1965. Additions to the Douglas Lake bryoflora. Mich. Bot. 4:26
______. 1970. Mosses new to the flora of Michigan. Mich. Bot. 9:139-141.
______. 1972. Mosses new to the state of Michigan. Mich. Bot. 11:123-124.
______. 1972. The geographc origins of the mosses of North America's eastern deciduous forest. J. Hattori Bot. Lab. 35:269-298.
______. 1973. Mosses of the Great Lakes Forest. Contr. Univ. of Mich. Herb. 10:1-404.
______. 1975. Comments of *Sphagnum capillaceum.* Contr. Univ. of Mich. Herb. 11:89-93.
______. 1976. Mosses of the Great Lakes Forest. Revised ed. 2 + 404 pp. Univ. Herb., University of Michigan, Ann Arbor.
______. 1979. An expanded description of Sphagnum splendens. Mich. Bot. 18:69-72.
______. 1981. Taxonomic and nomenclatural notes on middle American mosses. The Bryologist 84:390-393.
______. 1983. Mosses of the Great Lakes Forest. ed. 3. 417 pp. Univ. Herb., University of Michigan, Ann Arbor.
Crum, Howard and Lewis E. Anderson. 1980. Mosses of eastern North America. 2 volumes. Columbia University Press, New York.
Crum, Howard A. and Norton G. Miller 1967. Three propaguliferous Pohlias from Michigan. The Bryologist 70:118-119.
______, ______. 1967. Bryophytes from the Upper Falls of the Tahquamenon. Mich. Bot. 6:54-57.

______, ______. 1968. Bryophytes new to Michigan. Mich. Bot. 7: 132-134.

______, ______. 1969. Bryophytes new to Michigan II. Mich. Bot. 8:28-29.

Current, W.L. and B.Z. Lang. 1975. Three new snail hosts for *Haplometrana intestinalis* Lucker 1931 (Trematoda: Plagiochiidae) from Washington state. J. Parsitol. 61:681.

Curtis, John D. and Nels R. Lersten. 1978. Heterophylly in *Populus grandidentata* (Salicaceae) with emphasis on resin glands and extrafloral nectaries. Amer. J. Bot. 65:1003-1010.

______, ______. 1980. Morphology and anatomy of resin glands in *Salix lucida* (Salicaceae). Amer. J. Bot. 67:1289-1296.

Cuthbert, Francesca J. 1981. Caspian tern colonies in the Great Lakes: responses to an unpredictable environment. Ph.D. Thesis, Univ. of Minnesota, Duluth.

Davidoff, Mary L. 1960. *Tsuga canadensis* in middle Michigan. The relationship of its ecology to its status as a natural resource. M.S. Thesis, University of Michigan, Ann Arbor.

Davidson, Marilyn and Harold Heatwole. 1960. Late summer oviposition in the salamander, *Plethodon cinereus.* Herpetologica 16:141-142.

Dawson, William R. 1975. On the physiological significance of the preferred body temperature of reptiles. Springer-Verlag, New York.

Dawson, William R., Albert F. Bennett, and Jack W. Hudson. 1976. Metabolism and thermoregulations in hatchling ring-billed gulls. The Condor 78:49-60.

DeByle, Norbert V. 1961. Tracing and evaluating functional root connections among stems within aspen clones. Ph.D. Dissertation, University of Michigan, 269 pp. Publ. in microfilm 62-2715.

______. 1964. Detection of functional intra-clonal aspen root connections by tracers and excavation. For. Sci. 10:386-398.

______. 1965. Short-tailed shrew attacks garter snake. J. Mammalogy 46:329.

Delcourt, P.A. 1973. Seiche activity: significant in late summer lake primary production? Bull. Assoc. SE Biol. 20:29.

Dickson, Kenneth L., John Cairns, Jr., Benjamin C. Gregg, David I. Messenger, James L. Plafkin, William H. van der Schalie. 1977. Effects of intermittent chlorination on aquatic organisms and communities. J. Water Poll. Contr. 35-44.

Dickson, K.L., A. Maki, and J. Cairns, Jr. (eds.) 1982. *Modeling for Estimating the Fate of Chemicals in the Aquatic Environment.* Ann Arbor Science Publ. Inc. Ann Arbor, MI. 214 pp.

Dogma, Irineo. 1969. Additions to the phycomycete flora of the Douglas Lake region. VII. Observations on some cellulosic chytridiaceous fungi. Arch. Mikrobiol. 66:203-219.

______. 1969. Additions to the phycomycete flora of the Douglas Lake region. VIII. *Chytridiomyces annulatus* sp. nov. and notes on other zoosporic fungi. Nova Hedwigia 18:349-365.

______. 1970. A developmental, morphological and taxonimic study of some monocentric Chytridiomycetes. Ph.D. Dissertation. University of Michigan, Ann Arbor. Publ. in microfilm.

Dogma, Irineo, Jr. and F.K. Sparrow. 1970. A hyperparasitic *Blyttiomyces.* Mycologia 61:1149-1158.

Dole, Jim W. 1964. Movement and spatial relations of *Rana pipiens* in spring and summer in northern Michigan. Ph.D. Dissertation, University of Michigan, Ann Arbor, 298 pp. Publ. in microfilm 64-6674.

______. 1965. Summer movements of adult leopard frogs, *Rana pipiens* Schreber in northern Michigan. Ecology 46:236-255.

______. 1965. Spatial relations in natural populations of the leopard frog, *Rana pipiens* Schreber in northern Michigan. Amer. Midl. Nat. 74:464-478.

______. 1967. The role of substrate moisture and dew in the water economy of leopard frogs, *Rana pipiens.* Copeia 1:141-149.
______. 1967. Spring movements of leopard frogs, *Rana pipiens* Schreber in northern Michigan. Amer. Midl. Nat. 78:167-181.
______. 1967. Homing and orientation in *Rana pipiens.* (Abs.) Amer. Zool. 7:199.
______. 1968. Homing in leopard frogs, *Rana pipiens.* Ecology 49:387-399.
______. 1971. Dispersal of recently metamorphosed leopard frogs, *Rana pipiens.* Copeia 2:221-228.
______. 1972. The role of olfaction and audition in the orientation of leopard frogs, *Rana pipiens.* Herpetologica 28:258-260.
______. 1972. Homing and orientation of displaced toads, *Bufo Americanus,* to their home sites. Copeia 2:151-158.
______. 1972. Evidence of celestrial orientation in newly-metamorphosed *Rana pipiens.* Herpetologica 28:273-276.
______. 1973. Celetial orientation in recently metamorphosed *Bufo americanus.* Herpetologica 29:59-62.
Donnelly, J.R. 1974. Seasonal changes in photosynthate transport within elongating shoots of *Populus grandidentata.* Can. J. Bot. 52:2547-2559.
Dronen, N.O. and B.A. Land. 1974. The life cycle of *Cephalogonimus salamandrus* sp. n. from *Ambystoma tigrinum* of eastern Washington. J. Parasitol. 60:75-79.
Duncan, T. 1973. Forty years of succession on an abandoned building site at the University of Michigan Biological Station. Mich. Bot. 12:167-177.

Ebbers, Bert C. 1983. Changes in tree composition in a northern Michigan hardwood forest since 1934. The Mich. Bot. 22:103-109.
Ebbers, Bert C. and Edward M. Barrows. 1980. Individual ants specialize on particular aphid herds (Hymenoptera: Formicidae; Homoptera: Aphididae). Proc. Entomol. Soc. Wash. 82:405-407.
Edgar, Arlan L. 1960. The biology of the order Phalangida in Michigan. Ph.D. Dissertation, University of Michigan, 251 pp. Publ. in microfilm.
______. 1962. A new phalangid (Opiliones) from Michigan, *Leiobunum lineatum,* sp. nov. Trans. Amer. Micro. Soc. 81:146-149.
______. 1963. Proprioception in phalangids. Bio. Bull. 124-262-267.
______. 1966. Phalangida of the Great Lakes region. Amer. Midl. Nat. 75:347-366.
______. 1971. Studies on the biology and ecology of Michigan Phalangida (Opiliones). U. Mich. Museum of Zool. Misc. Publ. 144. 64 pp.
______. 1980. Physiological and ecological aspects of the cosmopolitan Opilionid, *Phalangium opilio. In:* Soil biology as related to land use practices. Proc. VII Interntl. Colloqium Soil Zoll., Interntl. Soc. Soil Sci. Publ. by Off. Pesticide and Toxic Substances, EPA, Washington, D.C.
Edgar, Arlan L. and Sharon E. Smith. 1969. *Sphaerium occidentale:* water loss at varying temperatures and humidities. Trans. Amer. Micro. Soc. 88 (4): 479.
Eggleton, Frank E. 1961. Paul Smith Welch. Hydrobio. 17:259-261.
Eggleton, Frank E. and George M. Davis. 1961. Hinge-tooth reversals in populations of Ohio Sphaeriidae. Ann. Rep't. Amer. Malacol. Union.
Elston, S., D. Rymal, and W.E. Southern. 1977. Intraspecific kleptoparasitism in breeding Ring-billed Gulls. *In:* Proc. 1977 Conf. Colonial Waterbird Group. pp. 102-109.
EPA, United States Environmental Protection Agency. 1982. Zooplankton community composition in the nearshore waters of southern Lake Michigan. EPA-905/3-82 001.
Eriksen, Clyde H. 1959. A comparative study of the standing crops of the mat-edge fauna of three bog lakes. Papers Mich. Acad. Sci., Arts, and Ltrs. 44:97-110.
______. 1961. Respiration and substrate as factors influencing the distribution of the burrowing mayflies *Ephemera simulans* and *Hexagenia limbata.* Ph.D.

Dissertation, University of Michigan, Ann Arbor, 113 pp. Publ. in microfilm.
Evans, M.S. 1983. Crustacean and rotifer zooplankton of Lake Huron, 1980; factors affecting community structure with an evaluation of water quality status. University of Michigan, Great Lakes Res. Div. Spec. Report. 175 pp.

Fairchild, George W. 1980. Effects of littoral conditions on the distribution, behavior, and population dynamics of a filter feeding microcrustacean: *Sida crystallina*. Ph.D. Dissertation, University of Michigan, Ann Arbor.
______. 1981. Movement and microdistribution of *Sida crystallina* and other littoral microcrustacea. Ecology 62:1341-1352.
______. 1982. Population responses of plant-associated invertebrates to foraging by large-mouth bass fry (*Micropterus salmoides*). Hydrobio. 96:169-176.
______. 1983. Birth and death rates of a littoral filter feeding microcrustacean, *Sida crystallina* (Cladocera) in Cochran Lake, Michigan. Int. Revue ges. Hydrobio. 68:339-350.
Fairchild, G. Winfield and Daniel Sell. 1978. A water quality survey of Munro Lake, Michigan. Bio. Station Tech. Report No. 7.
Fairchild, G. Winfield, R. Stemberger, L. Epskamp, and H. Debaugh. 1977. Environmental variables affecting small scale distribution of five rotifer species in Lancaster Lake, Michigan. Int. Revue ges Hydrobio. 62:511-521.
Farmer, R.E. 1962. Some physiological aspects of root sucker initiation and early growth in *Populus tremuloides* and *P. grandidentata*. Ph.D. Dissertation, University of Michigan, Ann Arbor, 181 pp. Publ. in microfilm, 62-2729.
______. 1962. Aspen root sucker formation and apical dominance. J. For. Sci. 8:403-410.
______. 1963. Vegetative propagation of aspen by greenwood cuttings. J. For. Sci. 61:385-386.
Farrand, William R., Robert Zahner, and William S. Benninghoff. 1969. Cary-Port Huron Interstate: evidence from a buried bryophyte bed, Cheboygan County, Michigan. Geol. Soc. Amer. Spec. Paper 123 (INQUA Volume) :249-262.
Fennel, William E. 1959. The natural history of *Dorylaimus stagnalis* (Nematoda). Ph.D. Dissertation, University of Michigan, Ann Arbor.
Fenwick, Mason G. 1962. Some interesting algae from Lake Huron. Trans. Amer. Micro. Soc. 81:72-76.
______. 1982. A new green alga, *Coelastrum costatum* var. schmidlei, and a review of costate *Coelastrum* species. Mich. Bot. 21:141-143.
Filipek, Lorraine H. and R.M. Owen. 1979. Geochemical associations and grain-size partitioning of heavy metals in Lacustrine sediments. Chemical Geology 26:105-117.
Fincke, Ola M. 1982. Lifetime mating success in a natural population of the damselfly, *Enallagma hageni* (Walsh) (Odonata: Coenagrionidae). Behav. Ecol. and Sociobio. 10:293-302.
______. 1983. Lifetime mating patterns and reproductive success in the damselfly, *Enallagma hageni* (Walsh) (Odonata: Coenagrionidae). Ph.D. Dissertation, University of Iowa, Iowa City.
Foote, B.A., S.E. Neff, and C.O. Berg. 1960. Biology and immature stages of *Atrichomelina pubera* (Diptera: Sciomyzidae). Ann. Entomol. Soc. Amer. 53:192-199.
Foster, William L. 1976. *Profile of the Land: Natural Features of the Inland Water Route Region of Northern Lower Michigan.* Univ. of Michigan Bio. Station Infor. Report No. 2, 29 pp.
Foster, W.L. and James Tate, Jr. 1966. The activities and coactions of animals at the sapsucker tree. Living Bird 5:87-113.
Fuller, Douglas R., Richard S. Stemberger, and John E. Gannon. 1977. Limnetic rotifers as indicators of trophic change. J. Elisha Mitchell Sci. Soc. 93:104-113.
Futyma, Richard P. 1980. The distribution and ecology of *Phyllitis scolopendrium* in Michigan. Amer. Fern J. 70:81-87.

______. 1981. The northern limits of glacial Lake Algonquin in upper Michigan. Quaternary Res. 15:291-310.
______. 1982. Postglacial vegetation of eastern upper Michigan. Ph.D. Dissertation, University of Michigan, Ann Arbor.
Gaertner, Alwin M. and F.K. Sparrow, Jr. 1966. A preliminary study of aquatic Phycomycetes in the lakes of the Huron Mountains, Michigan. Veröff. Inst. Meeresforsch. Bremerhaven 10:93-106.
Galbreath, Janet E. 1975. Thoracic polymorphism in *Mesovelia mulsanti* (Hemiptera: Mesoveliidae). U. Kansas Sci. Bull. 50:457-482.
Gannon, John E. 1967. The sub-surface current patterns in South Fishtail Bay, Douglas Lake, Cheboygan County, Michigan. M.S. Thesis, University of Michigan, Ann Arbor.
______. 1972. Effects of eutrophication and fish predation on recent changes in zooplankton Crustacea species composition in Lake Michigan. Trans. Amer. Micro. Sco. 91:82-84.
______. 1974. The crustacean zooplankton of Green Bay, Lake Michigan. Proc. 17th Conf. Gt. Lakes Res. Interntl. Assoc. Gt. Lakes Res. 28-51.
______. 1974. The ecology of Lake Michigan zooplankton — a review with special emphasis on the Calumet area. Appendix B. *In*: R.H. Snow (ed.), *Water Pollution Investigation: Calumet area of Lake Michigan,* Vol. 2 (append.) pg. 56, EPA, Chicago.
______. 1975. Horizontal distribution of crustacean zooplankton along a cross-lake transect in Lake Michigan. J. Great Lakes Res. 1:79-91.
______. 1976. The effects of differential digestion rates of zooplankton by alewife, *Alosa pseudoharengus,* on determinations of selective feeding. Trans. Amer. Fish. Soc. 105:89-95.
______. 1979. Diagnosing water quality problems in inland lakes. *In*: Conf. on Inland Lake Eutrophication: Causes, Effects, and Remedies; May 1979. Michigan St. Univ. Dept. Nat. Res. and the Office of Water Res. and Tech. 20 pp.
______. 1979. Utilization of environmental knowledge for watershed management in northern Michigan. Environ. Management 3:113-121.
______. 1981. Zooplankton of the North American Great Lakes. Verh. Interntl. Verein. Limnol. 21:1725-1733.
Gannon, John E., F.J. Bricker, and K.S. Bricker. 1982. Zooplankton community composition in nearshore waters of southern Lake Michigan. U.S. Environmental Protection Agency Rep. No. EPA-905-3/82/001. 91 pp.
______, ______, ______. 1982. Zooplankton community composition in Green Bay, Lake Michigan. U.S. Environmental Protection Agency Rep. No. EPA 905/3/82/002. 83 pp.
Gannon, J.E., K.S. Bricker, and T.V. Ladewski, 1976. Crustacean zooplankton of the Straits of Mackinac and northern Lake Michigan. *In*: C.L. Schelske, E.F. Stoermer, J.E. Gannon, and M.S. Simmons (eds.), Biological, chemical and physical relationships in the Straits of Mackinac. pp. 133-190. U. of Michigan Gt. Lakes Res. Div. Spec. Report No. 60. 333 pp.
Gannon, J.E. and David C. Brubaker. 1969. Sub-surface circulation in South Fishtail Bay, Douglas Lake, Cheboygan County, Michigan. Michigan Acad. 2:19-36.
Gannon, J.E. and A.L. Edgar. 1981. Freshwater winter ecology. J. Marine Educ. 2:10-13.
Gannon, John E. and G. Winfield Fairchild. 1983. Melding classroom instruction with real-world problem-solving. J. Exper. Educ. 6:27-30.
Gannon, J.E. and E.J. Fee. 1970. Surface seiches and currents in Douglas Lake, Michigan. Limnol. Oceanogr. 15:281-288.
Gannon, J.E. and S.A. Gannon. 1975. Observation on the narcotization of crustacean zooplankton. Crustaceana 28:220-224.

Gannon, John E. and M.E. Gold. 1981. Grass-roots water quality protection. Water Spectrum, Summer 1981:18-23.

Gannon, J.E., James M. Haynes, and Gary W. Thorburn. 1981. Melding classroom instruction and real-world problem-solving in the aquatic sciences. *In*: Proc. Sympos. on Improving Practical Skills of Fishery Students. Amer. Fish. Soc., Fish. Educ. Sec. Report 1. 47 pp.

Gannon, J.E. and R.P. Howmiller. 1973. Ecological notes on paddlefish (*Polyodon spathula*) with short rostrums. Michigan Acad. 6:217-222.

Gannon, John E., Daniel J. Mazur, and A.M. Beeton. 1978. Distribution of glacial relic crustacea in some Michigan inland lakes. Michigan Acad. 11:5-18.

Gannon, J.E., D.J. Mazur, and Arthur Gold. 1979. Limnological features of Crooked and Pickerel Lakes, Emmet County Michigan. Part I: Water Quality and Nutrient Budget. Part II: The suitability of soils for on-site wastewater disposal. Bio. Station Tech. Report No. 8.

Gannon, J.E. and M.W. Paddock. 1974. Investigations into ecological and sociological determinants of land-use decisions — a study of inland lake watersheds in northern Michigan. Bio. Station Tech. Report No. 1, 314 pp.

Gannon, John E. and Andrew Robertson. 1978. Note: Development of checklists on Great Lakes biota. J. Great Lakes Res. 4:104-105.

Gannon, J.E. and M. Secrest-Gold. 1981. Grass-roots water quality protection. Water Spectrum 13:18-23.

Gannon, John E. and Richard S. Stemberger. 1978. Zooplankton (especially crustaceans and rotifers) as indicators of water quality. Trans. Amer. Micro. Soc. 97:16-35.

Gannon, John E. and Jack E. Stockwell. 1978. Limnological investigation of Florence Lake, South Manitou Island, Michigan. Bio. Station Tech. Report No. 5.

Garrett, P.W. and R. Zahner. 1964. Clonal variation in suckering of aspen obscures effect of various clearcutting treatments. J. For. 62:749-751.

Gates, David M. 1966. Transpiration and energy exchange. Quart. Rev. Bio. 41:353-364.

______. 1976. Energy exchange and transpiration. *In*: O.L. Lange, L. Kappen, and E.D. Schulze (eds.), *Ecological Studies 19, Water and Plant Life.* Springer-Verlag, New York. pp. 136-147.

______. 1978. Carbon dioxide and climate. Uniterra. Vol. 3. United Nations Environment Programme, Nairobi, Kenya.

______. 1978. Atmospheric carbon dioxide increase and climate change. European Sci. Notes 32:288-289.

______. 1980. *Biophysical Ecology*. Springer-Verlag, New York.

______. 1982. Plants and environment. *In*: J. Grace, E.D. Ford, and P.G. Jarvis (eds.) Book Review: Plants and Their Atmospheric Environments. Ecology 63:1612-1613.

Gates, D.M. 1983. Plants gas up. Natural History 92:4-8.

Gates, D.M., C.H.D. Clarke, and J.T. Harris. 1983. Wildlife in a Changing environment. *In*: Flader, S.L. (ed.) *The Great Lakes Forest: An Environmental and Social History*. pp. 52-80. Univ. of Minnesota Press, Minneapolis.

Gates, David M. and R.J. Hanks. 1967. Plant factors affecting evapotranspiration. *In*: Irrigation of agricultural lands. Amer. Soc. Agronomy Monogr. 11:506-521.

Gates, D.M. and H. Johnson. 1979. The role of pubescence on the light climate of tree leaves. Univ. München, Meteorologisches Inst. Münchener Universitäts-Schriften 35:11-25.

Gates, D.M. and R.B. Schmerl (eds.). 1975. *Perspective of Biophysical Ecology, Ecological Studies 12*. Springer-Verlag, New York. 609 pp.

Gates, D.M., B.R. Strain, and J.A. Weber. 1982. Changing atmospheric CO_2 concentration and plant response. *In*: O.L. Lange (ed.), *Encyclopedia of Plant*

Physiology. New Series, Vol. 12b Physiological Ecology.
Gatten, Robert E. Jr. 1980. Aerial and aquatic oxygen uptake by freely-diving snapping turtles (*Chelydra serpentina*). Oecologia (Berl.) 46:266-271.
Giesy, J.P. and A.L. Edgar. 1970. Effects of automatic exhaust on litter invertebrates. Michigan Acad. 3(2):27-31.
Gilbert, Elizabeth F. 1966. Structure and development of sumac clones. Amer. Midl. Nat. 75:432-445.
Gilliam, M.S. 1975. Periodicity of spore release in *Marasmius rotula*. Mich. Bot. 14:83-90.
Gladstone, Sarah. 1980. Investigations on seed dispersal in the Naked Miterwort, *Mitella nuda*. Mich. Bot. 19:15-21.
Gold, Arthur. 1978. Environmental features of Walloon Lake and its watershed, Emmet and Charlevoix Counties, Michigan. Univ. of Michigan Bio. Station Tech. Report No. 6 — Project CLEAR Staff.
Gold, Arthur. 1979. Douglas Lake profile. Univ. of Michigan Bio. Station Lake Profiles No. 4
Goodell, Stephen G., Craig A. Wheeler, and Arlan L. Edgar. 1971. Some effects of automobile exhaust on litter invertebrates. Michigan Acad. 4:267-277.
Graham, William L. 1969. The occurrence of the lichen complex, *Cetraria ciliaris,* in the Straits region of Michigan. Mich. Bot. 8:67-71.
Grossnickle, Nevin E. 1982. Feeding habits of *Mysis relicta* — an overview. Hydrobio. 93:101-107.
Guth, Daniel J., Harvey D. Blankespoor, and John Cairns, Jr. 1977. Potentiation of toxic stress caused by parasitic infection of snails. Hydrobio. 55:225-229.
Guth, Brian D., Harvey D. Blankespoor, Ronald L. Reimink, and Wilbur C. Johnson. 1979. Prevalence of dermatitis-producing schistosomes in natural bird populations of lower Michigan. The Helminthol. Soc. of Washington 46:58-63.
Guire, Kenneth E. and Edward G. Voss. 1963. Distributions of distinctive shoreline plants in the Great Lakes region. Mich. Bot. 2:99-114.
Haard, Karen K. 1968. Taxonomic studies on the genus *Arthrobotrys* Corda. Mycologia 60:1140-1159.
Haard, R.T. and C.L. Kramer. 1971 ("1970"). Periodicity of spore discharge in the Hymenomycetes. Mycologia 62:1145-1169.
Haas, T.R. and A. Clawson, 1972. Vertical distribution of the lichen genus *Physcia* on Bigtooth Aspen, Northern Red Oak, and Red Maple at Douglas Lake, Michigan. Mich. Bot. 11:39-42.
Hannah, P.R. 1969. Stemwood production related to soils in red pine plantations in Michigan. For. Sci. 15:280-285.
Hannah, P.R. and Robert Zahner. 1969. Non-pedogenetic texture bands in outwash sands of Michigan: their origin and influence on tree growth. Soil Sci. Soc. Amer. Proc. 33:598-601.
Harris, R.C. 1973. The corticolous pyrenolichens of the Great Lakes region. Mich. Bot. 12:3-68.
______. 1975. Lichens of the Mackinac Straits region. I. The *Cladonia cariosa* group. Mich. Bot. 14:44-48.
Harris, Richard C. and William R. Buck. 1978. Lichens of the Mackinac Straits region. II. *Candelariella* Müll. Arg. Mich. Bot. 17:155-161.
Harrison, Kenneth A. 1968. Studies on Hydnums of Michigan I. Genera *Phellodon, Bankera, Hydnellum.* Mich. Bot. 7:212-264.
Hart, K.M. and J. Cairns, Jr. The maintenance of structural integrity in freshwater protozoan communities under stress. Hydrobio.
Hartshorne, Charles. 1973. Born to sing: an interpretation and world survey of bird song. University of Indiana Press, Bloomington.
Haynes, R.R. 1975 ("1974"). A revision of North American *Potamogeton* subsection *Pusilli* (Potamogetonaceae). Rhodora 76:564-649.

Haynes, Robert R. and C. Barre Hellquist. 1978. The distribution of the aquatic vascular flora of Douglas Lake, Cheboygan County, Michigan. Mich. Bot. 17:183-191.

Haynes, R.R. and W.A. Wentz. 1974. Notes on the genus *Najas* (Najadaceae). Sida 4:259-264.

______, ______. 1975. Family 3A. Potamogetonaceae. *In*: R.E. Woodson and R.W. Schery (eds.), *Flora of Panama*. Ann. Mo. Bot. Garden 62:1-10.

Haynes, R.R. and D.C. Williams. 1975. Evidence for the hybrid origin of *Potamogenton longiligulatus* (Potamogetonaceae). Mich. Bot. 14:94-100.

Heard, William H. 1961. Biology of Great Lakes sphaeriid faunas. Great Lakes Res. Div. Publ. No. 7:159 (abst.)

______. 1961. *Pisidium henslowanum* (Sheppard) in Lake Michigan. Nautilus 74:123.

______. 1962. The Sphaeriidae (Mollusca: Pelecypoda) of the North American Great Lakes. Amer. Midl. Nat. 67:194-198.

Heard, William H. and J.B. Burch. 1966. Key to the genera of freshwater pelecypods (mussels and clams) of Michigan. Univ. of Michigan, Museum of Zool. Circ. No. 4.

Heatwole, Harold. 1959. The forest floor and its utilization by selected species of terrestrial amphibians. Ph.D. Dissertation, University of Michigan, 407 pp. Publ. in microfilm 60-2537.

______. 1960. Burrowing ability and behavioral responses to desiccation of the salamander, *Plethodon cinereus*. Ecology 41:661-668.

______. 1961. Rates of desiccation and rehydration of eggs in a terrestrial salamander, *Plethodon cinereus*. Copeia 75:110-112.

______. 1961. Inhibition of digital regeneration in salamanders and its use in marking individuals for field studies. Ecology 42: 593-594.

______. 1961. Analysis of the forest floor habitat with a structural classification of the litter or L layer. Ecol. Monogr. 31:267-283.

______. 1962. Environmental factors influencing local distribution and activity of the salamander, *Plethodon cinereus*. Ecology 43:460-472.

______. 1965. Ecology of three sympatric species of parasitic insects of the genus *Megarhyssa* (Hymenoptera: Ichneumonidae). Ecology 46: 140-149.

______. 1966. Moisture exchange between the atmosphere and some lichens of the genue *Cladonia*. Mycologia 58:148-156.

Heatwole, Harold, Donald M. Davis, and Adrian M.W. Wenner. 1963. The behavior of *Megarhyssa*, a genus of parasitic hymenopterans (Ichneumonidae: Ephialtinae). Zeitschrift fur Tierpsychologie 19:652-664.

______, ______, ______. 1964. Detection of maters and hosts by parasitic insects of the genus *Megarhyssa* (Hymenoptera: Ichneumonidae). Amer. Midl. Nat. 71:374-381.

Heatwole, Harold and Katherine Lim. 1961. Relation of substrate moisture to absorption and loss of water by the salamander, *Plethodon cinereus*. Ecology 42:814-819.

Heatwole, Harold and Frederick H. Test. 1961. Cannibalism in the salamander, *Plethodon cinereus*. Herpetologica 17:143.

Hellum, A.K. 1965. Factors influencing frond size of bracken on sandy soils in northern lower Michigan. Ph.D. Dissertation, University of Michigan, Ann Arbor. 106 pp. Publ. in microfilm 65-5909.

______. 1966. The frond size of bracken fern on forested outwash sand in northern lower Michigan. Soil Sci. Soc. Amer. Proc. 30:520-524.

Helmich, Darlene E. 1963. Pollen morphology in the maples (*Acer* L.). Papers Mich. Acad. Sci., Arts, and Ltrs. 48:151-164.

Henebry, M.S. and J. Cairns, Jr. 1980. The effect of island size, distance, and epicenter maturity on colonization in freshwater protozoan communities. Amer. Midl. Nat. 104:80-92.

______, ______. 1980. The effect of source pool maturity on the process of island colonization: an experimental approach with protozoan communities. Oikos 35:107-114.

______, ______. The relationship between dystrophy and phytoplankton productivity in some northern Michigan wetland lakes. J. Protozool.

Henebry, M.S., J. Cairns, Jr., C.R. Schwintzer, and W.H. Yongue. 1981. A comparison of vascular vegetation and protozoan communities in some freshwater wetlands of northern lower Michigan. Hydrobio. 83:353-375.

______, ______, ______, ______. 1982. A study of microbial colonization in eight wetlands near Douglas Lake, Michigan. Hydrobio. 83:353-375.

Hesler, L.R. 1979. North American species of *Lactarius*. University of Michigan Press, Ann Arbor, MI 841 pp.

Hesler, L.R. and Alexander H. Smith. 1960. Studies on *Lactarius*. I. The North American species of Section *Lactarius*. Brittonia 12:119-139.

______, ______. 1961. Studies on *Lactarius* II. The Norther American species of sections *Scrobiculus, Crocei, Theiogali,* and *Vellus*. Brittonia 12:306-350.

______, ______. 1963. The North American species of *Hygrophorus*. Univ. of Tennessee Press. 450 pp.

Hinds, Harold R. 1970. Vertical distributions of lichens on aspens in Michgan. Bryologist 73:626-628.

Hogh, Gottfried. 1966. Local distribution of a fern sawfly, *Strongylogaster multicinctus* Norton (Hymenoptera: Tenthredinidae). J. Kansas Entomol. Soc. 39:347-354.

Holcombe, Jeffrey W. 1976. The bryophyte flora of *Thuja* seedbed logs in a northern White-Cedar swamp. Mich. Bot. 15:173-181.

Hollensen, Raymond H. 1964. The morphology of *Blepharostoma trichophyllum* (L.) Dumort. J. Hattori Bot. Lab. 27:159-177.

Hollensen, R.H. and Jane Taylor. 1981. A gemmiparous population of *Marchantia polymorpha* var. *aquatica* in Cheboygan County, Michigan. Mich. Bot. 20:189-191.

Homola, R.L. 1972. Section Celluloderma of the genus *Pluteus* in North America. Mycologia 64:1211-1247.

Hough, Jack L. 1962. Lake Stanley, a low stage of Lake Huron indicated by bottom sediments. Geolog. Soc. Amer. Bull. 73:613-620.

Howe, H.F. 1974. Evidence of "floaters" in the American Redstart. Jack-Pine Warbler 52:91.

______. 1974. A case of age-related territory usurpation in the American Redstart. Jack-Pine Warbler 51:91-92.

______. 1974. Age-specific difference in habitat selection by the American Redstart. Auk 91:161-162.

Howell, John H. and Paul M. Thomas. 1964. Anesthetic effect of 4-styryl-pyridine on lamprey and fishes. Trans. Amer. Fish. Soc. 93:206-208.

Hull, Christopher N. 1979. A comparative study of bird populations on a wooded expressway median. The Jack-Pine Warbler 57:184-189.

Hussey, Kathleen L. 1971. A microspordian hyperparasite of strigeoid trematodes, *Nosema strigeodieae* sp. n. J. Protozool. 18:676-679.

______. 1973. Effects of microsporidan infection on larval trematodes: infection with *Nosema strigeoideae* or *N. echinostomi*. J. Inverte. Path. 22:193-198.

Istock, Conrad. 1963. Coexistence and competition in populations of similar species of whirligig beetles (Gyrinidae). Bull. Ecol. Soc. Amer. 44:116.

______. 1966. Distribution, coexistence, and competition of whirligig beetle species. Evolution 20:211-234.

______. 1973. Population characteristics of a species ensemble of waterboatmen (Corixidae). Ecology 54:535-544.
______. 1977. Logistic interaction of natural populations of two species of waterboatmen. American Nat. 111:279-287.
Jarvis, William L. 1976. Food habits of Ring-billed Gulls breeding in the Great Lakes region. Wilson Bull. 88:621-631.
Jeanne, Robert L. 1965. A case of weasel climbing trees. J. Mammal. 46:344-345.
Johns, Robert M. 1966. Morphological and ecological study of *Physoderma dulichii.* Amer. J. Bot. 53:34-45.
Jones, P.D. and W.T. Momot. 1981. Crayfish productivity, allochthony, and basin morphometry. Can. J. of Fish. and Aqua. Sci. 38:175-183.
Jones, R.C., R. Christian, J. Cairns, Jr., and W.H. Yongue, Jr. 1976. Vertical gradients in artificial substrate-associated protozoan community structure in a stratified freshwater lake. J. Elisha Mitchell Sci. Soc. 92:1-8.
Jurik, Thomas W. and David M. Gates. 1983. *Albedo* following fire in a northern hardwood forest. J. Climate and Applied Meteorol. 22:1733-1737.

Kashkashian, D., B. Koch, B. Levenson, L.A. Schirle, and J. Zuckerman. 1980. *A Water Quality Assessment and Management Strategy for Manuka Lake.* The Northeast Michigan Council of Governments. 98 pp.
______, ______, ______, ______. 1980. *A Water Quality Assessment and Management Strategy for Heart Lake.* The Northeast Michigan Council of Governments. 58 pp.
______, ______, ______, ______. 1980. The Glennie Lakes Project: *A water quality assessment and management strategy for Hunters, North, and Vaughn Lakes.* The Northeast Michigan Council of Governments. 98 pp.
Kempinger, James. 1962. Habitate of the Cisco, *Coregonus artedii* (Lesueur) in inland lakes of Michigan. M.S. Thesis, University of Michigan.
Kenyon, Patricia E. and Arlan L. Edgar. 1971. Behavioral effects of carbon monoxide on selected forest litter invertebrates. Bios. 42:139-143.
Kilburn, Paul D. 1960. Effect of settlement on the vegetation of the University of Michigan Biological Station. Papers Mich. Acad. Sci., Arts, and Ltrs. 45:77-81.
______. 1960. Effects of logging and fire on xerophytic forests in northern Michigan. Bull. Torr. Bot. Club 87:402-405.
______. 1963. Exponential values for the species-area relation. Science 141:1276.
______. 1966. Analysis of the species-area relation. Ecology 47:831-843.
Kilham, Peter. 1982. Acid precipitation: its role in the alkalinization of a lake in Michigan. Limnol. and Oceanogr. 27:856-867.
Kingsolver, Joel G. 1979. Thermal and hydric aspects of environmental heterogeneity in the pitcher plant mosquito. Ecol. Monogr. 49:357-376.
______. 1981. The effect of environmental uncertainty on morphological design and fluid balance in *Sarracenia purpurea* L. Oecologia 48: 364-370.
Kingston, J., R. Lowe, and G. Stoermer. 1979. Morphological observations of *Amphora thumensis* (Mayer) A.C1. using light and scanning electron microscopy. Micron 10:203-204.
______, ______, ______. 1980. Attached winter floral assemblage on sand from Grand Traverse Bay, Lake Michigan. Micron 11:9-10.
______, ______, ______. 1980. The frustular morphology of *Amphora thumenis* (Mayer) A.C1. from northern Lake Michigan and consideration of its systematic position. Trans. Amer. Micro. Soc. 99:276-283.
Koch, William J. 1960. A sexual aquatic phycomycete parasitic in *Hyalotheca.* J. Elisha Mitchell Sci. Soc. 76:186.
______. 1961. Studies of the motile cells of chytrids. III. Major types. Amer. J. Bot. 48:786-788.
______. 1961. Types of fungus motile cells. ASB Bull. 8:32

Koenig, R.L. 1960. Variation in tree size and quality of bigtooth aspen clones. M.S. Thesis, University of Michigan, 69 pp.

Koerper, Greg. 1977. The aboveground biomass and annual net production of bigtooth aspen (*Populus grandidentata* Michx.) on three soil types in northern lower Michigan. M.S. Thesis. University of Michigan.

Koerper, Greg J. and Curtis J. Richardson. 1980. Biomass and net regressions for *Populus grandidentata* annual primary production on three sites in northern lower Michigan. Can. J. of Forest Res. 10:92-101.

Knutson, L.V., J.W. Stephenson, and C.O. Berg. 1970. Bi-systematic studies of *Salticella fasciata* (Meigen), a snail-killing fly (Diptera: Sciomyzidae). Trans. R. Ent. Soc. London 122:81-100.

Kormondy, Edward. 1959. The systematics of *Tetragoneuria,* based on ecological, life history, and morphological evidence (Odonata: Corduliidae). University of Michigan Museum of Zool. Publ. 107: 79 pp.

______. 1960. Territoriality and dispersal in dragon flies (Odonata). J. New York Entomol. Soc. 69:42-52.

Krause, Herbert. 1965. Nesting of a pair of Canada Warblers. The Living Bird 4:5-11.

Kuhn, D.L., J.L. Plafkin, R.L. Lowe, and J. Cairns, Jr. 1981. Qualitative characterization of environmental conditions using diatom life form strategies. Trans. Amer. Micro. Soc. 100:165-182.

Kukor, Jerome L. and M.M. Martin. 1983. Acquisition of digestive enzymes by *Siricid* woodwasps from their fungal symbiont. Science 220:1161-1163.

Lane, David M. 1977. Extent of vegetative reproduction in eleven species of Sphagnum from northern Michigan. Mich. Bot. 16:83-89.

Lang, Bruce Z. 1963. Comparison of xiphidiocercariae of *Plagiorchis muris* and *P. proximus* (Trematoda: Plagiorchiidae). J. Parasitol. 50:104.

Lang, Bruce Z. 1966. Host-parasite relationships of *Fasciola hepatica* in the white mouse: I. Response to a primary infection. J. Elisha Mitchell Sci. Soc. 82:195-203.

______. 1968. The life cycle of *Cephalogonimus americanus* Stafford, 1902 (Trematoda: Cephalogonimidae). J. Parasit. 54:945-949.

______. 1969. Modes of infection of *Rana clamitans* with *Cephalogonimus americanus* (Trematoda). J. Parasit. 55:832.

______. 1970. The effect of *Fasciola hepatica* infection in mice as determined by WBC leves, pathology, and mortality. *In*: A. MacInnes and M. Voge (eds.), *Experiments and Techniques in Parasitology*. Freeman & Co. San Francisco. pp. 104-106.

______. 1972. Host-parasite relationships of *Fasciola hepatica* in the white mouse. IV. Studies on worm transfer and the induction of acquired immunity by worms of different ages. J. Parasitol. 58:84-87.

______. 1974. *Metagonimoides oregonensis* Price 1931 from California, Washington, Oregon, and Michigan and its development in hamsters. NW Science 48:125-131.

______. 1974. Host-parasite relationships of *Fasciola hepatica* in the white mouse. V. Age of fluke responsible for the induction of acquired immunity. J. Parasitol. 60:90-92.

Lang, Bruce Z. and N.O. Dronen, Jr. 1970. Eggs and attachment site for egg capsules of *Valvata lewisi.* Nautilus 84:9-12.

Lang, Bruce Z., F. Rachford, and L.N. Gleason. 1970. Effects of *Metagonimoides oregonenis* Price, 1931 (Trematoda: Heterophyidae) and *Mosesia chordeilesia* McMullen, 1936 (Trematoda: Lecithodendriidae) on *Goniobasis proxima* (Say). J. Parasitol. 56:836-838.

Lang, Bruce Z. and H.D. Vail. 1970. *Metagonimoides oregonensis* Price, 1921

(Trematoda: Heterophyidae) from *Mustela vison* Schreber in Michigan. J. Parasitol. 56:1031-1032.
Lanigan, Patrick J. and Edward M. Barrows. 1977. Sexual behavior of *Murgantia histrionica* (Hemiptera: Pentatomidae). Psyche 84:191-197.
Lauff, G.H., E.B. Henson, J.C. Ayers, D.C. Chandler, and C.F. Powers. 1961. The bottom sediments of the Straits of Mackinac region. Gt. Lakes Res. Div. Publ. No. 6: 69 pp.
Lauritsen, Diane D. and David S. White. 1981. Comparative studies of the zoobenthos of a natural and a man-made rocky habitat on the eastern shore of Lake Michigan. Gt. Lakes Res. Div. Spec. Rep't No. 74. University of Michigan.
Lee, Peter A. 1965. Histological and biochemical analysis of the annual cycle of growth and secretion in the oviduct of *Rana pipiens*. Ph.D. Dissertation, University of Michigan, Ann Arbor, 187 pp. Publ. in microfilm 65-10986.
Legault, Romeo O. 1960. Mass and controlled production of zebra danio eggs. Trop. Fish Hobbyist 8:44-46.
______. 1962. The early embryology of teleosts with special reference to *Percina caprodes, Brachydanio rerio,* and *Osmerus mordax*. Ph.D. Dissertation, University of Michigan, Ann Arbor. 110 pp. Publ. in microfilm 62-2760.
______. 1963. Nidification chez les poissons. La Revue de l'Université d'Ottawa 33.
Lersten, Nels R. 1960. A note on the sexual condition in *Mnium spinulosum*. Bryologist 63:245-246.
______. 1961. A comparative study of generation from isolated gametophytic tissues in *Mnium*. Bryologist 64:37-47.
Lersten, N.R. and J.D. Curtis. 1977. Anatomy and distribution of secretory glands and other emergences in *Tofieldia* (Liliaceae). Ann. of Bot. 41:879-882.
______, ______. 1977. Preliminary report of outer wall helices in trichomes of certain dicots. Can. J. Bot. 55:128-132.
______, ______. 1977. Anatomy and distribution of secretory glands and other emergences in *Tofieldia* (Liliaceae). Ann. of Bot. 41:879-882.
Lind, Owen T. 1978. Interdepression differences in the hypolimnetic areal relative oxygen deficits of Douglas Lake, Michigan. Verh. Internat. Verein. Limnol. 20:2689-2696.
Lloyd, James E. 1972. Chemical communication in fireflies. Environ. Entomol. 1:265-266.
Lloyd, J.E. and A.E. Pace. 1975. Seasonality in northern field crickets. Florida Entom. 58:31-32.
Lotan, J.E. and R. Zahner. 1963. Shoot and needle responses of 20-year-old red pine to current soil moisture regimes. For. Sci. 9:497-506.
Lowe, R.L. 1975. Comparative ultrastructure of the valves of some species of *Cyclotella* (Bacillariophyceae). J. Phycol. 11:415-424.
________. 1976. Michigan near-shore phytoplankton in Lakes Superior and Huron. Michigan Dept. of Natural Res. Tech. Rept. 30 pp.
________. 1981. The distribution and frustular morphology of *Cyclotella gamma* sov. (Bacillariophyceae). Proc. Iowa Acad. Sci. 82:82-84.
Lowe, R.L., B.H. Rosen, and L.C. Kingston. 1982. A comparison of epiphytes on *Bangia atropurpurea* (Rhodophyta) and *Cladophora glomerata* (Chlorophyta) from northern Michigan. J. Great Lakes Res. 8:164-168.
Ludwig, James Pinson. 1962. A survey of the gull and tern populations of Lakes Huron, Michigan, and Superior. Jack-Pine Warbler 40:104-119.
________. 1963. Return of herring gulls to natal colony. Bird Banding 34:68-72.
________. 1965. Ring-billed Gull nesting within Caspian Tern colony. The Jack-Pine Warbler 43:
________. 1965. Biology and structure of the Caspian Tern *(Hydroprogne*

caspia) population of the Great Lakes from 1896-1964. Bird Banding 36:217-233.

________. 1966. Herring and Ring-billed Gull populations of the Great Lakes 1960-1965. Great Lakes Res. Div. Publ. No. 15:80-89.

________. 1967. Band-loss: its effect on banding data and apparent survivorship in the Ring-billed Gull population of the Great Lakes. Bird-Banding 38:309-323.

Ludwig, James P. and Carl S. Tomoff. 1966. Reproductive success and insecticide residues in Lake Michigan Herring Gulls. Jack-Pine Warbler 44:77-84.

Lushbaugh, William B. 1968. A biochemical approach to the systematics of the trematode family Azygiidae. Bios 39:161-167.

Lyon, John G. 1980. Data sources for analyses of Great Lakes wetlands. Tech. Papers Amer. Soc. of Photogrammetry ACSM-ASP Conv., St. Louis, MO, March 9-14, 1980: 512-525.

Macklin, James E. and Robert M. Owen. 1979. The geochemistry of sediments from Little Traverse Bay, Lake Michigan: influence of physical processes. Canadian J. of Earth Sci. 16:532-539.

Mahoney, R. 1973. The lichen flora on *Ulmus americana* in northern Michigan. Mich. Bot. 12:163-166.

Maki, Alan W., K.L. Dickson, J. Cairns, Jr. 1980. Biotransformation and fate of chemicals in the aquatic environment. Amer. Soc. for Microbio. Washington, D.C. 150 pp.

Marquis, Robert J. and Edward G. Voss. 1981. Distribution of some western North American plants disjunct in the Great Lakes region. Mich. Bot. 20:53-82.

Marans, Robert W. 1976. Waterfront living: a report on permanent and seasonal residents in northern Michigan. 289 pp. U. of Michigan, Ann Arbor, Inst. for Soc. Res., Survey Res. Center, Urban Environ. Res. Program.

Marans, R.W. and J.D. Wellman. 1978. The quality of non-metropolitan living: experiences in northern Michigan. Inst. for Soc. Res. U. of Michigan, Ann Arbor 263 pp.

Marsh, Richard L. 1980. Development of temperature regulation in nestling tree swallows. Condor 82:461-463.

Marzolf, G.R. 1964. Substrate relations of *Pontoporeia affinis* (Amphipoda) in Lake Michigan. Verh. Int. Ver. Limnol. 15:864.

________. 1965. Substrate relations of the burrowing amphipod *Pontoporeia affinis* in Lake Michigan. Ecology 46:579-592.

Mazzer, Samuel J. and A.J. Sharp. 1963. Some moss reports for Michigan. Bryologist 66:68-69.

Mellichamp, Larry. 1982. Field studies on CP at UMBS. Carnivorous Plant Newsletter 11:10-12.

Merrill, Dorothy. 1969. The distribution of case recognition behavior in ten families of caddis larvae (Trichoptera). Animal Behavior 17:486-493.

Merrill, Dorothy and Glenn B. Wiggins. 1971. The larva and pupa of the caddisfly genus *Setodes* in North America (Trichoptera: Leptoceridae), Royal Ontario Museum Occas. Papers No. 19.

Messersmith, Donald H. 1963. Birds in a red pine plantation. Wilson Bull. 75:235-243.

Miller, Norton G. 1973. Lateglacial plants and plant communities in northwestern New York state. J. Arnold Arb. 54:123-159.

________. 1983. The identity of the Pleistocene mosses *Drepanocladus minnesotensis* and *Neocalliergon intergrifolium* (Amblystegiaceae). Brittonia 35:87-92.

Miller, N.G. and William S. Benninghoff. 1969. Plant fossils from a Cary-Port interstade deposit and their paleoecological interpretation. Geol. Soc. Amer. Spec. Papers 123 (INQUA Volume): 225-249.

Miller, N.G. and Howard Crum. 1966. Bryophytes new to the Douglas Lake area. Mich. Bot. 5:57-61.

Miller, N.G. and Richard L. Halbert. 1971. A collection of bryophytes from Summer Island, Delta County, Michigan. Mich. Bot. 10:3-13.

Miller, N.G. and D.H. Vitt. 1970. Additional bryophytes from sink-holes in Alpena County, Michigan, including *Orthotrichum pallens,* new to eastern North America. Mich. Bot. 9:87-94.

Miller, Orson K. 1964. The Gomphidiaceae, a monograph of the genera and species and their world distribution. Ph.D. Dissertation, University of Michigan. 136 pp. Publ. in microfilm 64-6719.

________. 1964. A monograph of *Chroogomphus* (Gomphidiaceae). Mycologia 56:526-549.

Miller, Philip C. and David M. Gates. 1967. Transpiration resistance of plants. Amer. Midl. Nat. 77:77-85.

Modlin, R.F. and J.E. Gannon. 1973. A contribution to the ecology and distribution of aquatic acari in the St. Lawrence Great Lakes. Trans. Amer. Micro. Soc. 92:217-224.

Momot, W.T. 1961. The osteology of the troutperch, *Percopsis omiscomaycus* (Walbaum). 42 pp. M.S. Thesis, University of Michigan.

Momot, W.T. and Howard Gowing. 1972. Differential seasonal migrations of the crayfish, *Orconetes virilis* (Hagen) in marl lakes. Ecology 53:479-483.

________, ________. 1977. Results of an experimental fishery on the crayfish *Orconectes virilis.* J. of Fish. Res. Board of Canada 34:2056-2066.

Monroe, James H. 1965. Electron microscopic observation of spore germination in *Funaria hygrometrica* Hedw. Ph.D. Dissertation, U. of Texas.

________. 1965. Some factors evoking formation of sex organs in *Funaria* Bryologist 68:337.

________. 1968. Light- and electron-microscopic observations on spore germination in *Funaria hygrometrica.* Botan. Gaz. 129-247-258.

Murrell, K. Darwin. 1963. *Helisoma antrosum,* first intermediate host for *Wardius zibethicus.* J. Parasitol. 49:101.

________. 1965. Stages in the life cycle of *Wardius zibethicus* Barker, 1915. J. Parasitol. 51:600-604.

Neff, S.E. and C.O. Berg. 1966. Biology and immature stages of malacophagous Diptera of the genus *Sepedon* (Sciomyzidae). Bull. Agr. Exp. Sta. VPI & SU, Blacksburg, VA 566:1-113.

Normandin, Diane K. 1960. Regeneration of *Hydra* from endoderm. Science 182:678.

Oliver, James H. 1962. A mite parasitic in the cocoons of earthworms. J. Parasitol. 48:120-123.

O'Neil, Wendy. 1977. This land and man: an historical look at the use of land and natural resources in the inland water route region of northern lower Michigan. 21 pp. University of Michigan Biological Station Infor. Rep. No. 3.

Otto, Patricia C. 1980. The effects of sewage effluent on *Acer* sp. mycorrhizae and related soil properties. M.A. Thesis, University of Michigan Sch. of Nat. Res. 65 pp.

Paterson, R.A. 1963. Observations on two species of *Rhizophydium* from northern Michigan. Trans. Brit. Mycol. Soc. 46:530-536.

________. 1966. Planktonic and benthic Physcomycetes from Lake Michigan. Ninth Conf. on Great Lakes Res. p. 19.

________. 1967. Benthic and planktonic Phycomycetes from northern Michigan. Mycologia 59:405-416.

Patterson, C.M. and J.B. Burch. 1966. The chromosome cycle in the land snail *Catinella vermeta* (Stylommatophorae Succineidae). Malacologia 3:309-325.

Patton, S.R. and W.E. Southern. 1977. The influence of fox predation on gull breeding success. *In:* Proc. 1977 Conf. Colonial Waterbird Group. pp. 91-101.

Paulson, P.C., J.R. Pratt, and J. Cairns, Jr. 1983. Relationship of alkaline stress and acute copper toxicity in the snail *Goniobasis livescens* (Menke). Bull. Env. Contam. Toxicol. 31:719-726.

Payne, Robert B. 1965. Clutch size and numbers of eggs laid by Brown-headed Cowbirds. Conder 67:44-60.

Pelz, Donald C. and J.E. Gannon. 1979. Profile: utilization of environmental knowledge for watershed management in northern Michigan. Michigan Environ. Managmt. Vol. 3:113-121.

Pelz, Donald C. and J.E. Gannon, Jr. 1980. Lakeland Reports: A communicative tool in watershed management. Tech. Writing and Commun. 10:17-24.

Pettingill, Olin Sewall, Jr. 1959. Late breeding of the American woodcock. Jack-Pine Warbler 37:160.

________. 1962. Hawk migrations around the Great Lakes. Audubon Mag. 64:44-45, 49.

________. 1963. All-day observations at a robin's nest. Living Bird 2:47-55.

________. 1970. *Ornithology in Laboratory and Field,* 4th Ed. 524 pp. Burgess Publ. Co., Minneapolis, MN.

________. 1970. Philadelphia Vireo breeding in Michigan. Jack-Pine Warbler 48:85.

________. 1971. Cape May Warbler nesting in Michigan. Jack-Pine Warbler 49:125-126.

________. 1973. Exceptional nesting sites of the Eastern Kingbird. Jack-Pine Warbler 51:124-126.

________. 1974. Ornithology at the University of Michigan Biological Station and the birds of the region. Spec. Publ. Kalamazoo Nature Center. No. 1.

________. 1976. The prey of six species of hawks in northern lower Michigan. Jack-Pine Warbler 54:70-74.

________. 1977. Observed acts of predation on birds in northern lower Michigan. The Living Bird 15:33-41.

________. 1979. My thirty-six summers in Michigan. Jack-Pine Warbler 57:127-132.

Pfister, D.H. 1973. The psilopezoid fungi. III. The genus *Psilopezia* (Pezizales). Amer. J. Bot. 60:355-365.

________. 1973. The psilopezoid fungi. IV. The genus *Pachyella* (Pezizales). Can. J. Bot. 51:2009-2023.

Phillips, Edwin A. 1976. Changes in the phytosociology of Boreal-Conifer-Hardwood forests on Mackinac Island, Michigan, 1934 to 1974. Amer. Midl. Nat. 96:317-323.

Piehl, Martin A. 1962. The parasitic behavior of *Melampyrum lineare* and a note on its seed color. Rhodora 64:757.

________. 1963. Mode of the attachment, haustorium structure and hosts of *Pedicularis canadensis.* Amer. J. Bot. 50:978-985.

________. 1964. Records of Michigan vascular plants, with primary reference to the Mackinac Straits region. Mich. Bot. 3:39-44.

________. 1965. The natural history and taxonomy of *Comandra* (Santalaceae). Mem. Torrey Bot. Club. 22:1-97.

Plafkin, J.L., D.L. Kuhn, J. Cairns, Jr., and Wm. H. Yongue, Jr. 1980.

Protozoan species accrual on artificial island in differing lentic and wetland systems. Hydrobio. 75:161-178.

Planisek, Sandra L. 1983. The breeding system, fecundity, and dispersal of *Iris lacustris*. Mich. Bot. 22:93-102.

Postupalsky, Sergej. 1969. The status of the Osprey in Michigan in 1965. J.J. Hickey (ed.), Peregrine falcon populations: their biology and decline. University of Wisconsin Press, Madison.

Powers, C.F. and J.C. Ayers. 1960. Water transport studies in the Straits of Mackinac region of Lake Huron. Limnol. Oceanog. 5:81-85.

Pratt, J.R. and J. Cairns, Jr. 1983. Export of species from sources of differing maturities. Assoc. Southeast Biol. Bull. 30:78 (abst.)

Pratt, J.R. and B.H. Rosen. 1983. Associations of species of *Vorticella* (Peritrichida) and planktonic algae. Trans. Amer. Micro. Soc. 102:48-54.

Pringle, Catherine M. 1979. The herbivorous feeding behavior of *Baetis* with special reference to the effect of midge tube building activities on the diatom flora. M.S. Thesis. University of Michigan, Ann Arbor.

Pringle, C.M., D.S. White, C.P. Rice, and M.L. Tuchman. 1981. The biological effects of chloride and sulfate with special emphasis on the Laurentian Great Lakes. University of Michigan Gt. Lakes Res. Div. Publ. 20.

Pringle, James. 1968. Status and distribution of *Gentiana linearis* and *G. rubricaulis* in the upper Great Lakes region. Mich. Bot. 7:99-112.

________. 1969. Documented plant chromosome numbers 1969:1. Sida 3:350-351.

________. 1976. Annotated chromosome counts for some plants of the dunes and pannes along the shores of the upper Great Lakes. Mich. Bot. 15:157-163.

________. 1976. *Gypsophila scorzonerifolia* (Caryophyllaceae), a naturalized species in the Great Lakes region. Mich. Bot. 15:215-219.

________. 1982. The distribution of *Solidago ohioensis*. Mich. Bot. 21:51-57.

Quigley, M.A. 1975. An investigation of the effects of sublethal ammonia exposure upon aspects of behavior in the rainbow trout *(Salmo gairdneri* Richardson). M.S. Thesis, U. of Michigan Sch. of Nat. Res. Ann Arbor.

Read, R.H. 1975. Vascular plants of Pictured Rock National Lakeshore, Algar County, Michigan. Mich. Bot. 14:3-143.

Reid, Derek A. 2963. Notes on some fungi of Michigan. I. Cyphellaceae. Persoonia 3:97-154.

Richardson, Curtis J. 1976. The chemical composition of atmospheric precipitation from selected stations in Michigan. Water, Air, and Soil Pollution 6:385-393.

________. 1978. Investigations into ecological and sociological determinants of land-use decisions. U. of Michgan Biological Station Tech. Rep. No. 4. 189 pp.

________. 1979. Ground water quality in northern Michigan ecosystems as affected by land use patterns and geologic characteristics. Agro-Ecosy. 5:231-243.

Richardson, Curtis J. and Greg J. Koerper. 1981. The influence of edaphic characteristics and clonal variation on quantity and quality of wood production in *Populus grandidentata* Michx. in the Great Lakes region of the U.S.A. *In:* W. Tranquillini (ed.), Radial Growth in Trees. IV. Fro. Conf., Innsbruck, Austria 1980. 469 pp.

Richardson, C.J. and J.A. Lund. 1975. Effects of clear-cutting on nutrient losses in aspen forests on three soil types in Michigan. *In:* F.G. Howell, J.B. Gentry, and M.H. Smith (eds.), Mineral Cycling in Southeastern Forest Ecosystems. ERDA Symposium Series (CONF-740513) pp. 673-686.

Ridgeway, B.T. 1964. Observations on the morphology and life history of *Oswald acruzia* sp. in frogs. Proc. Iowa Acad. Sci. 71:525-531.

Roberts, Mark R. 1983. Variability and mechanisms of secondary forest succession in the aspen ecosystems of northern lower Michigan. Ph.D. Dissertation, Duke University, Durham, NC. 250 pp.

Robertson, A. and J.E. Gannon. 1981. An annotated checklist of the free-living copepods of the Great Lakes. J. Great Lakes Res. 7(4):382-393.

Rockett, T.R. and C.L. Kramer. 1974. The biology of sporulation and of selected Tremellales. Mycologia 66:926-941.

Rogerson, Clark T. and Samuel J. Mazzer. 1971. Two new species of Hypomyces from Michigan. Mich. Bot. 10:107-113.

Rohrer, Joseph R. 1982. Sporophyte production and sexuality of mosses in two northern Michigan habitats. The Bryologist 85:394-400.

Romeril, A.B. 1961. Selection of genetically superior clones of bigtooth aspen in northern lower Michigan. M.S. Thesis. University of Michigan. 57 pp.

Rood, J.P. and Frederick H. Test. 1968. Ecology of the Spiny Rat, *Heteromys anomalus,* at Rancho Grande, Venezuela. Amer. Midl. Nat. 79:89-102.

Rosatti, Thomas J. 1982. Trichome variation and the ecology of *Arctostaphylos* in Michigan. Mich. Bot. 21:171-180.

Rosen, B.H., J.C. Kingston, and R.L. Lowe. 1981. Observations of differential epiphytism of *Cladophora glomerata* and *Bangia atropurpurea* from Grand Traverse Bay, Lake Michigan. Micron 12:219-220.

Rosen, B.H. and R.L. Lowe. 1981. Valve ultrastructure of some confusing Fragilariaceae. Micron 22:293-294.

________, ________. 1982. Consideration of the taxonomic position of *Entromoneis ornata* (J.W. Bial). Reim. Micron 13:57-58.

Roth, James C. 1967. Notes on *Chaoborus* species from the Douglas Lake region, Michigan, with a key to their larvae (Diptera: Chaoboridae). Papers Mich. Acad. Sci., Arts, and Ltrs. 52:63-68.

________. 1968. The pupa of *Chaoborus albatus* with a key to eastern *Chaoborus* pupae. Entomol. News 79:275-277.

Rothstein, Stephen I. 1973. Variations in the incidence of hatching failure in the Cedar Waxwing and other species. Condor 75:164-169.

________. 1973. Extreme overlap between the first and second nestings in the Rose-breasted Grosbeak. Wilson Bull. 85-242-243.

________. 1975. An experimental and teleonomic investigation of avian brood parasitism. The Condor 77:250-271.

________. 1976. Cowbird parasitism of the Cedar Waxwing and its evolutionary implications. The Auk 93:498-509.

________. 1976. Experiments on defenses Cedar Waxwings use against Cowbird parasitism. The Auk 93:675-691.

Russell, John S. 1969. A new location for *Porella pinnata* in lower Michigan. Mich. Bot. 8:104-106.

Ruthven, Jeanne A. and John Cairns, Jr. 1973. Response of freshwater protozoan communities to metals. J. Protozool. 20:127-135.

Ryan, James M. 1982. Distribution and comparative ecology of the Pygmy *(Sorex hoyi)* and Masked *(Sorex cinereus)* Shrews in northern lower Michigan. M.S. Thesis. University of Michigan, Ann Arbor.

________. 1982. Distribution and habitat of the pygmy shrew, *Sorex* (Microsorex) *hoyi* in Michigan. Jack-Pine Warbler 60:85-86.

Samuels, Gary J. 1976. A revision of the fungi formerly classified as *Nectria* subgenus *Hyphonectria.* Mem. N.Y. Bot. Garden 26:1-126.

Sanders, Christopher J. 1965. Natural regulation of the aphid *Pterocomma populifoliae* on bigtooth aspen suckers in northern Michigan. Ph.D. Dissertation, University of Michigan, 105 pp. Publ. on microfilm 66-6691.

Sanders, Christopher J. and F.B. Knight. 1968. Natural regulation of the aphid *Pterocomma populifoliae* on bigtooth aspen in northern lower Michigan. Ecology 49:234-244.

Sanger, Robert and J.E. Gannon. 1979. Vegetation succession in Smith's Bog, Cheboygan County, Michigan. Mich. Bot. 18:59-60.

Saunders, George W. 1964. Studies of primary productivity in the Great Lakes. UM Great Lake Res. Div. Publ. No. 11: 122-129.

Saunders, G.W., F.B. Trama, and R.W. Bachmann. 1962. Evaluation of a modified C^{14} technique for shipboard estimation of photosynthesis in large lakes. UM Great Lakes Res. Div. Publ. No. 8, 61 pp.

Say, W.E., M.W. Paddock, J.E. Gannon, and W.L. Foster. 1975. Inland lakes protection in northern Michigan. University of Michigan Biological Station Educ. Ser. Publ. No. 1. 40 pp.

Scheiner, Samuel M. 1983. The persistence of *Danthonia spicata* during secondary succession. Ph.D. Dissertation, U. of Chicago. 170 pp.

Scheiner, S.M. and James A. Teeri. 1981. A 53-year record of forest succession following fire in northern lower Michigan. Mich. Bot. 20:3-14.

Schelske, C.L. and R.L. Lowe. 1982. Introduction and bibliography on algal nuisances and indicators of pollution. *In:* Rosowski and Parker (eds.), *Selected Papers in Phycology II.* U. of Nebraska Press.

Schelske, C.L. and J.C. Roth. 1973. Limnological survey of Lakes Michigan, Superior, Huron, and Erie. U. of Michigan, Great Lakes Res. Div. Publ. 17. 108 pp.

Schelske, C.L., E.F. Stoermer, and L.E. Feldt. 1971. Phytoplankton, nutrients, and primary productivity in Lake Michigan as influenced by upwelling. Proc. 14th Conf. Great Lakes Res. Internatl. Assoc. Great Lakes Res.: 102-113.

Schelske, C.L. and E.F. Stoermer. 1971. Eutrophication, silica depletion, and predicted changes in algal quality in Lake Michigan. Science 173:423-424.

________, ________. 1972. Phosphorus, silica, and eutrophication of Lake Michigan: The limiting nutrient controversy. Amer. Soc. Limnol. Oceanogr. symposium, Vol. 1, Allen Press, Lawrence, KS.

Schneider, M.J. and A.J. Sharp. 1962. Observations on the reproduction and development of the gametophyte of *Tetraphis pellucida* in culture. Bryologist 64:154-166.

Schnell, Gary D. 1965. Recording the flight-speed of birds by Dopplar radar. Living Bird 4:47-87.

________. 1967. Additional notes on the birds of Wilderness State Park. Jack-Pine Warbler 45:66-67.

Schoen, Daniel J. 1977. Floral biology of *Diervilla lonicera* (Caprifoliaceae). Bull. Torrey Bot. Club 104:234-240.

Schuyler, Alfred E. 1964. A biosystematic study of the *Scirpus cyperinus* complex. Proc. Acad. Nat. Sci. Philadelphia 115:283-311.

Schwintzer, Christa R. 1978. Vegetation and nutrient status of northern Michigan fens. Canadian J. of Bot. 56:3044-3051.

________. 1978. Nutrient and water levels in a small Michigan bog with high tree mortality. The Amer. Midl. Nat. 100:441-451.

________. 1979. Vegetation changes following a water level rise and tree mortality in a Michigan bog. Mich. Bot. 18:91-98.

________. 1981. Vegetation and nutrient status of northern Michigan bogs and conifer swamps with a comparison to fens. Canadian J. of Bot. 59:842-853.

Schwintzer, C.R. and Shmuel Moreshet. 1971. Water use by bog shrubs. Missouri Bot. Garden Bull. 59:23-32.

Schwintzer, C.R. and T.J. Tomberlin. 1982. Chemical and physical characteristics of shallow ground waters in northern Michigan bogs, swamps, and fens. Amer. J. Bot. 69:1231-1239.

Schwintzer, C.R. and G.R. Williams. 1974. Vegetation changes in a small Michigan bog from 1917 to 1972. Amer. Midl. Nat. 92:447-459.

Secrest, Marion M., Stanley Pollack, and Arthur J. Gold. 1979. A water quality survey of Otsego Lake, Michigan. Biological Station Tech. Report No. 10: 72 pp.

Sexton, Owen J. and Lee Claypool. 1978. Nest sites of a northern population of an oviporous snake, *Opheodrys vernalis* (Serpentes Colubridae). J. of Nat. Hist. 12:365-370.

Sexton, O.J., J.F. Douglass, R.R. Bloye, and Andrea Pesce. 1982. Thirteen-fold change in population size of *Peromyscus leucopus*. Canadian J. of Zool. 60:2224-2225.

Sexton, Owen J., George M. Veith, and David M. Philips. 1979. Ultrastructure of the eggshell of two species of anoline lizards. J. of Exper. Zool. 207:227-236.

Shaffer, R.L. 1962. The subsection *Compactae* of *Russula*. Brittonia 14:254-284.

________. 1963. Synonyms, new combinations, and new species in *Volvariella*. Mycologia 54:563-572.

________. 1964. The subsection *Lactarioideae* of *Russula*. Mycologia 56:202-231.

________. 1968. Keys to genera of higher fungi. Ed. 2. U. of Michigan Biological Station, Ann Arbor.

________. 1970. Notes on the subsection *Crassotunicatinae* and other species of *Russula*. Lloydia 33:49-96.

________. 1970. Cuticular terminology in *Russula*. Brittonia 22:230-239.

________. 1972. North American *Russulas* of the subsection *Foetentinae*. Mycology 64:1008-1053.

________. 1975. Some common North American species of *Russula* subsection *Emeticinae*. Beih. Nova Hedwigia 51:207-237.

________. 1975. The major groups of Basidiomycetes. Mycologia 67:1-18.

Schaffer, R.L. and Margaret G. Weaver. 1965. A new species of *Crinipellis*. Mycologia 57:472-475.

Sharp, Aaron J. 1961. Bryophyta. Encyclopedia Brit. 4:303-304.

________. 1961. Liverworts. Encyclopedia Brit. 14:234a, 234b, 235.

________. 1961. Moss. Encyclopedia Brit. 15:844a, 844b, 845.

________. 1961. Review: Index Muscorum, by R. van der Wijk, W.D. Margadant, P.A. Florshütz. Nova Hedwigia 2:571-572.

________. 1962. Responsibilities and opportunities of the taxonomist today. Amer. Bio. Teacher 24:87-90.

________. 1963. Review. Index Hepaticarum by C.E.B. Bonner. Pars II 1962 and Pars III 1963. Bull. Torrey Bot. Club 90:418-419.

________. 1964. The complete botanist. Science 146:745-748.

________. 1965. Review, Index Hepaticarum, by C.E.B. Bonner. Torrey Bot. Club Bull. 92:141-142.

Sharp, Aaron J. and Beverly Chrobak. 1965. A preliminary comparative study of asexual reproduction in *Dicranum flagellare* and *D. montanum*. J. Hattori Bot. Lab. 28:122-128.

Sharp, Aaron J. and Samuel J. Mazzer. 1963. Some moss reports for Michigan. Bryol. 66:68-69.

Shepard, Robert. 1971. Some aspects of photosynthesis in the bark of bigtooth aspen, *Populus grandidentata*, and trembling aspen, *Populus tremuloides*. Ph.D. Dissertation, University of Michigan, Ann Arbor. Publ. on microfilm 71-15304.

Short, R.B. and Margaret Y. Menzel. 1960. Pachytene in three species of schistosomes. Sex and autosomal bivalents in male and female. J. Heredity 51:3-12.

________, ________. 1960. Chromosomes of nine species of schistosomes. J. Parasitol. 46:273-287.

Shugart, G.W., W.C. Scharf, and Francesca J. Cuthbert. 1978. Status and reproductive success of the Caspian Tern *(Sterna caspia)* in the U.S. Great Lakes. Proc. 1978 Colonial Waterbird Meeting, pp. 146-156.

Smith, Alexander H. 1960. *Tricholomopsis* (Agaricales) in the western hemisphere. Brittonia 12:41-70.

________. 1966. New and noteworthy higher fungi from Michigan. Mich. Bot. 5:18-25.

Smith, Alexander H. and Howard E. Bigelow. 1966. Additional species of *Clitocybe* from Michigan. Mich. Bot. 5:218-226.

________, ________. 1970. A new Clitocybe from Michigan. Mich. Bot. 9:30-33.

Smith, A.H. and L.R. Hesler. 1962. Studies on *Lactarius*. III. The North American species of section *Plinthogalus*. Brittonia 14:369-440.

________, ________. 1965. North American species of *Crepidotus*. Hafner Publ. Co. New York. 168 pp.

Smith, Alexander H. and R.L. Shaffer. 1964. Keys to genera of higher fungi. Biological Station, Ann Arbor. 120 pp.

Smith, Alexander H. and Rolf Singer. 1964. A monograph of the genus *Galerina*. Hafner Publ. Co. New York. 384 pp.

Smith, Alexander H. and Harry D. Thiers. 1964. A contribution toward a monograph of North American species of *Suillus*. Publ. privately at Ann Arbor. 116 pp.

Smith, A.H., H.D. Thiers, and R. Watling. 1966. A preliminary account of the North American species of *Leccinum*, section *Leccinum*. Mich. Bot. 5:131-179.

________, ________, ________. 1967. A preliminary account of the North American species of *Leccinum*, sections *Luteoscabra* and *Scabra*. Mich. Bot. 6:107-154.

Smith, Alexander and H.D. Thiers. 1968. Notes on boletes I. Mycologia 60:943-954.

________, ________. 1968. Notes on the genus *Suillus* (Boletaceae). Mich. Bot. 7:14-18.

Smith, Alexander H., Harry D. Thiers, and Roy Watling. 1968. Notes on species of *Leccinum* I: additions to Section *Leccinum*. Lloydia 31:252-267.

________, ________. 1971. The Boletes of Michigan. U. of Michigan Press, Ann Arbor. 428 pp.

Smith, Alexander H. and S.M. Zeller. 1964. The genus *Calvatia* in North America. Lloydia 27:148-186.

________, ________. 1966. A preliminary account of the North American species of *Rhizopogon*. Mem. N.Y. Bot. Garden. 14:1-176.

Smith, Helen V. 1961. Michigan wildflowers. Illus. by Ruth Powell Brede. Cranbrook Inst. of Sci. 465 pp.

Smith, R. Jay. 1959. Ancylid snails: first intermediate host to certain trematodes with notes on ancylids as a new host for *Megalodiscus* and *Haematoloechus*. Trans. Amer. Micro. Soc. 78:228-231.

Smith, S.G. 1969. Natural hybridization of the *Scirpus lacustris* complex in North Central United States. Current Topics in Plant Science, 175-200.

________. 1973. Ecology of the *Scirpus lacustris* complex in North America. Polskie Arch. Hydrobiol. 20:215-216.

Smrchek, Jerry C. 1970. *Cranspedacusta sowerbyi:* northern extension of range in Michigan. Trans. Amer. Micro. Soc. 89:325-327.

________. 1971. Present status of *Elliptio complanatus* in Douglas Lake, Michigan. Sterkiana No. 43: 10

________. 1972. Extension of range of the triclad turbellaria *Phagocata gracilis* (Haldeman). Trans. Amer. Micros. Soc. 91:596-599.
Snider, Jerry A. 1970. Chromosome studies on some mosses of the Douglas Lake region. Mich. Bot. 9:67-71.
________. 1970. The genus *Sphagnum* in Illinois. Trans. Ill. State Acad. Sci. 63:329-338.
________. 1972. Chromosome studies of some mosses of the Douglas Lake region. II. Mich. Bot. 11:125-128.
________. 1973. Chromosome studies of some mosses of the Douglas Lake region. III. Mich. Bot. 12:107-117.
________. 1977. Chromosome studies of some mosses of the Douglas Lake region. IV. Mich. Bot. 16:51-55.
Soper, James H. and Edward G. Voss. 1964. Black Browberry in the Lake Superior region. Mich. Bot. 3:35-38.
Soper, James H., Edward G. Voss, and Kenneth E. Guire. 1965. Distribution of *Primula mistassinica* in the Great Lakes region. Mich. Bot. 4:83-86.
Southern, William E. 1959. Foster-feeding and polygamy in the purple martin. Wilson Bull. 71:96.
________. 1959. Homing of purple martins. Wilson Bull. 71:254-261.
________. 1961. A botanical analysis of Kirtland's Warbler nests. Wilson Bull. 73:148-154.
________. 1965. Biotelemetry: Avian navigation. Bioscience 15:87-88.
________. 1965. Biotelemetry: A new technique for wildlife research. Living Bird 4:45-58.
________. 1965. Some additions to the distributional list of Michigan birds. Jack-Pine Warbler 43:43.
________. 1967. Colony selection, longevity, and Ring-billed Gull populations: preliminary discussion. Bird-banding 38:52-60.
________. 1967. Dispersal and migration of Ring-billed Gulls from a Michigan population. Jack-Pine Warbler 45:102-111.
________. 1967. Further comments on subadult Bald Eagle plumages. Jack-Pine Warbler 45:70-80.
________. 1967. The role of environmental factors in Ring-billed and Herring Gull orientation. Ph.D. Dissertation, Cornell Univ. 281 pp.
________. 1968. Age composition of a breeding Ring-billed Gull population. Inland Bird Banding News 40:166-167.
________. 1968. Dispersal patterns of subadult Herring Gulls from Rogers City, Michigan. Jack-Pine Warbler 456:1-6.
________. 1968. Further observations on foster-feeding by Purple Martins. Wilson Bull. 80:234-235.
________. 1968. Experiments on the homing ability of Purple Martins. Living Bird 7:71-84.
________. 1969. Gull orientation behavior: influence of experience, sex, age, and group releases. Jack-Pine Warbler 47:34-43.
________. 1969. Orientation behavior of Ring-billed Gull chicks and fledglings. Condor 71:418-425.
________. 1969. Sky conditions in relation to Ring-billed and Herring Gull orientation. Ill. State Acad. Sci. 62:342-349.
________. 1970. Orientation in Gulls: effect of distance, direction of release and wind. The Living Bird 9:75-95.
________. 1970. En route behavior Herring Gulls as determined by radio-tracking. Wilson Bull. 82:189-200.
________. 1970. Influence of disturbances in the earth's magnetic field on Ring-billed Gull orientation. Amer. Zool 10:23.
________. 1970. En route behavior of homing Herring Gulls as determined by radio-tracking. Wilson Bull. 82:182-200.

________. 1971. Gull orientation by magnetic cues: a hypothesis revisited. Annals NY Acad. Sci. 188:295-311.

________. 1971. Evaluation of a plastic wing-marker for gull studies. Bird-banding 42:88-91.

________. 1972. Influence of disturbances in the earth's magnetic field on Ring-bill Gull orientation. Condor 74:102-105.

________. 1976. Migrational orientation in Ring-billed Gull chicks. Auk 93:78-85.

________. 1977. Development of a gull management plan for South Manitou. *In:* Office of the Chief Scientist, Annual Report CY 1975, U.S. Dept. of Interior, Nat'l. Park Ser. pp. 408-409.

________. 1977. Colony selection and site tenacity in Ring-billed Gulls at a stable colony. Auk 94:469-478.

________. 1977. Recent developments in avian migrational orientation. *In:* Proc. Northeastern Regional Meeting, Animal Beh. Soc., Beh. of Marine Animals 13-17 Oct., St. John's Newfoundland. Marine Sci. Res. Lab. Tech. Rep. #20. pp. 102-139.

________. 1978. Orientational responses of Ring-billed Gull chicks: a re-evaluation. *In:* K. Schmidt-Koenig and W.T. Keeton (eds.), *Animal Migration, Navigation, and Homing.* Springer-Verlag, New York, pp. 311-317.

Southern, W.E., F.J. Cuthbert, and S.R. Patton. 1976. The influence of fox predation on Ring-billed and Herring Gull nesting success. *In:* Proc. First Conf. on Sci. Res. in the Nat'l Parks, 9-13 Nov., New Orleans. Nat'l. Park Ser. publ. pp. 519-524.

Southern, W.E., W.L. Jarvis, and L. Brewick. 1976. Foraging ecology of Great Lakes region Ring-billed Gulls. *In:* Proc. Fish Eating Birds of the Great Lakes and Env. Contaminants Conf. 2-3 Dec., Ottawa. Canadian Wildlife Ser. pp. 100-144.

Southern, W.E., S.R. Patton, F.J. Cuthbert, and L.K. Kinkel. 1975. Wood storks in Michigan. Jack-Pine Warbler 53:158.

Southern, W.E. and Gary D. Schnell. 1964. Herring Gulls feeding on sea lamprey. Jack-Pine Warbler 42:231.

Southern, W.E. and L.K. Southern. 1980. A summary of the incidence of cowbird parasitism in northern Michigan from 1911-1978. Jack-Pine Warbler 58:77-84.

Southern, W.E. and H.B. Tordoff. 1959. Three birds new to the straits region of Michigan. Jack-Pine Warbler 37:51-53.

Southwick, A.K. and E.E. Southwick. 1983. Aging effect on nectar production in *Asclepias syriaca.* Oecologia 56:121-125.

Southwick, Edward E. 1973. Microclimate selection by nesting hummingbirds. Amer. Zool. 13:330.

________. 1977. Aspects of an interrupted incubation by the ruby-throated hummingbird. Jack-Pine Warbler 55:59-62.

________. 1980. Flower nectar and tree sap as energetic foods for pollinators. Rochester Acad. Sci. Proc. 13:138.

________. 1980. Sapsucker trees as a factor in the distribution of hummingbirds in a northern climate. Rochester Acad. Sci. Proc. 13:96.

________. 1982. Nectar biology and pollinator attraction in the north temperate climate. *In:* M.D. Breed, C.D. Michener, and H.E. Evans (eds.) *The Biology of Social Insects,* Westview Press, Boulder, CO. pp. 19-23.

________. 1983. Nectar biology and nectar feeders of common milkweed, *Asclepias syriaca* L. Bull. Torrey Bot. Club 110:324-334.

________. 1983. Photosynthetic cost of nectar production. Rochester Acad. Sci. Proc. 14:89.

Southwick, E.E. and D.M. Gates. 1975. Energetics of occupied hummingbird nests. *In:* D.M. Gates and R.B. Schmerl (eds.), *Perspectives of Biophysical Ecology, Ecological Studies 12.* Springer-Verlag, New York, N.Y. pp. 417-430.

Southwick, E.E. and A.K. Southwick. 1980. Energetics of feeding on tree sap by ruby-throated hummingbirds in Michigan. Amer. Midl. Nat. 104:328-334.

Sparrow, F.K. 1961. Observations on chytridiaceous parasites of phanerogams. X. Notes on some species of *Physoderma* occurring in Douglas Lake region of northern Michigan. Papers Mich. Acad. Sci., Arts, Ltrs. 46:183-194.

________. 1964. Observations on chytridiaceous parasites of phanerogams. XIII. *Physoderma maculare* Wallroth. Archiv für Mikrobiologie 48:136-149.

________. 1964. Observations on chytridiaceous parasites of phanerogams. XIV. *Physoderma calami.* Amer. J. Bot. 51:958-963.

________. 1965. A preliminary note on the population of *Monoblepharis.* Trans. Brit. Mycol. Soc. 48-55-58.

________. 1966. A new bog chytrid. Archiv Mikrobiol. 53:178-180.

________. 1970. Observations on chytridiaceous parasites of phanerogams. XVIII. A *Physoderma* on *Juncus pelocarpus.* Arch. Mikrobiol. 70:72-81.

________. 1975. Observations on chytridiceous parasites of phanerogams. XXIII. Notes on *Physoderma.* Mycologia 67:552-568.

________. 1975. Observations on chytridiaceous parasites of phanerogams. XXIV. The epibiotic stage of *Physoderma.* Canadian J. Bot. 53: 1365-1370.

________. 1976. Observations on chytridiaceous parasites of phanerogams. XXV. *Physoderma johnsii* Sparrow, a parasite of *Caltha palustris* L. Amer. J. Bot. 63:602-607.

________. 1977. Observations on chytridiaceous parasites of phanerogams. XXVI. *Physoderma gerhardti* Schroeter on *Phalaris arundinacea* L. Arch. Microbio. 114:241-247.

________. 1979. Observations on chytridiaceous parasites of phanerogams, XXVIII. Physodermas on *Sium suave.* Mycologia 71:423-433.

Sparrow, F.K., J.E. Griffin, and R.M. Johns. 1961. Observations on chytridiaceous parasites on phanerogams. XI. A *Physoderma* on *Agropyron repens.* Amer. J. Bot. 48:850-858.

Sparrow, F.K. and Joyce E. Griffin. 1964. Observations on chytridiaceous parasites on phanerogams. XV. Host range and species concept studies in *Physoderma.* Archiv für Mikrobiologie 49:103-111.

Sparrow, F.K. and R.M. Johns. 1965. Observations on chytridiaceous parasites of phanerogams. XVI. Notes on *Physoderma* from *Scirpeae.* Archiv für Mikrobiologie 51:351-364.

________, ________. 1970. Observations on chytridiaceous parasites of phanerogams. XVII. Notes on a *Physoderma* parasitic on *Asclepias incarnata.* Archiv für Mikrobiologie 70:104-108.

Sparrow, F.K. and W.J. Koch. 1959. Additions to the phycomycete flora of the Douglas Lake region. IV. New records and notes for 1956-1957. Papers Mich. Acad. of Sci., Arts, and Ltrs. 44:153-161.

Sparrow, F.K. and L. Lange. 1977. Some bog chytrids. Canadian J. Bot. 55:1879-1890.

Sparrow, F.K., R.A. Paterson, and R.M. Johns. 1965. Additions to the phycomycete flora of the Douglas Lake region. V. New or interesting fungi. Papers Mich. Acad. Sci., Arts, and Ltrs. 50:115-123.

Sparrow, F.K., and M.S. Saunders. 1964. Observations on chytridiaceous parasites of phanerogams. XXII. A *Physoderma* on *Ranunculus septentrionalis* Poir. Arch. Microbiol. 100:41-50.

Spotila, James R., P. W. Lommen, G.S. Bakken, and D.M. Gates. 1973. A mathematical model for body temperatures of large reptiles: implications for dinosaur ecology. Amer. Nat. 107:391-404.

Stemberger, Richard S. 1974. Temporal and spatial distributions of planktonic rotifers in Milwaukee Harbor and adjacent Lake Michigan. Proc. 17th Great Lakes Res., Internt'l. Assoc. Great Lakes Res. 120-134.

________. 1976. *Notholca laurentiae* and *N. michiganensis,* new rotifers from the Laurentian Great Lakes region. Canadian Fish. Res. Bd. J. 33:2814-2818.

________. 1979. A guide to rotifers of the Laurentian Great Lakes. EPA Publ. 600/4-79-021.

________. 1981. A general approach to the culture of planktonic rotifers. Canadian J. Fish and Aqua. Sci. 38/721-724.

Stemberger, R.S., D.R. Fuller, and A.M. Beeton. 1979. Role of predacious rotifers in Great Lakes plankton dynamics. Final Rep. to Nat'l. Oceanic and Atmosph. Admin., Grant No. 04-7-022-44012.

Stemberger, R.S. and J.E. Gannon. 1977. Multivariate analysis of rotifer distributions in Lake Huron. *In:* Proc. 1st Internat'l. Rotifer Symp. Lunz, Austria. Ergebn. Limnol. 8:38-42.

Stemberger, R.S., J.E. Gannon, and F.J. Bricker. 1979. Spatial and seasonal structure of rotifer communities in Lake Huron. EPA Publ. 600/3-79-085.

Stockard, A.H. 1963. The University of Michigan Biological Station. Amer. Zool. 3:331-333.

Stockwell, J.E. and J.E. Gannon. 1975. Water quality studies in the Sleeping Bear Dunes Nat'l. Lakeshore region — the Lower Platte River system, Michigan. Univ. of Mich. Bio. Station Tech. Rep. No. 2. 50 pp.

________ ________. 1977. Observations on the winter ecology of Red Fox *(Vulpes fulva)* on South Manitou Island, Michigan. Univ. Mich. Bio. Station Tech. Rep. No. 3. 22 pp.

Stoermer, E.F. 1970. Distribution and relative abundance of dominant plankton diatoms in Lake Michigan. University of Michigan Great Lakes Res. Div. Publ. No. 16.

________. 1977. Post-Pleistocene diatom succession in Douglas Lake, Michigan. J. of Phycology 13:73-80.

Stoermer, E.F., C.L. Schelske, and E.E. Feldt. 1971. Phytoplankton assemblage differences at inshore versus offshore stations in Lake Michigan and their effects on nutrient enrichment experiments. Proc. 14th Conf. Great Lakes Res., Internt'l. Assoc. Great Lakes Res. 114-118.

Stoermer, E.F. and J.J. Yang. 1969. Plankton diatom assemblages in Lake Michigan. University of Michigan Great Lakes Res. Div. Spec. Rep. No. 47.

________ ________. 1972. Contributions to the diatom flora of the Laurentian Great Lakes. I. New and little-known species of *Amphora* (Bacillariophyta, Pennatibacillariophyceae). Phycologia 10:397-409.

Stoneburner, Ann. 1979. Fruiting in relation to sex ratios in colonies of *Pleurozium schreberi* in northern Michigan. Mich. Bot. 18:73-81.

Streusand, Virginia. 1982. *Tetraplodon angustatus* in Michigan. Mich. Bot. 21:103-104.

Stuckey, Ronald L. 1966. Differences in habitats and associates of the varieties of *Rorippa islandica* in the Douglas Lake region of Michigan. Mich. Bot. 5:99-108.

Sudds, Richard H., Jr. 1960. Observations of schistosome miracidial behavior in the presence of normal and abnormal snail hosts and subsequent tissue studies of these hosts. J. Elisha Mitchell Sci. Soc. 76:121-133.

Tallman, R.J. 1975. Epilimnion circulation in North Fishtail Bay, Douglas Lake, Michigan. Mich. Bot. 7:397-408.

Tate, D. Jean and J.L. Tate, Jr. 1970. Mating behavior of the Common Loon. Auk 87:125-130.

Tate, James, Jr. 1963. Tree swallow nesting in martin colony. Wilson Bull. 75:278.

________. 1969. Red-breasted Nuthatch forages on deer's back. Jack-Pine Warbler 47:32.

________. 1970. Economic aspects of foraging by the Yellow-bellied Sapsucker. Conservation Circular 8:1-3.

________. 1970. Woodpecker damage and the homeowner. Conservation Circular 8:1-3.

________. 1970. Nesting and development of the Chestnut-sided Warbler. Jack-Pine Warbler 48:57-65.

________. 1973. Methods and annual sequence of foraging by the sapsucker. Auk 90:840-856.

Tate, J. and Sergej Postupalsky. 1965. Food remains at a Bald Eagle nest. Jack-Pine Warbler 43:146-147.

Tate, J. and David K. Weaver. 1966. Nest analysis of the Tree Swallow. Jack-Pine Warbler 44:15-22.

Taylor, Jane, G.J. LeVee, Peggie J. Hollingsworth, and W.C. Bigelow. 1976. Sporopollenin and major mineral constituents of the spores, elaters, and capsule wall of *Conocephalum conicum*. Mich. Bot. 15:167-172.

Taylor, Jennifer. 1971. The habitat and orientation of capsules of *Buxbaumia aphylla* in the Douglas Lake region of Michigan. Mich. Bot. 11:70-73.

Teeri, James A. 1981. Stable carbon isotope analysis of mosses and lichens growing in xeric and moist habitats. The Bryologist 84:82-84.

Teeri, J.A. and D.A. Schoeller. 1979. ^{13}C values of an herbivore and the ratio of C_3 to C_4 plant carbon in its diet. Oecologia 39:197-200.

Tenhunen, J.D. and D.M. Gates. 1975. Light intensity and leaf temperature as determining factors in diffusion resistance. *In:* D.M. Gates and R.B. Schmerl (eds.), *Perspectives of Biophysical Ecology, Ecological Studies, 12.* Springer-Verlag, New York. pp. 213-225.

Tenhunen, J.D., J.D. Hesketh, and D.M. Gates. 1980. Leaf photoshythesis models. *In:* J.D. Hesketh and J.W. Jones (eds.), *Predicting Photosynthesis for Ecosystem Models,* Vol. 1., CRC Press, Boca Raton, FL. pp. 123-181.

Tenhunen, J.D., A. Meyer, O.L. Lange, and D.M. Gates. 1980. Development of a photosynthesis model with an emphasis on ecological applications. V. Test of the applicability of a steady-state model to description of net photosynthesis of *Prunus armeniaca* under field conditions. Oecologia 45:147-155.

Tenhunen, J.D., O.L. Lange, P.C. Harley, A. Meyer, and D.M. Gates. 1980. The diurnal time course of net photosynthesis of soybean leaves: analysis with a physiologically based steady-state photosynthesis model. Oecologia 46:314-321.

Tenhunen, J.D., J.A. Weber, C.S. Yocum, and D.M. Gates. 1976. Development of a photosynthesis model with an emphasis on ecological applications. II. Analysis of a data set describing the PM surface. Oecologia 26:101-119.

Tenhunen, J.D., J.A. Weber, L.H. Filipek, and D.M. Gates. 1977. Development of a photosynthesis model with an emphasis on ecological applications. III. Carbon dioxide and oxygen dependencies. Oecologia 30:189-207.

Tenhunen, J.D., J.A. Weber, C.S. Yocum, and D.M. Gates. 1979. Solubility of gases and the temperature dependency of whole leaf affinities for carbon dioxide and oxygen. Plant Physiology 63:916-923.

Tenhunen, J.D., C.S. Yocum, and D.M. Gates. 1976. Development of a photosynthesis model with an emphasis on ecological applications. I. Theory. Oecologia 26:89-100.

Test, Frederick H. and H. Heatwole. 1962. Nesting sites of the red-backed salamander, *Plethodon cinereus,* in Michigan. Copeia: 206-207.

Test, Frederick H. and Robert G. McCann. 1976. Foraging behavior of *Bufo americanus* tadpoles in response to high densitites of microorganisms. Copeia 3:576-578.

Thieret, John W. 1977. Life-forms in the Michigan flora. Michigan Bot. 16:27-34.

Thomas, Paul. M. 1967. The effects of industrial wastes from Charmin Paper Products Co. on fish of the Cheboygan River drainage system. Water Res. 1:117.

Thomas, Paul M. and Dennis D. Bromley. 1968. The establishment of aquatic vegetation in and around artificial fish shelters in Douglas Lake, Michigan. Amer. Midl. Nat. 80:550-554.

Thomas, Paul M., R.O. Legault, and G.F. Carpenter. 1968. Durability and efficiency of brush shelters installed in 1937 in Douglas Lake, Michigan. Wildlife Mgt. 32:515-520.

Tilchin, Michael, *et al.* 1979. Non-point pollution assessment in northern Michigan: a groundwater monitoring approach in evaluating on-site wastewater disposal systems. A report prepared for the NSF and the E. Kennedy Found. Univ. of Michigan Bio. Station Tech. Rep. No. 9.

Tordoff, Harrison B. 1966. Additions to the birds of Michigan. Jack-Pine Warbler 44:2-7.

Tordoff, H.B. and W.E. Southern. 1959. Caspian tern and black skimmer in Newfoundland. Wilson Bull. 71:385-386.

Tracy, Barbara J., C.R. Tracy, and D.S. Dobkin. 1978. Desiccation in the black dragon, *Hagenius brevistylus* Slelys. Experientia 35:751.

Tracy, C. Richard. 1976. Tyrannosaurs: evidence for endothermy. Amer. Nat. 110:1105-1106.

________. 1977. Minimum size of mammalian homeotherms: Role of the thermal environment. Science 198/1034-1035.

Tracy, C.R., B.J. Tracy, and D.S. Dobkin. 1979. The role of posturing in behavioral thermoregulation by Black Dragons *(Hagenius brevistylus* Selys: Odonata). Physiol. Zool. 52:565-571.

Trama, F.B., G.W. Saunders, and R.W. Bachmann. 1961. Photosynthesis: Chlorophyll *a* in Grand Traverse Bay with reference to its use as an index of primary productivity. (Abstr.) Great Lakes Res. Div. Publ. No. 7:173.

Ulken, Annemarie and F.K. Sparrow, Jr. 1968. Estimation of chytrid propagules in Douglas Lake by the MPN-Pollen grain method. Veroff. Inst. f. Meeresforsch., Bremerhaven 11:83-88.

Van Uden, Nicholas. 1963. Occurrence and population densities of yeast species in a fresh-water lake. A. Van Leeuwenhoek J. Microbiology and Serology 29:308-312.

Vitt, Dale H. 1968. Sex determination in mosses. Mich. Bot. 7:195-203.

________. 1973. A revision of the genus *Orthotrichum* in North America, north of Mexico. Bryophy. Bibliotheca 1:208.

________. 1973. The infrageneric evolution, phylogeny, and taxonomy of the genus *Orthotrichum* (Musci) in North America. Nova Hedwigia 21:683-711.

Vitt, D.H., H. Crum, and J.A. Snider. 1975. The vertical zonation of *Sphagnum* species in hummock-hollow complexes in northern Michigan. Mich. Bot. 14:190-200.

Vitt, D.H. and N.G. Slack. 1975. An analysis of the vegetation of *Sphagnum*-dominated kettle-hole bogs in relation to environmental gradients. Canadian J. Bot. 53:332-359.

Voss, Edward G. 1961. Burt Lake named after Michigan Baptist pioneer. Michigan Baptist 44:7.

________. 1961. Which side is up? A look at the leaves of *Oryzopsis.* Rhodora 63:285-287.

Voss, Edward G. 1963. Arthur Ward Lindsey (1894-1963). J. Lepidopterists' Soc. 17:181-190.

———. 1964. The Michigan Lily. Mich. Bot. 3:44-47.
———. 1964. Skunk-cabbage in Michigan. Mich. Bot. 3:97-101.
———. 1965. A weed orchid? Michigan Audubon Newsletter. 13:4.
———. 1965. Comparative revegetation of denuded areas in northern Michigan. Papers Mich. Acad. Sci., Arts, and Ltrs. 50:139-160.
———. 1965. On citing the names of publishing authors. Taxon 14:154-160.
———. 1965. Our lone native primrose. Michigan Audubon Newsletter. 13:4.
———. 1965. Some rare and interesting aquatic vascular plants of northern Michigan, with special reference to Cusino Lake (Schoolcraft Co.). Mich. Bot. 4:11-25.
———. 1966. Carnivora of the plant world. Michigan Audubon Newsletter. 3:4-5.
———. 1966. Nomenclatural notes on Monocots. Rhodora 68:435-463.
———. 1966. The little bellwort. Michigan Audubon Newsletter 13:3-4.
———. 1966. Two kinds of beauties. Michigan Audubon Newsletter 14:7-8.
———. 1967. A vegetative key to the genera of submersed and floating aquatic vascular plants of Michigan. Michigan Bot. 6:35-50.
———. 1967. Michigan Mistletoe. Michigan Audubon Newsletter. 15:5.
———. 1967. The status of some reports of vascular plants from Michigan. Mich. Bot. 6:13-24.
———. 1968. A preliminary report on the distribution of gymnosperms in Michigan. Mich. Bot. 7:121-128.
———. 1968. By-ways of the north shore. Michigan Audubon Newsletter. 16:4-5, 16(3):4.
———. 1968. The spring beauties *(Claytonia)* in Michigan. Mich. Bot. 7:77-93.
———. 1969. Moths of the Douglas Lake region (Emmet and Cheboygan Counties), Michigan. I. Sphingidae-Ctenuchidae (Lepidoptera). Michigan Entomol. 2:48-54.
———. 1969. Nomenclature. Encycl. Brit. 21:730A-731.
Voss, Edward G. 1970. Charles H. Swift's botanical work in Michigan. Mich. Bot. 9:38-40.
———. 1972. Additional nomenclatural and other notes on Michigan Monocots and Gymnosperms. Mich. Bot. 11:26-37.
———. 1972. Michigan flora. Part I, Gymnosperms and Monocots. Cranbrook Inst. Sci. Bull. 55.
———. 1972. The state of things: contributions of the plant taxonomist in Michigan. Michigan Acad. 5:1-7.
———. 1973. Wild plants in flower. II: the boreal forest and borders. Notes on the species and their distributions. T. Korling, Dundee, IL. 72 pp.
———. 1977. Additions and corrections to the list of vascular plants from the Douglas Lake region, Michigan. Mich. Bot. 16:126-141.
———. 1978. Botanical beachcombers and explorers: pioneers of the 19th century in the Upper Great Lakes. Univ. of Michigan Herb. Contribution No. 13. 100 pp.
———. 1981. Moths of the Douglas Lake region (Emmet and Cheboygan Counties), Michigan: II. Noctuidae (Lepidoptera). Gt. Lakes Entomol. 14:87-101.
Voss, Edward G. and Mark W. Bohlke. 1978. The status of certain hawkweeds *(Hieracium* subgenus *pilosella)* in Michigan. Mich. Bot. 17:35-47.
Voss, E.G. and Garrett E. Crow. 1976. Across Michigan by covered wagon: A botanical expedition in 1888. Mich. Bot. 15:3-70.
Voss, E.G. and R.E. Riefner, Jr. 1983. A pyralid moth (Lepidoptera) as pollinator of blunt-leaf orchid. Gt. Lakes Entomol. 16:57-60.
Wagner, W.H., E.G. Voss, J.H. Beaman, E.A. Bourdo, F.W. Case, J.A.

Churchill, and P.W. Thompson. 1977. Endangered, threatened, and rare vascular plants in Michigan. Mich. Bot. 16:99-110.

Waldbauer, G.P. 1983. Flower associations of *Mimetic syrphidae* (Diptera) in northern Michigan. Gt. lakes Entomol. 16:79-85.

Walter, K.S. 1975. A preliminary study of the achene epidermis of certain *Carex* (Cyperaceae) using scanning electron microscopy. Mich. Bot. 14:67-72.

Weaver, M.G. and R.L. Shaffer. 1969. Records of higher fungi of Minnesota. J. Minnesota Acad. Sci. 35:123-128.

Weber, James A. 1972. The importance of turions in the propogation of *Myriophyllum exalbescens* (Haloragidaceae) in Douglas Lake, Michigan. Mich. Bot. 11:115-121.

Weber, J.A., J.D. Tenhunen, C.S. Yocum, and D.M. Gates. 1979. Variation of photosynthesis in *Elodea densa* with pH and/or high CO_2 concentration. Photosynthetica 13:454-458.

Weber, J.A., J.D. Tenhunen, S.S. Westrin, C.S. Yocum, and D.M. Gates. 1981. An analytical model of photosynthetic response of aquatic plants to inorganic carbon and pH. Ecology 62:697-705.

Weber, Nancy Smith. 1972. The Genus *Helvella* in Michigan. Mich. Bot. 11:147-201.

Weis, Arthur E. 1982. Apical dominance asserted over lateral buds by the gall of *Rhabdophaga strobiloides.* Canadian Entomol.

Welch, William R. and C. Richard Tracy. 1977. Respiratory water loss: a predictive model. J. Theor. Bio. 65:253-265.

Weller, Stephen G. 1970. A preliminary report on the varities of *Maianthemum canadense* in northern Michigan. Mich. Bot. 9:49-52.

Wellman, J.D. 1979. Recreational response to privacy stress: a validation study. J. Leisure Res. 11:61-73.

Wellman, J.D. and R.W. Marans. 1982. The value of time budgets in research and planning for recreation populations. J. Env. Systems 11:325-339.

________ ________. 1983. Social conflict associated with turn-around migration: evidence from northern Michigan. J. Commun. Develop. Soc. 14:1-15.

Wells, James R. 1978. Tree populations of a mature aspen forest in Cheboygan County, Michigan. Mich. Bot. 17:73-79.

Wetherbee, Richard. 1969. Population studies in the chemical species of the *Cladonia chlorophaea* group. Mich. Bot. 8:170-174.

Wetzel, R.G. 1960. Marl encrustation on hydrophytes in several Michigan lakes. Oikos 2:223-236.

White, David S. 1979. Utilization of study streams. Contribution No. 252, Great Lakes Res. Div., U. of Michigan, Ann Arbor.

Williams, Gary R. 1970. Investigations in the white waterlilies (Nymphaea) of Michigan. Mich. Bot. 9:72-86.

Williams, Gary and Jerry Nyckel. 1982. Taking photographs up close. The Sci. Teacher 49:22-25.

Williams, R.W. 1960. Quantitative studies on populations of biting midge larvae in saturated soil from two types of Michigan bogs (Diptera: Ceratopogonidae). J. Parasitol. 46:565-566.

________. 1960. A new and simple method for the isolation of fresh-water samples. Ecology 41:573-574.

Wilson, David S. 1978. Prudent predation: a field study involving three species of tiger beetles. Oikos 31:128-136.

________. 1982. Genetic polymorphism for carrier preference in a phoretic mite. Ann. Ent. Soc. Amer. 75:293-296.

________. 1983. The effect of population structure on the evolution of mutualism: a field test involving burying beetles and their phoretic mites. American Nat. 121:851-870.

Wolf, Larry. 1962. Some interesting Michigan bird records. Jack-Pine Warbler 40(2):56.

Wootton, Donald M. and K. Darwin Murrell. 1967. *Ptyalincola ondatrae,* gen. et sp. n. (Trematoda: Brachylaimidae), a fluke inhabiting the salivary glands of muskrats. J. Parasitol. 53:739-742.

Wunder, B.A. 1979. Evaporative water loss from birds: effects of artificial radiation. Comp. Biochem. Physiol. 63A:493-494.

Yongue, William H., Jr. 1964. A condition in blood cells of *Natrix* with reference to *Cytamoeba* and *Toddia.* I. Description. J. Elisha Mitchell Sci. Soc. 80(2):

________. 1966. A condition in blood cells of *Natrix* with reference to *Cytamoeba* and *Toddia.* II. Mechanical transmission. J. Elisha Mitchell Sci. Soc. 81.

________. 1966. Amoebae in forty-eight hours. Amer. Bio. Teacher 28:108-111.

Yongue, W.H. and John Cairns, Jr. 1971. Colonization of polyurethane substrates by fresh-water protozoans. J. Elisha Mitchell Sci. Soc. 87:71-72.

________, ________. 1971. Micro-habitat pH differences from those of the surrounding water. Hydrobio. 38:453-461.

________, ________. 1973. Long term exposure of artificial substrates to colonization by protozoans. J. Elisha Mitchell Sci. Soc. 81:115-119.

________, ________. 1976. A comparison between numbers and kinds of freshwater protozoans colonizing autoclaved and unautoclaved polyurethane substrates. Appl. Environ. Micro. 31:750-753.

________, ________. 1978. The role of flagellates in pioneer protozoan colonization of artificial substrates. Polskie Archiwum Hydrobio. 25:787-801.

Yongue, W.H., Jr., J. Cairns, Jr., and H. Boatin, Jr. 1973. A comparison of fresh-water protozoan communities in geographically proximate but chemically dissimilar bodies of water. Arch. Protistenk. Bd. 115:154-161.

Zahner, Robert. 1966. Soils and wood quality within an annual ring. Proc. Soc. Amer. For. Ann. Mtg. p. 187.

________. 1967. Refinement in empirical functions for realistic soil moisture regimes under forest cover. Int. Sym. For. Hydrol., Pergamon Press, Oxford, England. pp. 261-274.

________. 1968. Water deficits and growth of trees. T.T. Kozlowski (ed.), *Water Deficits and Plant Growth.* Academic Press, New York. pp. 191-254.

________. 1968. Means and effects of manipulating soil water in forests. Tennessee Valley Authority (ed.), *Forest Fertilization; Theory and Practice.* Knoxville, TN pp. 10-15.

Zahner, R. and N.E. Crawford. 1964. The clonal concept in aspen site relations. Proc. Second N. Amer. For. Soils Conf. Oregon State Univ. Corvallis, OR.

________ ________. 1964. Earlywood-latewood features of red pine grown under simulated drought and irrigation. For. Sci. 10:361-370.

Zahner, R. and N.V. DeByle. 1965. Effect of pruning the parent root on growth of aspen suckers. Ecology 46:373-375.

Zahner, R. and J.R. Donnelly. 1967. Refining correlations of water deficits and radial growth in young red pine. Ecology 48:525-530.

Zahner, R. and D.R. Hedrich. 1966. Moisture release characteristics of forested sand entisols in northern Michigan. Soil Sci. Soc. Amer. Proc. 30:646-649.

Zahner, R. and A.R. Stage. 1966. A procedure for calcul. ing daily moisture stress and its utility in regressions of tree growth on weather. Ecology 47:64-74.

Zeller, Sanford M. and A.H. Smith. 1964. The Genus *Calvatia* in North America. Lloydia 27:148-186.

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