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Editor
ELIZABETH McCOY

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TRANSACTIONS OF THE WISCONSIN ACADEMY

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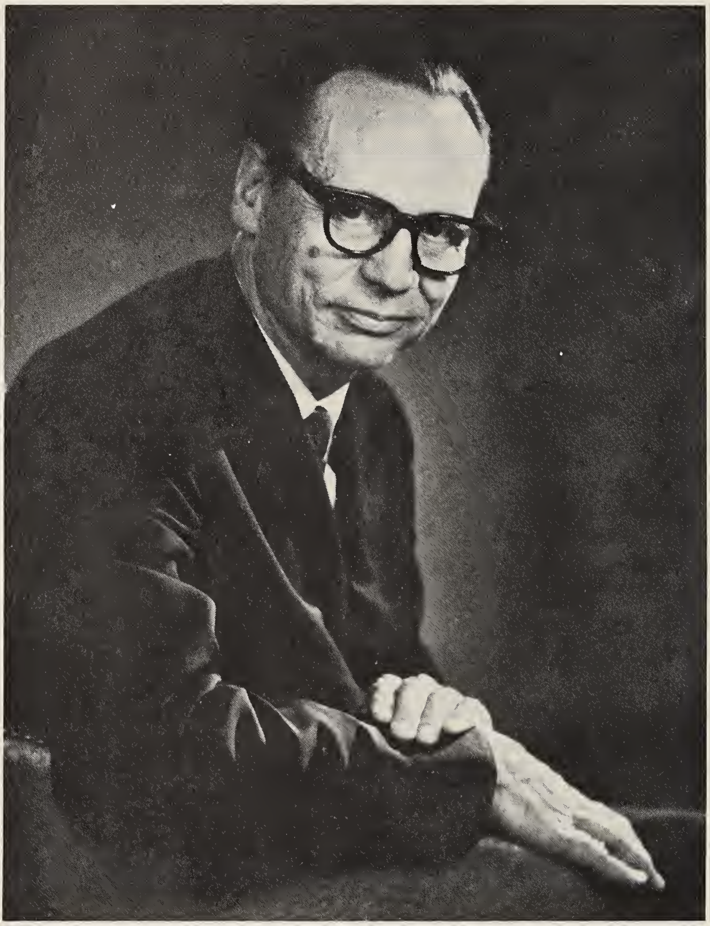

ROBERT E. GARD

55th President 1977
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ARTS AND LETTERS

OF ELMS AND THE ACADEMY

Robert E. Gard
Presidential Address
May 7, 1977
Wausau, Wisconsin

I am eternally searching for symbols of a permanence in life; of firm values that do not change, of faith and belief that is unshakable.

It is growing harder and harder to find such symbols. Occasionally I think I meet a man or woman who exemplifies what I mean, but the symbolic, traditional objects and institutions with their attendant securities, seem to be harder to find, or to recognize.

To me the Academy is one such symbol. It was founded by persons of idealism, and has stood more than one hundred years, a symbol of aspiration, of high hopes for mankind.

To me the Academy speaks of the magnification of man, of a vast humanism that encompasses all time, all knowledge, all hope that man might express the best of himself, not the worst. To me, the Academy is this kind of an Island.

But the eras do change, and our traditional symbols do slip away. I reverently hope that the Academy will remain, and that its ideals will prevail.

Let us expand a bit on what I mean by changing or disappearing symbols. The elm trees that once shaded America are excellent examples.

Near the front door at our home in Madison, we had one of the largest elms in the area. My wife purchased the house and property because of that great tree. Often she said, "If that tree ever goes, I go, too."

We had the wonderful tree for 20 years; then, though we struggled to save it with many scientific treatments, it withered and died. My lady wept when the men came to cut it down.

Something soon happened to our environment. A ground cover died the next summer; ivy began to cover the front of our house. The whole front looked different, inadequate. But she didn't go; she stayed, and we planted another tree: a Gingko. She said it would probably last for 500 years. I didn't want another tree. I felt the change. As a writer, the loss of the tree desensitized me for a while, but that's when I began to ponder about the death of elms across the breadth of the land.

The great elms are gone—victims of rampant dutch elm disease. The streets the elms once adorned are blank, empty. The feeling of grace, of an almost ageless tradition ended with the disappearance of their tall arch. With their passing, an atmosphere has vanished; the whole air of permanence, of a corridor through time, has passed. We have had a corresponding generation of turmoil and unrest.

When I was a lad, I heard of the arch of the elms of New England; and I was told how Kansas pioneers, many who came from the East, first planted elms in the town square and lined the new streets with the sturdy trees, almost before they built houses. The stability of America itself somehow was symbolized by the elms.

Lately I visited my old hometown in Kansas. Once there were tall elms in the courthouse park and green wooden benches placed beneath them. At one side stood an old horse watering trough. But when I visited last summer, the trees were all gone—so was the trough; so, indeed, was the old red-brick courthouse. A low structure of yellow brick, entirely unshaded, sat uneasily in the middle of the park.

I cannot believe that the death of the elms has had no effect upon us as a people. The tradition of a leisurely college life, enhanced by the presence of great trees above a quadrangle, or along a student walkway, appears to have departed. Perhaps students are more restless than they were a generation ago. Could it be that great trees that spoke of quietness, a timeless tradition, a deep feeling of place, had their effect upon the young?

There is a bleakness now in the atmosphere of colleges. Two or three generations hence, when the new trees have grown, the atmosphere may return. But what in the meantime? Colleges are not necessarily known for the beauty and uniformity of their architecture. Without the trees, the buildings sometimes look stark, and their windows empty and lonely. I have noticed also, as the trees have disappeared, that the traditions of the colleges themselves have grown less important—indeed, the traditions seem often forgotten. I recently found the senior class calumet—the peace pipe smoked in friendship by each senior class at the University of Wisconsin since, I believe, 1887, in a dark closet, entirely forgotten. The famed "little red wagon," so important to athletic teams of the university, has disappeared. Nobody knows where. It was the wagon that students drew with ropes; hauling the victorious teams from railroad station to campus.

And the tradition of great professors of magnificent bearing and influence . . . where are they? In a time of great elms the great professors flourished. Bennie Snow (Academy member), noted professor of physics, who received a "skyrocket" before each class; "Wild Bill" Kiekhoffer (Academy member), great economics professor with a deep love of students; Carl Russell Fish (Academy member), historian and lecturer par excellence who was literally followed by groups of students wherever he walked under the elms . . . these great professors have vanished with the trees. With them, of course, have gone the cherished stories . . . Bennie Snow, for example, one day walking down a sidewalk on State Street. He was walking with one foot in the gutter, one on the walk. An inquisitive student, noticing this curious performance, asked the professor whether something was the matter. "Why," said Bennie, "I believe one leg feels somewhat shorter than the other."

Ah, for the great trees again!

I have many older friends these days, especially since I myself have qualified for the golden years. Once the elderly sat peacefully beneath the elms. Tales told there carried on the oral tradition of generations. A bench now, set on a bare corner or in a treeless park, seems forlorn, though it may be occupied by two or three old cronies. Their daily meeting, the passing talk, seems to lack the benediction of the elms and often my older friends comment on the feeling of loneliness and uneasiness.

"Elm shade," one said, "was once the essence of friendship. Most of our elms are gone in this town. We moved in from the farm, my wife and I, to be under the elms . . . that's what my wife said. She liked this town because of the trees. She said the elm was a woman's tree, a woman's friend. This town will never be the same to us since the elms have gone. It's harder now to make new friends."

Our national values, our national character, may be affected by the loss of the trees. There are many, many reasons why our whole system of ethical and moral behavior is changing. The elms certainly are not to blame; yet the changes have occurred simultaneously with the death of these trees. The elms have always symbolized home and its values; the lure and pull of a homestead, of waiting friends and parents when one returns. Once, the trees planted at the doorstep to commemorate family events furnished shade and comfort in times of joy and grief. Now the trunks, dead and gray, stand sometimes in the yard beside the door. Or there is simply a blank space—or a stump remains where grandfather planted the elm sapling when the first baby died in the fall of 1861 . . .

We are certainly a nation which has developed its character through the associations of family life. Family life relied on the elms. The effect of their going may be subconscious upon us; but a phase of American life—the serene elm phase—probably will not come again.

Let us hope that the death of the elm trees does not point toward the demise of the ideals of the Academy.

Let us hope that we may preserve and nourish the Academy. It may be more precious than we realize. But institutions and organizations are subject to the winds of chance. Recognition of values and planning for the winds of change are the only answer. I plan to work on that, and trust that we all will.

SOIL EROSION IN THE LAKE STATES DRIFTLESS AREA — A HISTORICAL PERSPECTIVE

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ABSTRACT

The paper briefly describes the geological, settlement, and agricultural history of Wisconsin's unglaciated or "Driftless Area". Gullying of forested ridge sides and river terraces was especially severe during the 1920s and 1930s when the University of Wisconsin, U. S. Department of Agriculture, and the U.S. Forest Service began surveys of the erosion problem. Erosion has been less in recent years. Many gullies have healed naturally; the change from horse plowing to tractor plowing has resulted in less cultivation of steep slopes and less erosion. Ridgetops are used more for pastures and hay fields than for annual grain crops.

INTRODUCTION

Geologists know it as the "Driftless Area," local residents, as the "Coulee Region": "driftless" from the lack of glacial deposits (drift); "coulee" because of the steep-sided, narrow valleys. But no matter what one chooses to call it, the ridge-and-valley country of southwestern Wisconsin and adjoining States is an unusual land. Four times the great, continental glaciers pushed their icy fingers down over the upper Mississippi valley region. Some reached far down toward the tip of Illinois, and into Iowa. But for reasons still not clearly understood, southwestern Wisconsin and adjacent parts of Minnesota, Iowa, and Illinois were bypassed each time by the great, grinding mass of ice and rocks.

So, unlike the country that surrounds it, the land here was neither scoured, leveled, nor filled. Indeed, of all the many ways that nature uses to shape the face of the land, only erosion has been at work here.

In the Beginning

It began with nature's relentless wearing down of primeval mountains into primeval waters. It was then that the sandstones and limestones that we see exposed today were laid down. As the land emerged from the ancient sea a new cycle of erosion began, and the land forms of today's Driftless Area—the flattopped ridges, the slopes rising steeply from narrow valley floors, the rocky crags—began to take shape (Fig. 1).

Although it was never touched by the ice sheets, much of the area was nevertheless affected by the glacial advances. Erosion, this time by wind, was again the agent. As the rivers that spewed from the retreating glaciers finally subsided, they left in their wake huge deposits of rock flour, of silt, and sand. And as this material dried out it began to blow. We do not know how long this went on, but by the time it had stopped, a 100-mile-wide strip of country along the Mississippi River was blanketed with a layer of fine silt. In places it was as much as 20 feet thick, and it covered most of today's Driftless Area.

Thus, time and erosion shaped the face of the land. Later trees came to hold it in place—grasses too, because this region was the boundary between forest and prairie.

No wonder that early explorers who paddled up the Mississippi to view the bluffs and the steep hill country beyond the river were awed by what they saw. "The scenery combines every element of beauty and grandeur," wrote one. "The sunlit prairie with its soft

FIGURE 1. Driftless Area landscape as seen from ridgetop. The forest is oak-hickory and associated species.

swell . . . the somber depth of primeval forests . . . cliffs rising hundreds of feet . . . streams clear as crystal."

But this was 150 years ago. The natural advantages of the region brought on rapid settlement, primarily by Norwegian immigrants, who had found a new world counterpart to the old country. The sunlit prairie and the primeval forest began to give way to the plow and to the axe and the grubbing tool. Farmsteads and fields of grain began to dot the landscape; and a new cycle of erosion was not far off.

The Plowman's Folly

The settlers soon found that the deep, wind-laid blanket of silt was an excellent soil. The flattopped ridges, remnants of the ancient ocean bottom, were easily cleared and the rock-free soil was easily plowed. Unfortunately, for both the settler and for posterity, the amount of flat land was somewhat limited because much of the ocean bottom had been worn down into steep slopes following the period of geologic emergence. So a lot of steep land was cleared for agriculture, too. After all, the soil was just as fertile; and the settlers had been used to farming steep land back in the old country. Forests were left only on slopes too steep to plow.

The soil was very productive, but also very erosive. The wind-laid silt was free of rocks and relatively low in clay, the fine material that binds soil particles together. So soil erosion was inevitable. Forest remnants became the dumping ground for runoff water from overlying fields. Gullies slashed through the wooded slopes, disgorging rocks and rubble and silt onto valley floors and into flooding streams. "Civilization" had arrived in the Driftless Area.

Just when man-caused erosion actually began, we do not know, but it was probably about the mid-1800s, soon after the land was settled. At first wheat was the primary crop, but after 20 to 30 soil-depleting years, wheat farming gave way to dairying. Soil fertility probably declined rapidly under the annual wheat cropping system, and the new cycle of erosion must have started in this era. That a problem existed at least as early as the 1880s was shown by an immigrant German farmer, August Kramer, who began strip cropping on his farm near La Crosse, Wisconsin, about 1885 (Zeasman and Hembre 1963). One of the earliest published references to erosion in the area came from Professor F. H. King (1895) of the University of Wisconsin, in a textbook published 10 years after Kramer's practice began. Speaking of the Driftless Area, he wrote:

> "The hills, no longer protected by the forest foliage, no longer bound by the forest roots, are gullied and channeled in all directions. Storm by storm and year by year the old fields are invaded by gullies, gorges, ravines, and gulches, ever increasing in width and depth until whole hillsides are carved away . . ."

It appears that King was describing the forest land gully, caused by runoff from overlying fields. Other forms of erosion were probably going on at the same time: sheet and rill erosion on sloping fields; gully erosion on sandy river-terrace flatlands; and wind erosion on sand plain areas. Forty years later, Aldo Leopold also described (1935) the gullying of forest land:

> "Every rain pours off the ridges as from a roof. The ravines of the grazed slopes are the gutters. In their pastured condition they cannot resist the abrasion of the silt-laden torrents. Great gashing gullies are torn out of the hillside. Each gully dumps its load of hillside rocks upon the fields of the creek bottom, and its muddy waters into the already swollen streams".

Although Leopold was writing about just one small watershed (Coon Creek), the forest land gully was, and still is a common blight throughout the coulee region. Such gullies are found in practically every wooded slope that lies below farmland (Figs. 2 and 3). How extensive they were in the 1930s was shown by a systematic survey in 1935-1936 (Fig. 4).

Less common, but even more spectacular, than the erosion on the loess-covered hills were the gullies on level river terraces of sandy, alluvial soil. Here acres of productive farmland were sometimes destroyed by gullying during a single storm (Fig. 5). The gully in Fig. 5 advanced 1,000 feet during one storm in 1922, according to the owner:

> "This storm caught George Vollmer in the back field. On his way home the team had to swim the new gully with the wagon floating where the field was only minutes earlier.
>
> "The debris pile at the outlet of the gully had buried highway No. 37 repeatedly. A survey in 1929 revealed that this cone was about 14 feet thick near the road crossing and averaged over 6 feet over a 40-acre area. Much of the finer soil material had gone down the river" (Zeasman and Hembre 1963).

The largest of these river terrace gullies—one of many along the Buffalo River in southwestern Wisconsin—decimated a 50-acre

FIGURE 2. Beginning of a forest land gully. Photo was taken in 1936.

FIGURE 3. Part of extensive gully system below open land on Coulee Experimental Forest, La Crosse County, Wisconsin. Note man holding rod (lower left).

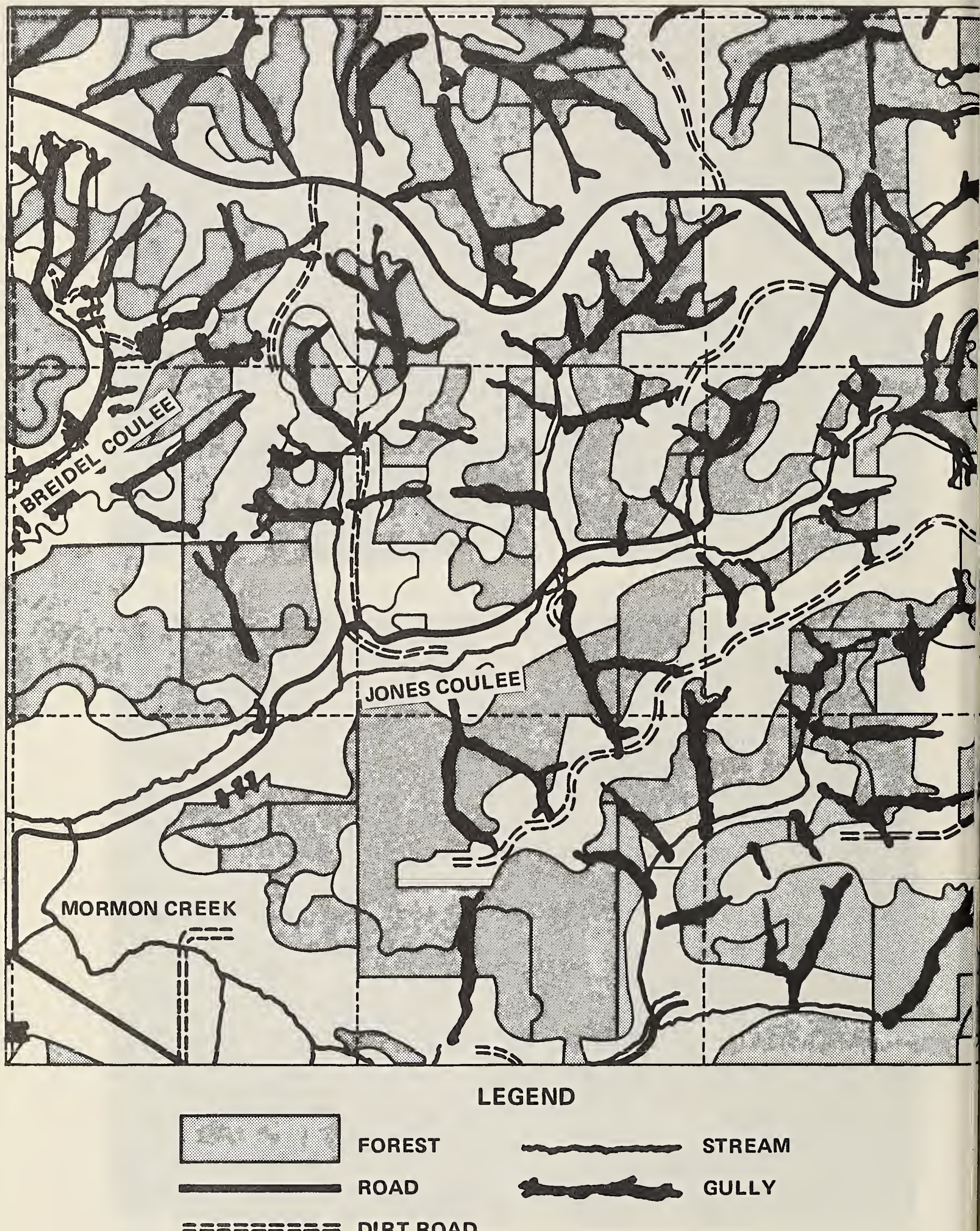

FIGURE 4. Land use and gully survey of part of a township in La Crosse County, 1935.

area, and ranged from 30 to more than 50 feet deep. Its beginning dated back to at least 1914. A 1929 survey of the Buffalo River area showed 170 gullies with a total length of 18 miles, a total area of 138 acres, and a total volume of 3,247,000 cubic yards in a 75 square-mile area (Bates and Zeasman 1930). Much of the eroded soil washed into the Buffalo River, and subsequently into the Mississippi.

The soil loss and sediment gain from sheet and rill erosion were inestimable. Soil surveys did indicate their magnitude, however. For example, Muckenhirn and Zeasman reported about 1940 that more than 60% of the cropland in southwestern Wisconsin had lost at least one plow depth of soil. This probably reflects water erosion of loessal silt loam soils on sloping fields for the most part. However, wind erosion also took its toll on flat fields of the sand plain area, as shown in a photo taken in 1960 (Fig. 6). A road nearby was protected from drifting sand by a snow fence.

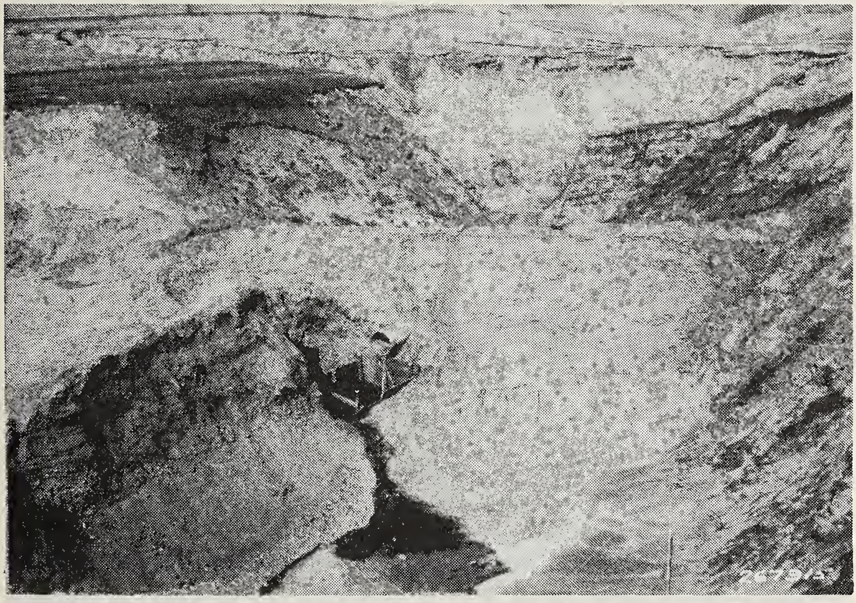

FIGURE 5. River terrace gully showing drop inlet dam, 1932. Except for growth of vegetation, the area looked much the same in 1958.

Early Control Efforts

Except for a few innovators like August Kramer, nothing much was done about the erosion problem until the early 1920s. The U.S.

Soil Conservation Service did not yet exist, and most landowners had nowhere to turn for help. Then in 1922, O. R. Zeasman, a University of Wisconsin extension specialist in land drainage, was assigned the job of "stopping ditches." Perhaps it was a sign of the times that Zeasman was originally moved into the erosion control field not to save farms or rivers, but to reduce highway maintenance costs in Buffalo County (Zeasman and Hembre 1963).

One of his early efforts was to stake out diversion terraces, the first in the fall of 1922. Later, he began building drop inlet gully control dams; the first large one was started on the Vollmer farm (Fig. 5) in 1928. In 1932 he laid out a diversion terrace there that successfully diverted the water away from the gullies. I visited the farm in 1958 and was told by Mr. Vollmer that construction of the terrace had taken care of the problem; water no longer ran through the gully.

In the meantime, the USDA Forest Service was called upon to help in a "Cooperative Study of Soil Erosion Problems in Wisconsin." The cooperative agreement between the Lake States Forest Experiment Station and the Wisconsin College of Agriculture was signed June 4, 1929.

A lot happened in the early 1930s. Research at the Upper Mississippi Valley Soil Conservation Experiment Station, a cooperative project between the U.S. Department of Agriculture and the Wisconsin College of Agriculture, began at La Crosse in 1931. A year later, watershed management research by the Lake States Forest Experiment Station (USDA Forest Service) also began there. The Nation's first watershed improvement project was begun in Coon Creek watershed in 1933, the same year that the Forest Service proposed public acquisition of some 1.4 million acres in the bluff lands area as an erosion control purchase unit (nothing came of this). The Soil Erosion Service was created as an emergency agency in the Department of Interior in 1933, and was transferred to the Department of Agriculture as a permanent agency in 1935. The Civilian Conservation Corps (CCC) was born, and many camps were engaged in erosion control work in the Driftless Area during 1933-34. Constructing gully control structures was a major activity: some 900 were built.

Other efforts in the 1920s and 1930s included construction of various kinds of check dams to protect railroads and highways from mud-rock flows (Fig. 7). These structures were largely ineffective because they attempted to cure the symptom rather than the disease. Some were filled after one storm. Nevertheless, large sums were spent in this futile effort.

FIGURE 6. Wind erosion on sand plain in north La Crosse County, 1960.

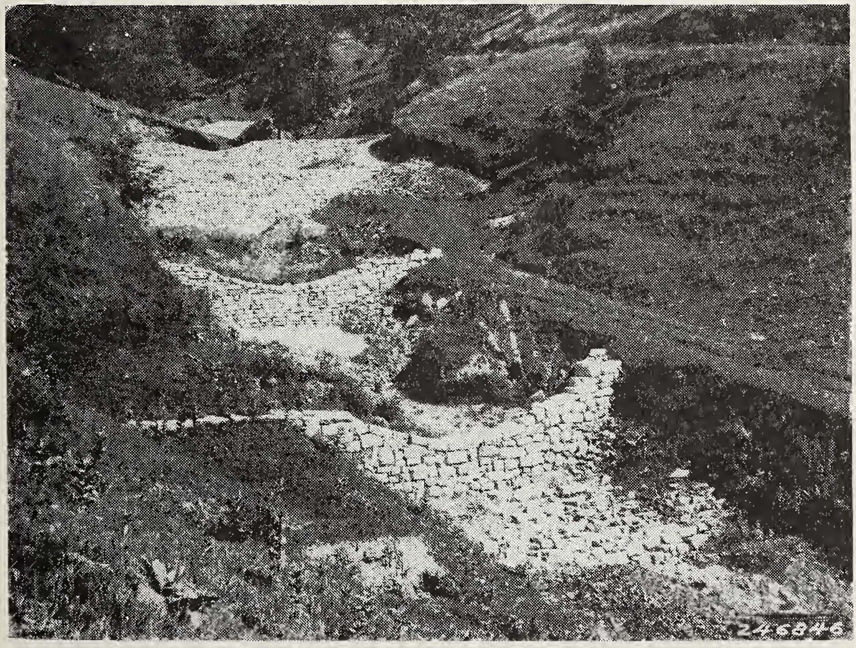

FIGURE 7. Check dams built by Chicago, Burlington, and Quincy railroad in the 1920s to protect tracks near Genoa, Wisconsin.

The Situation Today

Although yesterday's gullies still scar the land (there is no reasonable solution to large holes in the ground), most have at least stopped growing. This is largely the result of natural causes. The first big storms probably washed out most of the soil and rock fill. As the gullies enlarged, the erosion potential diminished. Even if the most destructive storms were repeated on the same area today, the potential for further erosion would not be there because some channels have long since been worn down to bedrock. However, the gullies have not entirely healed. Some still discharge rocks and rubble during high runoff storms.

Gradual changes in land use over the years have also speeded the healing process. With the change from annual grain cropping to dairying, some cropland went into permanent pasture. When the tractor replaced the horse, more was saved because tractors cannot safely negotiate steep slopes. As gullies ate into upland fields the plow line had to retreat upslope, and old fields soon became new forests of aspen, birch, and elm. Narrower ridges also went out of crop production eventually to revert to forest. And, of course, the increase in conservation farming over the years has also helped. With all of these changes, less water now flows from upland fields onto forested slopes.

Even so, new gullies can still form, given the proper combination of conditions. But now the triggering mechanism is more likely to be a bulldozer than a plow; and the site, a hillside subdivision instead of a farm field. However, all may not yet be right down on the farm. Steep land is still cultivated; so eroding fields and flash floods are still more than just a memory of bygone days. The Corps of Engineers is currently seeking support for two separate flood control projects in the area. And consider, for example, this quote from a recent newspaper story (Breitbach 1975):

> "If a final epitaph were to be written for 1974, it could best be summed up in one word . . . 'failure.' Failure to protect the land from soil erosion saw the most severe soil losses in the past 25 years."

One man's opinion? Perhaps. But coulee streams still run muddy with every rain. So the current cycle has not yet run its course. Nor is it likely to—as long as those who work the land continue to ignore the demands of an uncompromising nature.

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WISCONSIN'S FIRST UNIVERSITY SCHOOL OF THE ARTS

THE UNIVERSITY OF WISCONSIN—MILWAUKEE SCHOOL OF FINE ARTS: ITS FIRST TWELVE YEARS

Adolph A. Suppan
University Wisconsin—Milwaukee

In December 1962, the University of Wisconsin Regents established the state's first university school of the arts, at The University of Wisconsin-Milwaukee. This is an account of the creation of that School, its academic innovations, and its first twelve years of development.

It will be evident from what follows that a potent stimulus toward the possibility of such a school came when the University began its artist-in-residence program during the 1960 summer session.[1] On campus were poet John Ciardi, abstract-expressionist painter Jack Tworkov, composer Alvin Etler, the Fine Arts Quartet, the New York Woodwind Quintet, and pianist Frank Glazer. The program (subsequently given the inclusive title of "Summer Arts Festival") was unique, at that time, in several respects. The artists came not for a one-day visit, but to teach courses, lecture or perform, and hold conversations with students, faculty, and public. In round-table discussions between visiting artists and the faculty, the arts were examined in relation to one another under such topics as: "The Artist and the Critic," "Government Subsidy for the Arts," "The Artist and the Public: A Communications Gap?," and "The Artist in the University." At concert "previews" and lecture-demonstrations, Mozart and Beethoven, as well as Bartok and Schönberg, were explained and discussed. A spirit of aesthetic excitement prevailed for many weeks, as the audiences realized that the arts together had more impact than the arts individually.

The success of this, and the 1961 summer program relating the arts in teaching and performance, soon posed an obvious question for the University. Why should the arts come together only during the summer session?

Early in 1962, Chancellor J. Martin Klotsche created the Ad Hoc UWM *Committee to Consider the Future of The Arts.* The Committee, representing a broad range of the arts and art related administrators, included Professors Lester E. Fuhrmann

(Theatre), Frank M. Himmelmann (Education), Frederick I. Olson (Extension), Milton H. Rusch (Music), Robert Schellin (Art), and Adolph A. Suppan, Chairman (Director, Summer Session).

This committee wrote a document which, for those years, displayed significant foresight relating to the situation of the arts in most of the nation's universities. The essential recommendations were:

PROPOSAL FOR A UNIFIED FINE ARTS PROGRAM AT UWM

OBJECTIVES

1. To provide a continous and effective relationship between UWM departments related to the fine arts area
2. To enable these departments to coordinate their resources; to encourage generally in the university a recognition of the value of the disciplines inherent in the arts; and to intensify departmental offerings in the fine arts to both the students and the community
3. To make it possible for students to major in a fine arts curriculum which cuts across departmental boundries; permits students to see the arts in their natural relationship to one another; and allows concentration upon such areas as aesthetics, arts history, cultural development, and art in society
4. To permit within the professional training of each student majoring in the arts a maximum intensity of study and experience in his area
5. To centralize lines of communication between the total university arts program and civic organizations working in the arts
6. To coordinate programs in the arts (music, theatre, the dance, and the visual arts) so that each year a calender of arts activities can be printed in advance, providing the community with a total awareness of the varied activities and wide range of the arts in UWM.

RECOMMENDATIONS

1. The university should establish a separate division of fine arts with an administrative head directly responsible to the Provost [now Chancellor]. This division would include the departments of art, art history, theatre, music, and the dance. The present budgets of these departments (or what are now areas within departments, such as theatre and dance) would be incorporated into the total budget of the division.
2. The fine arts unit would include among its primary functions the objectives given above, and would implement them as soon as is possible.

The recommendations, approved by Chancellor Klotsche and the relevant departments and deans, were submitted to the University of Wisconsin administration in Madison. Action on the document came in the fall of 1962 when the new president of the University, Fred Harvey Harrington, also approved it and relayed it to the University Regents. In December 1962, the Regents created a School of Fine Arts for The University of Wisconsin-Milwaukee and appointed Adolph A. Suppan as its first dean.[2]

Intense planning by faculty and administration began; only eight months remained before the new School was to open. The deans and faculties involved had to consider the mechanics of bringing existing departments and new academic areas together. Dean Joseph G. Baier of the College of Letters and Science played an important role in effecting a smooth transition for Music (already a department) and Theatre Arts (three faculty members in the Speech Department). At the School of Education, the Art Department (like Music, already possessed of an excellent reputation in the state) was also involved in the move. The existing dance courses were offered by the Department of Women's Physical Education; that department preferred to retain the one faculty member involved and, therefore, an entirely new dance faculty had to be appointed.

A Faculty Planning Committee was formed to design a general curriculum for the new School—admission details, course requirements, and revised departmental programs. The Committee's recommendations were resourceful and innovative. Besides the four departmental programs—Art, Dance, Music, and Theatre Arts[3]—a fifth unique program was added: Inter-Arts. A student choosing to become a generalist in the arts could get a degree by working in any three of the four departments; e.g. 24-credit with "mini-majors" in Music, Theatre Arts, and Dance. This degree could form a background for fields such as arts administration, arts history, concert hall management, or arts journalism.

A second feature of the proposed new curriculum was a requirement that every student, no matter which of the five new majors he or she chose, should take two year-long survey courses: *Arts and Mankind* in the freshman year and *The Arts: Theory and Criticism* in the senior year. These wide-ranging courses, taught by a team of instructors from the entire arts faculty, would, in the first year of the students' academic experience, acclimate them to art disciplines other than their own and, in the fourth year, give them an overall view of critical principles and practices relating to all the arts, and thus broaden their aesthetic approaches. These classes would, we hoped, liberate the students from the too-concentrated, conventional arts major. As far as we knew, such courses were not offered in any other institution.

The Committee also was aware of current criticism that many private conservatory programs in music, art, theatre or dance neglected the students' liberal arts education. The new curriculum required 30 credits in the humanities and sciences, without sacrificing an adequate credit load in the major discipline.

In summary, the Committee proposed an arts education of rigorous professional competence, yet eschewed over-specialization by creating a balance with general education and an introduction to the other arts.

The labors of the Committee (its members always in consultation with colleagues in their various departments) were rewarded when, on March 28, 1963, the arts faculty approved the new curriculum. On April 11, the all-University faculty gave a unanimous go-ahead to the new School. Similar approval of the new curriculum by the University administration and Regents quickly followed. In a few months, the first university college of the arts in Wisconsin was ready to face its next challenge: its reception by students and the public.

First-semester registration, in September 1963, exceeded predictions. Enrollment in arts majors increased from 1,011 to 1,248—23 percent overall. Class registration rose from 6,798 to 7,579—12 percent, compared with an all University increase of 9 percent.

During that first year and the next, these developments in the academic progress of the School took place:

(1) Recognition of the Music Department by the two leading national accreditation systems: the National Association of Schools of Music and the National Council for Teacher Accreditation. These were significant not only for their stamp of approval for an already reputable department, but because there had been some faculty concern that the department might lose stature by joining an arts school with a new curriculum.

(2) The appointment of the internationally-famous Fine Arts Quartet to full-time faculty status with tenure. There were some resident quartets in other universities but, to our knowledge, none had ever been given tenure as a group. The acknowledged excellence of the Quartet also signalled to the community the standard of quality the new School would strive for in its appointments.

(3) New graduate programs in Art and Music: three Master of Music degrees (Applied Music, Conducting, Music History and Literature); a Master of Fine Arts degree, offered parallel to the existing degrees of Master of Science in Art, and Master of Science in Art Education.

(4) A four-year curriculum and an Education major in Theatre Arts.

(5) A four-year professional major program in the new Department of Dance.

(6) Revision of the Art Department's undergraduate program, with eight professional areas of specialization.

During subsequent years (1965-67) enrollment increase continued, exceeding all-University averages; the full-time faculty had now increased from 44 to 70. And, because of the burgeoning student population, a desperate need for additional classroom and office space developed. Only the Music Department was adequately housed; it had acquired, a few years before the formation of the School of Fine Arts, an efficient new building with an excellent recital hall. The Art Department was still in cramped quarters at the north end of old Mitchell Hall's third floor; dance and theatre classes were also scheduled in that building; music, theatre, and dance performances took place in Mitchell's "auditorium," originally designed for lectures and debates. It had a cramped stage which served only minimally for theatre purposes; also rows of uncomfortable, joined, wooden seats were movable, to make room for campus dances. The new School, with its many students, was suffering one of the most ancient of institutional diseases—lack of space.

In the fall of 1966, Chancellor Klotsche announced the welcome news that the Regents had approved a new Fine Arts Center for the University. A Faculty Planning Committee was immediately appointed to advise the state architects and engineers on the three-building complex (to adjoin the existent Music Building). We wanted a plan that would include classrooms, offices, studios, galleries, student recreation space, and a multi-purpose theatre. Though we wanted a center that would offer adequate performance and exhibition space, we hoped it could also be an appropriate environment for the artist/teachers and their students.

As indicated before, the School had a two-fold academic purpose: to provide professional and general training in the arts, and at the same time to alert students to the inter-relationship of the arts. We therefore asked the architects to design a quadrangle which would coordinate the arts in a spatial, as well as academic, continuum. They accomplished this with an inter-flow between the units, using covered walks and adjoining courtyards; provision was also made for a number of arts activities in each of the buildings.

A specific example of how this "inter-flow" principle was considered for every aspect of the Center can be seen in the Planning

Committee's objection to the architects' orginal plan for the galleries, which were to be in a squat, one-story structure, separated from the other buildings. We complained that this made them merely another museum, isolated from the ebb and flow of people on the campus. We suggested that the galleries be situated on the second floor of the Theatre Building (its first-floor lobby was also a concourse) where students, in the daytime, and the public, attending evening events, would be attracted to the painting, sculpture, and crafts exhibitions. The architects not only agreed, but put floor-to-ceiling gallery windows in the upper well of the theatre lobby. Day and night, many of the structures and colors of artworks could be seen from below—a continuing display of ongoing attractions in the visual arts.

A distinctive feature of the theatre itself was its flexibility in regard to both thrust- and proscenium-staging. Normally the theatre, with thrust-stage, would seat 550 people. Sharp-rise seating around three sides of the stage would make it possible for every member of the audience—even those sitting in the eleventh and last row—to have a clear and close view of the performances. Experts were also consulted to provide a variety of different acoustical situations to suit whatever would be staged. The theatre would not be limited to plays, but would be used for orchestral and choral concerts, recitals, lecture-demonstrations, and dance concerts as well. Hydraulic-electric devices would make it possible to lower the entire thrust-stage so that it disappeared, transforming the theatre into a 600-seat proscenium-type interior. Portions of the floor could also be lowered to form an orchestra pit for musical comedies and certain types of dance performances. Other features of the Theatre Building included a lower-level rehearsal room with a stage of the exact measurements of the thrust-stage, dance studios, and numerous shops for scenery, costuming, and stage design.

The Art Building had studios and classrooms adapted for every art activity: ceramics, sculpture, graphic arts, painting, photography, film, design, weaving. Between the Art Building and the Theatre was a sculpture court which served as both an outdoor working area (there was direct access to it from the interior studios) and an exhibition space.

Although the 300-seat Recital Hall was conceived mainly for chamber music, it also was flexible in its uses; and the Lecture-auditorium would serve equally well for film showings, theatre workshop productions, and lectures.

In the 1960s (the Fine Arts Center was completed in 1968), some cultural historians had complained that, although support for the arts was increasing, much of this manifested itself in a national "edifice complex"—that more money was being poured into hundreds of arts halls and centers than into badly-needed support for artists and arts organizations themselves. Our Fine Arts Center defied such a trend. More than a cluster of performance and exhibition spaces, it provided learning and studio space for 900 Fine Arts majors and 75 faculty members, and was a locus for over 150 arts events annually. It offered, because of its many resources, the widest possible range in the arts: from the classic to the contemporary, from the traditional to the experimental and the challenging. The arts could flourish here, free from the restraints and limitations of box-office commercialism. In addition, with opening of this Center, metropolitan Milwaukee had its first multipurpose performing arts building complex.

The Center, of course, also became the home of the Summer Arts Festival, which had continued and expanded each year. The selection process for the artists-in-residence began during the academic year, when faculty committees, departmental chairpersons, and administrators wrote letters, made phone calls, and conducted interviews. The artists were chosen not only for their reputation, but for their ability to be articulate and interested teachers.

Thus, when summer arrived, students, faculty and the community were offered the rich experiences of seeing, hearing, and meeting great creative personalities from the arts world beyond the campus. There was stimulation and controversy, and sometimes even shock, in observing and talking with such gifted people as composers Leon Kirchner and Milton Babbitt; painters Carl Holty and Lester Johnson; poets James Dickey and Kenneth Rexroth; dancers Ruth Currier and Lucas Hoving; musicans Sylvia Marlowe and Leon Fleisher; and theatre directors Alan Schneider and Gene Frankel. These—and many others—gave all of us fresh, invigorating ideas about the arts. Altogether, up to 1974, more than 60 artists-in-residence came to the campus.

The Arts Festival also included chamber music, modern dance, ballet, theatre, painting/sculpture/crafts exhibitions and experimental film series. There were concerts by a Festival Orchestra including the members of the Fine Arts Quartet, the New York Woodwind Quintet (and later our own Woodwind Arts Quintet), musicians from the Milwaukee Symphony Orchestra (and its predecessors), music faculty, and selected students. Among the conductors were Thor Johnson, Robert Whitney and Leonard Sorkin.

As a logical extension of the successful summer program, artists-in-residence were now appointed during the academic year as well. The four Fine Arts departments (and in the case of poets, the English Department cooperating) invited artists to teach, perform, lecture and conduct workshops.

Enrollments, as well as programs, continued to grow; and, as student involvement in university policies increased nationally, the School sought more student advice in academic decisions. In 1968, a Student Advisory Committee to the Dean was formed; members (representing their organizations in the various departments) were recommended by departmental chairpersons. The Committee met every two months; problems, issues, and proposals were frankly (and, if requested, confidentially) discussed; and if so directed by the students recommendations were relayed to the departments. The departments also created means by which students could communicate their opinions directly.

With the new quadrangle of buildings, an energetic faculty, and a steadily increasing enrollment, the School had become not only a respected academic unit, but a magnetic force for the arts in the Milwaukee area. *The Milwaukee Sentinel* described it as a "haven of the arts," but our goals went beyond that. In the 1960s the University of Wisconsin-Milwaukee was one of the pioneering urban institutions of its kind in the nation. We of the School of Fine Arts felt we had a mission, a major commitment to our city. We therefore began to offer both cooperation and initiative to the urban sector, wherever requested or needed. Major projects developed by us,[4] always in consultation and participation with citizen groups, were:

The People's Theatre

Formed in 1968 by G. L. Wallace, who had been appointed Inner City Arts Consultant to the Dean, this was the city's first black repertory group. Despite very limited resources, the company quickly won the respect of the community and has enjoyed critical and public approval.

The University Ballet

This, the city's first continuing ballet ensemble, was organized in 1966 with the participation of faculty and students in the Departments of

Dance, Music, and Theatre Arts. The latter two departments contributed their resources for staging, design, and a good orchestra.

The Milwaukee Ballet Company

In the fall of 1969 we were asked if the School would co-sponsor an attempt to found a repertory ballet for Milwaukee. A few months later, in response to invitations sent out by the School, a group of about 50 ballet enthusiasts met on campus to organize support for such a group. The School provided rehearsal and performance space for a number of years; the organization also got advice and participation from the faculty and students of the Dance Department.

Symphony-on-Campus

For many years the Milwaukee Symphony was invited annually to be "in residence" for a week on campus. Daily rehearsals in the Fine Arts Theatre were open to students and public; many thereby had their first opportunity to attend a symphony rehearsal. The orchestra included faculty composers' works in either "reading sessions" or in concert; and the visit would culminate in a free evening program.

The Community Theatre Institute

The Theatre Arts Department, hoping for a closer relationship with many community theatres in the area, inaugurated an informal community theatre organization which later evolved into what is now a similar state group.

The Preparatory Arts Division

With the realization that in the arts, especially in dance, training must begin before college age, University Extension Arts, in cooperation with the School of Fine Arts, began offering pre-college and children's classes in dance, theatre, and visual arts. This program has continued to enroll hundreds of students annually.

Downtown Concerts

Co-sponsored with the First Wisconsin National Bank, the Fine Arts Quartet, Woodwind Arts Quintet, and other artist/faculty from the Music Department gave a series of concerts in Vogel Hall (Performing Arts Center) every spring.

Art Exhibitions

The Department of Art, which got its first full-time gallery director in 1963, mounted literally hundreds of exhibitions in the years 1963-74. National invitational exhibitions included Paintings, and Sculpture, '64; the "10/10" Invitational Photography Exhibition; National Crafts

Exhibition; National Print Exhibition; and "Mice that Roar," National Political Cartoon Exhibition. Also, the department's own faculty and student exhibitions have made the Fine Arts Galleries a continuous showcase of significant and exciting traditional and contemporary art every month of the year.

Inner City Film Workshop

This workshop provided a range of activities and experiences for economically disadvantaged inner-city youth through the medium of photography. The age range was from 10-18. The younger people worked with art and animated films, and the older youth dealt with live-action films and still photography.

The above programs, mentioned to illustrate the School's outreach in the urban community, constituted only some of the projects developed by the departments.

In theatre, at least five classical and contemporary plays received major productions annually; the small studio theatre was used for student and experimental plays. The University Players won national honors from the American College Theatre Festival for a production staged in Washington D. C. at Kennedy Center.

In music, in addition to the traditional band, symphony orchestra, and choral concerts, numerous faculty and student recitals and operas were presented; baroque and contemporary ensembles were developed. A "Composers' Showcase" series with works by music faculty and students was instituted.

In dance, faculty and student concerts were presented each semester; and companies of international fame—those of Jose Limon, Erick Hawkins, and others—were brought to the campus for from one to three weeks, for teaching, workshops, and performance.

By the time the School celebrated its tenth birthday (1973), it had demonstrated in many ways the advantages of combining the arts under one academic roof. The North Central Association of Colleges and Universities described it as follows:

> Perhaps this is the most impressive example of how the UWM has been able to achieve high quality by concentrating its resources. Unlike its parent campus the Milwaukee campus has been able to bring together all creative performers in the arts into one School housed in a single complex, the Fine Arts Center . . . Clearly, from all respects, this is one of the most distinguished and successful efforts of the University!

In enrollment (majors), the School was now among the first 10 of 100 or more similar schools in the nation. Some of its faculty had achieved international recognition.

The short history of the School also showed that such an academic structure could nurture a climate of creativity. New student plays were continually being produced; original faculty and student choreography was being presented. Of the 147 exhibitors in the 1971 Wisconsin Designer-Craftsmen Exhibition, 47 were faculty, students, or former students of our Art Department. They received 10 of the 22 awards of the exhibition. Three faculty composers won national recognition; their works and their students' works were performed on campus by faculty and student ensembles.

Although some problems remained, such as the prevalent (and national) disproportion in salaries between artist-faculty and other university faculty, and the need for additional classroom and performance space, solutions were gradually being found. The auditorium of Engelman Hall, although being renovated for the School of Architecture, was equipped for some stage and concert presentations. And, in the spring of 1974, planning was begun for an extensive renovation of Mitchell Hall, with large areas assigned to the School. In May of that year, the University Faculty Senate approved plans for a needed fifth department—Film Arts. And a new Master of Performing Arts degree was proposed and approved by our faculty and the University administration, for the next biennium.

In character with the history of the State of Wisconsin itself, a history distingushed by innovation and progress in both social and educational areas, the School of Fine Arts at UWM continued in its pioneering directions. It demonstrated pragmatically the advantages of an "alliance" between the arts; that, indeed, such cooperation was a logical development in a century where art forms had become more related than ever before. It also demonstrated that a school of the arts can greatly strengthen the arts in a metropolitan area. It can use its human and technical resources to reveal the value and profundity of the old, and at the same time the excitement and necessity of the new.

Finally, if any single word describes the spirit of this School, it is "interflow." From the earliest manifestation of cooperation between departments and visiting summer artists, through the subsequent formation and development of the School, there was an interflow of goodwill and mutual effort between administration and faculty, faculty and students, creators and performers. The physical proximity, the common curriculum, the innovative programs made this interflow natural, continual and rewarding for all.

NOTATIONS

1. Artists-in-residence had come to the campus as early as 1955 for the *Summer Evenings of Music* series; however, they obviously represented only one art form.

2. Subsequently, similar schools of the arts have been formed at UW-Whitewater, UW-Stevens Point, and UW-Superior of the University of Wisconsin System. 3. The Art History Department elected not to join the new School.

4. The *People's Theatre, Preparatory Arts Division*, and the *Inner City Film Workshop* were implemented with the invaluable cooperation and assistance of the University Extension Arts, which also inaugurated many workshops with the Department of Music.

NEW DEAL WORK PROJECTS AT THE MILWAUKEE PUBLIC LIBRARY

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"Give a man a dole and you save his body and destroy his spirit; give him a job and pay him an assured wage and you save both the body and the spirit."[1] This statement by Harry Hopkins reflects the philosophy of the New Deal, its creator Franklin D. Roosevelt and like-minded social thinkers such as Homer Folks. Thus, an important purpose of the many work-relief bureaus was to "substitute work for relief"[2] so as to restore feelings of self-esteem to the unemployed.

Some authorities would contend that the unprecedented intervention of the Federal government caused a revolution in the State-Federal relationships, not to mention waste and inefficiency, which is summed up in the word "boondoggling." The New Deal did effect a revolution in the nature of the government and there was undoubtedly a great deal of waste and inefficiency. But to emphasize only these negative aspects would seriously distort the picture. In seeking to save the capitalistic system from collapse, the New Deal made unstinted efforts to salvage human resources.

Many people today are familiar with the New Deal's accomplishments through an awareness of its physical outcroppings—the dams, airports and parks that dot America's landscape. But the New Deal also played a sizeable role in fostering cultural and scholarly programs which became known as "white collar" jobs because they provided work to such unemployed professionals as musicians, artists, and clerks. This article will discuss the origins, nature and results of the "white collar" enterprises of the Civilian Works Authority (C.W.A.), the Federal Emergency Relief Administration (F.E.R.A.) and the Works Projects Administration (W.P.A.) which were administered through the Milwaukee Public Library.

From 1933 until 1942, the Milwaukee Public Library and the New Deal were closely linked. Many New Deal programs were of marginal significance, making no lasting impact on the Library and contributing nothing of consequence to the cultural heritage of the community. Among these was the National Industrial Recovery Act or the N.R.A., as its administration came to be called. The

N.R.A. was an attempt at industrial self-regulation coupled with a Federal works program. But as it affected the Library, N.R.A. activity was confined to the regulation of hours in the bindery and adherence to certain purchasing policies and guidelines.[3] By themselves these agreements were unimportant. Yet, in another respect, they signalled a readiness on the part of the Library to enter cooperative undertakings with the Federal government.

Of greater consequence were the varied programs of the C.W.A. and the F.E.R.A. They ranged from the mundane though necessary repair and painting of branch and main libraries to artistic and bibliographic projects such as the reorganization of the card catalog and the restoration of books. These latter projects involved the recopying of 287,500 cards and their redistribution throughout the catalog, and the repair of 17,840 books. These C.W.A. undertakings gave employment to forty-eight persons including six librarians and forty-two clerk typists.[4] Unfortunately, the task was never completed, possibly due to a shortage of funds but more likely because the expenditure of money on library programs *per se* was not yet encouraged.[5] "Blue collar" maintenance work received higher priority. Nonetheless, the work that was completed was considered an important contribution.[6] Moreover, the catalog reorganization was significant in that it represented a departure from the typical roof repair projects which had characterized so many C.W.A. library activities.[7] A valuable precedent was thus created for the more expansive white collar programs of the F.E.R.A. and later the W.P.A.

One such white collar undertaking was an F.E.R.A. music project. The plan entailed the copying and duplication of "good music" in manuscript form. (Fig. 1). In all, 755 selections were completed on master sheets and 67,256 sheets were dittoed.[8] Selection was made on the basis of demand and also on the advice of recognized musicians in the city, among them Herman Smith, supervisor of music in the Milwaukee Public Schools, and Milton Rusch of the Milwaukee State Teachers College.[9] In addition to employing twenty to thirty jobless musicians, the plan enabled the Library's Art and Music Room to meet a borrower demand beyond the capacity of normal library appropriations.[10] The project resulted in what was described as a "splendid collection" that was made available to the general public and also to small churches for use on Palm Sunday and Easter Sunday. It was thought that if the work were continued, it would, in the words of library director Mathew S. Dudgeon, "eventuate in the Milwaukee Library having

FIGURE 1. Music copying under W.E.R.A. Project 40-F5-460.

the finest collection of good music in any library in the country."[11] While a "strict constructionist" might ponder the constitutionality of these displays of government "aid" to religious bodies, none could question the pragmatism of the undertaking. It helped the Library to meet a public need; it put unemployed musicians back to work; and it was the first successful attempt at employing the white collar worker within the Library.

Many C.W.A. and F.E.R.A. projects were haphazardly planned, inadequately funded, or faced with bureaucratic impediments. This was particularly true of the C.W.A. and applied not only to the reorganization of the card catalog, and to book repairs but to "blue collar" programs as well.[12] The Library also attempted to use F.E.R.A. funds to finish repair jobs which had not been completed by the C.W.A.[13] One can surmise that the C.W.A., in providing relief, had embarked upon a murky area in Federal-local relationships, undefined and unprecedented. Consequently, programs such as the catalog reorganization were eliminated because of uncertainties as to whether Federal funds could be used solely for library-related work. Moreover, the C.W.A. was a short term effort of only five months. The above limitations were not peculiar to the Milwaukee Public Library but were characteristic of most C.W.A. and F.E.R.A. programs throughout the country. Hiring restrictions, for example, limited library work almost exclusively to "blue collar" projects.[14]

On the other hand, both the C.W.A. and the F.E.R.A. allowed the Library to satisfy patron demands which would have been impossible with the Library's restricted financial resources. It is interesting to note that such library projects did not constitute "made work", as even the maintenance jobs were long overdue, or, like the catalog reorganization, had been planned years in advance. They did not constitute "boondoggling" as that word is generally understood.

The W.P.A., the third New Deal bureaucracy to operate within the Library, was the most successful in terms of duration, lasting contributions and sheer variety of programs. Undoubtedly much of the W.P.A. success in the Milwaukee Public Library can be attributed to the fact that both local and Federal officials learned a great deal from their past mistakes.[15] There was not the same pell-mell rush to put people to work as was typical of other works programs. Rather, the W.P.A. possessed what one writer has called a "unity of purpose" and a "continuity of operation"[16] which lent a characteristic stability to all of its undertakings.

Initially, W.P.A. programs were characterized by the stock-in-trade manual labor projects. But they were important. Consider, for example, the repair of books. During 1935-1936 alone 422,841 books were renovated[17] and tens of thousands more in the years following. (Fig. 2). In fact, the enormity of the book binding project was such that Dudgeon noted that he knew of no bindery prepared to do that amount of work.[18] In any case, the limited city budget which had already reduced Library expenditures by twenty-five per cent simply would not allow for sending books out for repair.[19] The binding project takes on an added significance, when it is considered that thousands of volumes were in "desperately bad condition" and some collections near collapse.[20] To prevent deterioration, W.P.A. workers shellacked and varnished the covers of all new books and reinforced their bindings, thereby doubling the books' durability. Similar procedures were applied to older books. Without this conservation policy, the library might have experienced a net loss of over 100,000 volumes.[21] Richard Krug, who succeeded Dudgeon in 1941, fully appreciated the W.P.A.'s contribution when he wrote to a W.P.A. supervisor, "I cannot emphasize too strongly the importance of the W.P.A. menders and

FIGURE 2. Book mending under Project 7787.

book repairers to the library," further noting that the the institution could not have assumed such a burden by itself.[22] The total Federal contribution to the project came to $877,475, which was really a small price considering what was gained.[23]

As the W.P.A. gained momentum, it branched out into areas which suggested imagination and special concern for the needs of artists, businessmen, and scholars. White collar work became dominant and questions of whether money could be used for library work *per se* were no longer raised. Included were bibliographic and indexing undertakings of major proportions: the indexing of the federal censuses for 1860 and 1870, a Union List of Serials, and the *Milwaukee Sentinel* Newspaper Index.

The census indices were important for several reasons: They could be used to establish eligibility for citizenship and for pensions. They were also of historical value at the State Historical Society of Wisconsin. Undoubtedly, they aided many genealogists doing research in family history. Hitherto it had been difficult and time consuming, if not impossible, to locate the name of a forebear because names were entered in the order in which the census taker visited the homes. But the 70,000 index cards which the project created were alphabetically arranged with a citation to the volume and page where the name could be found.[24] Almost forty years after its creation, the census indices located in the Local History Room of the Milwaukee Public Library remain an important research tool, both for the amateur genealogist and especially for the Milwaukee County Genealogical Society.

Unquestionably the most significant W.P.A. venture in the Milwaukee Public Library was the *Milwaukee Sentinel* Newspaper Index, jointly sponsored by the Library, the Milwaukee State Teachers College, and the Milwaukee County Board of Supervisors. It was hoped that the Index would "supply an unbroken chain of information from the earliest days to the present day."[25] *The Milwaukee Sentinel* was chosen both because it was the earliest newspaper in circulation and because it provided the best continuity and had the largest number of issues available.

Newspaper indexing was a common W.P.A. library project throughout the United States. The Cleveland Public Library had its *Annals of Cleveland.* But the *Sentinel* Index was unique in that all information about a person or subject appeared under one entry and thus saved the researcher the bother of having to consult a number of volumes, as in the *Annals.* Like the *Annals*, the *Sentinel* Index was never completed. Only the years 1837-1879 were finished. The library was left holding over 750,000 cards, 70,000 feet of microfilm, and several thousand unfinished entries.[26] Although incomplete, the Index stands at the pinnacle of W.P.A. achievements. It remains today as a major aid for the historian, the student and the genealogist doing research on Milwaukee and Wisconsin.[27]

The Union List of Periodicals was the last link in the triad of bibliographic projects. The plan was a cooperative undertaking of the Municipal Reference Library in City Hall, the Milwaukee Public Library, and the Milwaukee chapter of the Special Libraries Association. The Reference Room of the Milwaukee Public Library played an important role in assembling and coordinating the list. The purpose of the Union List was to increase bibliographic access to expensive business magazines, proceedings, and other periodicals which were owned by several business libraries in the city and by the Milwaukee Public Library. This could be done by compiling a list of libraries that held certain titles. It was felt that the List would have the dual advantage of pooling resources but allow the libraries to retain their own identities. The outcome of the project, a 250 page book which gave the libraries access to 5,000 reference sources, was indeed a marked improvement from the previous average of 44 magazines in each library.[28] Aside from its obvious value of broadening the base of what were frequently very specialized publications, the Union List demonstrated the innovative ways in which the W.P.A. and its co-sponsors were able to respond to the needs of Milwaukee's businesses and industrial economy.

A second major division of white collar work consisted of a variety of art and music programs, from the preparation of music scores to live performances. The library's role rested upon its willingness to be sole sponsor as well as to cooperate with other agencies. For example, W.P.A. bands gave live performances at the Library.[29] The significance of these concerts should not be overlooked as they undoubtedly served to relieve some mental anxieties, furthered social contacts and perhaps helped people temporarily to forget their economic plights.

Copying of music was another program carried out by the Federal Music Project. The plan was essentially a continuation of the W.E.R.A. project noted earlier but far more extensive in that it attempted to raise the cultural level of the community. For example, it provided for the teaching of music to under-privileged groups and for lectures, forums and panel discussions on "music as an art and as a social agency".[30] The copying itself was a success both locally and nationally. Worked out by the Library's capable director, M. S. Dudgeon, it employed up to sixty eight musicians who copied scores on which the copyrights had expired. Some of the scores were rare and old compositions lent to the library by local musicians who had extensive musical libraries.[31] Exact figures as to how many pieces were copied, vary and were admittedly difficult to tabulate. But one report noted that from 322 selections there were made 5,999 masters and 42,386 dittos.[32] The scores were kept in the library and lent to the public on the same basis as library books. From 1939-1941, over 2900 selections were circulated.[33] That the music attained the highest standards of excellence is evidenced by the fact that Bach's Chorales were used by the Music Educators National Conference and the State Teachers Convention.[34] Moreover, the project attracted attention from other parts of the Midwest. Librarians came from Ohio, Michigan and Indiana to observe what was being done in the Library.[35]

The music copying project was important because of the quality of the work, the people it employed, and the cultural heritage it created for the Library. Almost thirty years after its completion, Richard Krug could still affirm that the W.P.A. orchestration copying project was "a valuable part of the library's music collection."[36]

Library exhibits on practical how-to-do-it skills such as etchings, woodcuts, lithography, and air brush art were yet other facets of W.P.A. "art" work.[37] These exhibits were important because they furnished employment and because they indicated a reluctance to give narrow interpretations to the idea of art. Once again, the pragmatic and innovative character of the New Deal carried the day.

W.P.A., like many New Deal recovery and reform agencies, fell victim to World War II. Yet it is interesting to note the degree to which the onset of war shaped the character of some later W.P.A. programs. As war clouds hovered over Europe, America's munition plants began to tool up as the "arsenal of democracy." F.D.R.'s image as "Dr. New Deal" was replaced with "Dr. Win-the-War." Similarly, the W.P.A. played important roles in national defense both in the construction of war material and in serving as an information source, once America entered the conflict. Playing a part in the latter capacity was the War Information Center of the Milwaukee Public Library.

The War Information Center was established by the Library in conjunction with the W.P.A. to deal with a variety of war-related questions which "cut across the normal divisions of library work."[38] Its functions were threefold: to supply information about the war's progress on both home and fighting fronts; to keep records of Milwaukee's part in the war effort; and to cooperate with the Victory Book Campaign.[39]

These activities were influenced by the trends of the war. In the initial stages of the conflict, the thrust of the Center was toward civilian defense. Thus, it maintained lists of air raid wardens in Milwaukee County, indexed a twelve volume set of Milwaukeeans who had served in World War I, clipped newspapers for information related to the city's war efforts, and maintained index cards on Milwaukee County men and women in the service.[40] As more and more Americans faced the prospects of induction, as the public wanted to know about areas in which their countrymen were fighting, or the names of important allied and axis military personnel, the center's work gravitated toward the military aspects.[41]

When one views the multitude of tasks to which the War Information Center addressed itself, it is easy to understand the disappointment that followed the closing of the Center, a victim of the W.P.A.'s dissolution in 1942. The quality of its contributions is the more surprising in that it was staffed by fourteen people with little or no library experience.[42] So successful was the Center that it received national recognition from the National War Office of Civilian Defense and the American Library Association for its community activities.[43] The Board of Trustees made a concerted effort to save the Center by operating it under Library auspices because of its informational services and because it was the only department in the county that kept a systematic record of Milwaukee's role in the war.[44] But these efforts came to nothing. Support within the Board of Estimates was lukewarm at best.[45]

With the closing of the Center, the work of the New Deal in the Library came to an end. Its overall accomplishments were important both then and now. Its services permitted the Library to fulfill some normal obligations to the public which had been curtailed by depression budgets, and some of the projects, notably the *Sentinel* Index, went far beyond the normal expectations of library service. Some of the W.P.A. work survives to this day. The Local History Room has thousands of war related photographs left from the War Information Center; the census indices are a continuing boon to genealogical workers; and one could scarcely imagine not using the *Sentinel* Index for research on Milwaukee and State history prior to 1879.

Surprisingly, all of these achievements were carried out with an absence of serious friction. There were no fights over "turf," as it were, between W.P.A. and library personnel. Rather the relationship was one of "unusual cooperation."[46] Perhaps this harmony can be attributed to the leadership provided by the city librarians, Matthew Dudgeon and Richard Krug. Both men had excellent administrative backgrounds which created a "can-do" atmosphere.[47] Interestingly enough, both had law degrees and no formal training in librarianship. One should also consider that the caliber of W.P.A. workers assigned to library projects was uniformly high. The depression had created a desperate employment situation which encouraged in many a desire for work and productivity. This positive outlook toward the W.P.A. projects was shared by Milwaukeeans in general. As one former W.P.A. supervisor has commented, "people wanted to work."[48]

It is also worth noting that library participation in the New Deal was comprehensive in scope and not limited to one small or traditional aspect of library operations. This is best illustrated by pointing to some of the projects which never materialized. Among them were plans for a separate Sports Room; a Collection of Foreign Language Publications which would have operated like a union list;

and especially, a Circulation Survey Project which would have attempted to determine precisely how many people used the library and when.[49] No evidence remains as to why these plans were never carried out. Yet they strongly indicate that everything within the library from circulation to technical operations was thoroughly appraised so as to improve services to all clients.

The increasing contributions of the C.W.A., F.E.R.A. and the W.P.A. to the Library take on a final significance, when one compares Federal expenditures for white collar projects in the Library with those in other city institutions. In 1935, the Library ranked eighth out of seventeen agencies, receiving but 0.35% of Federal appropriations. By 1942, it ranked second out of eleven, receiving 6.31%.[50] This sharp increase reflects the diversification and expansion of white collar work and usefulness which allowed the W.P.A. to prosper even after the war had started. By way of comparison, the W.P.A. in the Cleveland Public Library was moribund by 1940.

One could conclude by saying that the white collar thrust of the New Deal was momentous because of its utility, the quality of its work, or because of its legacies to the community. But Harry Hopkins captured the true flavor and humanity of its intent in his frequently quoted statement that the unemployed white collar workers got hungry, and they too had to eat.[51]

NOTATIONS

1Quoted in William W. Breme, "Along the American Way": The New Deal's Work Relief Programs for the Unemployed, Jour. Amer. Hist. 62, 637, 1975.

2William Leuchtenberg, *Franklin D. Roosevelt and the New Deal* New York, p. 124, 1963.

3M. S. Dudgeon, Secretary of the Board of Trustees and library director to Joseph W. Nicholson, City of Milwaukee purchasing agent, Sept. 16, 1933; "Minutes of the Board of Trustees," Dec. 12, 1933; "Memo for Consideration of the Board," Oct. 10, 1935; Frank T. Boesel, Milwaukee N.R.A. Compliance Board, to M.S. Dudgeon, April 3, 1934. All citations in *Proceedings of the Board of Trustees.* Hereafter cited as *Proceedings.*

4"Memo for Consideration of the Board," Dec. 12, 1933; Dudgeon to R.E. Stoelting, Commissioner of Public Works and city member of the Local Civil Works Board, Dec. 2, 1933, *Proceedings.* Unidentified typescript, "Final Completion Report for C.W.A. Project #151, Dec. 8, 1933.

5"Minutes of the Board of Trustees," Dec. 12, 1933, *Proceedings.*

6"Memo for Consideration of the Board," Apr. 10, 1934, *Proceedings.*

7Dudgeon to Stoelting, Dec. 2, 1933, *Proceedings.*

8Typescript, "Progress Report," W.E.R.A. Project 40-F5-460. Copying and Reproducing Music. Hereafter cited as W.E.R.A. Project 40-F5-460.

[9]Clipping, *Milwaukee Leader*, Feb. 2, 1934, W.E.R.A. Project 40-F5-460.

[10]"Memo for Consideration of the Board," Jan. 8, 1935, *Proceedings*.

[11]"Memo for Consideration of the Board," Dec. 12, 1933; "Minutes of the Board of Trustees," May 14, 1935; "Memo for Consideration of the Board," Mar. 12, 1935. *Proceedings;* clipping, *Milwaukee Leader*, Feb. 2, 1934; W.E.R.A. Project 40-F5-460. The music project operated under the aegis of the Wisconsin Emergency Relief Administration (W.E.R.A.), which distributed federal funds. See William P. Raney, *Wisconsin, A Story of Progress*, New York, p. 495-497, 1940.

[12]Both of these projects were revised under the F.E.R.A. See typescript, "Cataloging, Filing, Book Rehabilitation," July 17, 1935. Project 40-F7-150. Records and Catalog.

[13]"Memo for Consideration of the Board," May 8, 1934, *Proceedings*.

[14]See Edward Barrett Stanford, *Library Extension under the W.P.A., An Appraisal of an Experiment in Federal Aid*, University of Chicago Press, 1944 p. 24, 31.

[15]Interview: Harry Janicki, former supervisor of W.P.A. projects, June 23, 1976, Brown Deer, Wisconsin.

[16]Stanford, op. cit., p. 2.

[17]"Summary of Situation," Mar. 8, 1937, *Proceedings*.

[18]Dudgeon to C.J. McGrane, Project Engineer, Jan. 26, 1939. Project 447. Rehabilitation of Books.

[19]Roy Charmock, District Director to Don Teter, W.P.A. Supervisor, Sept. 23, 1935, *Ibid;* typescript, "Supplementary Information and Operating Schedule Sponsor No. 229" Project 7787. Book Binding and Repair.

[20]"Summary of Situation," Mar. 8, 1937. *Proceedings*.

[21]*Ibid.*

[22]Krug to Harriet Clinton, W.P.A. Supervisor, July 14, 1941, W.P.A. Mending Project.

[23]"W.P.A. Mending Project Copy" W.P. A. Mending Project. The project was not limited to book repair but also included the preparation of bibliographies, the cataloging of unclassified library materials and several other tasks. See Project 7787. Book Binding and Repair.

[24]"A brief summary of library activities for 1937," Mar. 8, 1938, *Proceedings*.

[25]*Ibid; Milwaukee Newspaper Index Project* (Manual) September, 1941.

[26]Daniel F. Ring, "The Cleveland Public Library and the W.P.A.: A Study in Creative Partnership," Ohio Hist. 84: (Summer, 1975) 160; *Minutes of the Board of Estimates*, Oct. 29, 1942, p. 420-421; "Minutes of the Board of Trustees," Oct. 13, 1942, *Proceedings; Milwaukee Newspaper Index Project.*

[27]Clipping, *Milwaukee Sentinel*, Dec. 18, 1963, Milwaukee Sentinel Index File. In 1969 Dr. Herbert Rice began the awesome task of "editing, combining, alphabetizing, and interalphabetizing" the items for the years 1880-1890. For further information see his "The Milwaukee Sentinel Index," *Milwaukee Reader and Calendar of Local Events*, 30, Apr. 24, 1972.

[28]*Union List of Periodicals* (Manual) preface, Mar. 20, 1939.

[29]William V. Arvold, State Supervisor, W.P.A. Music Project, To Krug, Apr. 23, 1941, W.P.A. Music Copying Project.

[30]Teter to Dudgeon, Oct. 9, 1939. Project 10032. Music State Wide.

[31]*Milwaukee Journal,* Aug. 25, 1935; Dudgeon to Teter, Nov. 13, 1938. W.P.A. Music Copying Project.

[32]"Final Report W.P.A. Program — City of Milwaukee," Oct. 1, 1942. Project 2211. Copying and reproducing music scores to be kept in Public Library.

[33]"Art Department," *Department Reports,* 1941.

[34]"Art and Music Department," *Progress Reports,* 1942.

[35]*Milwaukee Journal,* Aug. 25, 1935.

[36]Clipping, *Milwaukee Journal,* Feb. 11, 1975. Milwaukee Public Library Clipping Collection. *The Catalog of Musical Selections in Milwaukee Public Library Reproduced under the Federal Music Project,* (1937) is itself a superb guide and well worth looking at.

[37]"Art and Music Department," *Progress Reports,* 1942.

[38]"Memo for Consideration of the Board," Dec. 8, 1942, *Proceedings;* A.L. Wapp, Superintendent, W.P.A. to Krug, Aug. 5, 1941. War Information Center.

[39]"Memo for Consideration of the Board," Dec. 8, 1942. *Proceedings;* "Sponsors Request for Project Authorization and Sponsors Agreement," War Information Center; "Memo for Consideration of the Board," Jan. 13, 1942, *Proceedings.* The Victory Book Campaign was an effort on the part of the Red Cross, the U.S.O. and the American Library Association to acquire books for servicemen.

[40]"War Information Center," *Progress Reports,* 1942.

[41]Unidentified newspaper clipping, May 25, 1942, Milwaukee Public Library Clipping Collection.

[42]"War Information Center," *Progress Reports,* 1942.

[43]Krug to Wapp, Apr. 13, 1942. Project 1005. Library-State-Wide.

[44]Unidentified newspaper clipping, Dec. 9, 1942, Milwaukee Public Library Clipping Collection; "Memo for Consideration of the Board," Dec. 8, 1942, *Proceedings.*

[45]*Minutes of the Board of Estimates,* Dec. 9, 1942.

[46]Dr. Herbert Rice, former supervisor of *Sentinel* Index, communication to author, May 30, 1976.

[47]Interview, Harry Janicki, June 23, 1976; Interview, Kenneth Haagensen, former Project Director, Milwaukee, Wisconsin, June 25, 1976; telephone interview, Harry Friedman, former projects technical advisor for *Sentinel* Index, June 11, 1976. Dudgeon had served in various capacities as a lawyer, legislator and district attorney before becoming director in 1920. Krug had been Municipal Reference Librarian 1930-1939 and assistant city librarian from 1939-1941.

[48]Interview, Harry Janicki, June 23, 1976.

[49]See folders "W.P.A. Sports Room," "W.P.A. Circulation Survey Project" and "W.P.A. Miscellaneous" in Local History Room, Milwaukee Public Library.

[50]City *of Milwaukee W.P.A. Work Accomplished and Money Expended, 1935-36, 1942-43.* In 1935, white collar work in the city bureaus ranked in the following order: School Board, Public Museum, City Comptroller,

Health Department, Tax Assessor, Fire Department, Vocational School, Public Library, City Treasurer, Building Inspector, Real Estate Division, Harbor Commission, Land Commission, City Clerk, Municipal Reference Library, City Attorney, Layton Art Gallery. In 1942, the order was Land Commission, Public Library, Civilian Defense, Health Department, Public Museum, School Board, City Comptroller, Municipal Reference Library, Building Inspector, City Treasurer, Tax Enforcement.

[51]Cited in Frank Freidel, American Historians: a Bicentennial Appraisal, Jour. Amer. Hist. 63 (June, 1976), p. 7.

LANDFORM DISTRIBUTION AND GENESIS IN THE LANGLADE AND GREEN BAY GLACIAL LOBES, NORTH-CENTRAL WISCONSIN

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ABSTRACT

Landforms in the Langlade Lobe have a distribution characteristic of many glacial lobes in the midwest. In the nothern part of the Green Bay Lobe, landform distribution is more complex, with several recessional moraines and extensive areas blanketed with outwash and ice-contact stratified drift. Three landform zones are recognized: 1) an end moraine zone made up of five ridge types based on orientation, lithology, and form; 2) an intermediate zone of ground moraine, eskers, and kames (not present in the Green Bay Lobe); and 3) a zone of erosional drumlins.

The Langlade Lobe advanced twice from the highlands of the Upper Peninsula of Michigan obliquely down the regional bedrock slope. The Green Bay Lobe repeatedly advanced up the regional bedrock slope out of the Green Bay lowland. The differences in landform distribution and development between the two lobes is due primarily to contrasting bedrock slopes of the glacier bed and secondarily to the pattern of advances and retreats of each lobe.

INTRODUCTION

Numerous authors have noted a similarity in the distribution of glacial landforms in areas formerly covered by the lobes of continental ice sheets (Flint, 1971). The fact that this classic distribution is so common despite differences in the scale, thermal regime, and bed lithology of the glaciers involved suggests that the distribution of landforms in glacial landscapes is determined primarily by 1) the glaciological conditions which prevailed at or near the maximum of a glacial advance, and 2) the location of the landforms with respect to the center of the ice sheet or lobe (Sugden and John, 1976). However, not all glacial landscapes exhibit this classic distribution due to a number of other locally important factors (Clayton and Moran, 1974). We will discuss the importance of two of these factors — regional bedrock slope and glacial history — in determining landform distribution in the Langlade and Green Bay glacial lobes in north-central Wisconsin.

Because only one major recessional moraine exists, and in most areas is adjacent to the terminal moraine, the landforms of the Langlade Lobe conform to the classic distribution of landforms within a lobe. The landform distribution in the northern part of the Green Bay Lobe is more complex, with several recessional moraines and extensive areas blanketed with outwash and ice-contact stratified drift. We will discuss the landforms of both lobes in terms of zones similar to those proposed by Clayton and Moran (1974), Sugden and John (1976), and earlier workers, in which sets of landforms exist in an orderly fashion. We feel that the degree of development of these zones can be explained primarily by the differences in the pre-Woodfordian topography of the areas over which these lobes advanced. As Thwaites (1943) noted, the ice from the Green Bay Lobe advanced up the regional slope out of the Green Bay Lowland. The ice of the Langlade Lobe, after crossing the highlands of the Upper Peninsula of Michigan, advanced obliquely down the regional slope. Other factors, such as differences in the length of time the ice was in an equilibrium position, the thermal regime of the base, or bed lithology, which might have influenced landform distribution and development are difficult to distinguish from the overriding influence of topography.

We have previously discussed the till lithologies and glacial chronology in north-central Wisconsin in detail in Mickelson, Nelson, and Stewart (1974) and Nelson (1973). During Woodfordian (late Wisconsin) time, ice advanced into north-central Wisconsin from the southeast (Green Bay Lobe), the northeast (Langlade Lobe), and the north and northwest (Wisconsin Valley Lobe) (Fig. 1). Prominent terminal moraines were built by each lobe and the existence of these moraines has been recognized since the work of Chamberlin (1883.). The lobes were named by Weidman (1907) who assumed the ice advances in each lobe were simultaneous. Subsequent reconnaissance mapping by Thwaites (1943), who named all of the moraines mentioned in this study except the Harrison Moraine, outlined the basic distribution of drift in the Langlade and Green Bay Lobes. Thwaites argued that the deposition of the terminal moraines in the three lobes was contemporaneous and that ice masses of the Langlade Lobe and Green Bay Lobe were in contact with each other during retreat. From our recent work we can demonstrate that these moraines are

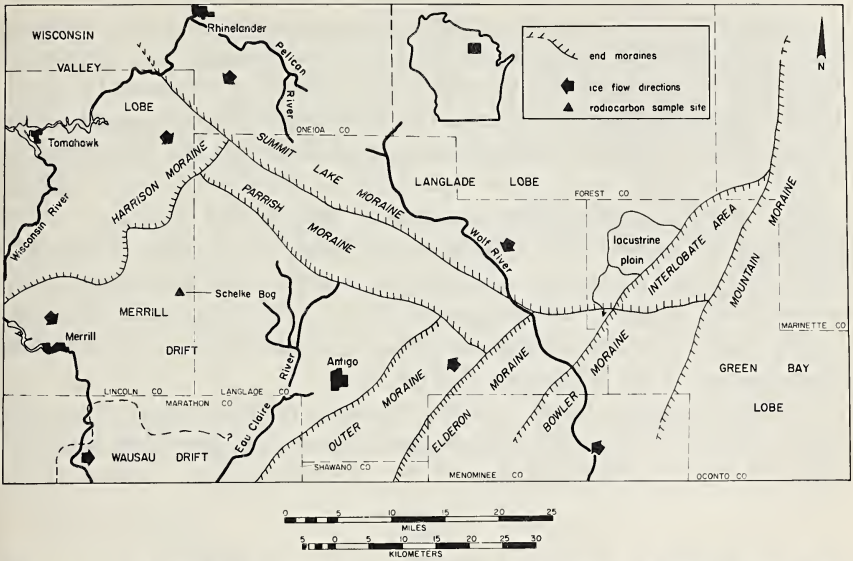

FIGURE 1. Location map of north-central Wisconsin showing ice flow directions, major moraines, drift boundaries, and other physiographic features. The Merrill and Wausau Drifts and Schelke Bog Site which pre-date the late Wisconsin moraines are discussed in Stewart & Mickelson (1976).

not really time equivalents, although all of the events described took place during Woodfordian time (about 12,500-20,000 years ago).

THE LANDFORM ZONES

End Moraine Zone

Our end moraine zone is much like the wastage zone of Sugden and John (1976) and the marginal suite of Clayton and Moran (1974), consisting mainly of till ridges oriented parallel to the former ice margin with some ice disintegration features along the inner edge of the zone.

Four genetically different lithologies make up the sediments of the end moraine zone — lodgement till, ablation till, ice-contact stratified drift, and outwash. Differences between ice-contact stratified drift and outwash are due chiefly to deposition behind and in front of the ice margin respectively (Price, 1973). Although more detailed till classifications have been proposed (Boulton, 1968; 1970) we prefer the two-fold lodgement-ablation classification used by Flint (1971) and Dreimanis and Vagners (1971) because of difficulty in distinguishing till deposited by meltout and flow processes particularly in coarse-grained tills.

Lodgement tills in north-central Wisconsin can be distinguished from ablation tills on the basis of stratigraphic position, thickness, color, grain size variability, and pebble fabric orientation (Nelson, 1973). Lodgement till in the end moraine zone of the Langlade Lobe is typically 1-7m thick with red-brown (2.5YR4/6 to 5YR4/4) colors, massive to platy structure, approximately 6% clay, and strong pebble fabrics perpendicular to the larger end moraines. The overlying ablation till is light brown (7.5YR6/3) in color, massive to semistratified and very friable, and has no preferred pebble orientation, at least from outcrop to outcrop. Grain size distribution in the latter averages 73% sand, 26% silt, and 1% clay, but is highly variable, as is the thickness (0-4m).

In the Langlade Lobe the end moraine extends from the distal edge of the Parrish Moraine to the proximal edge of the Summit Lake Moraine, and averages 12 km in width (Fig. 2). Due to the

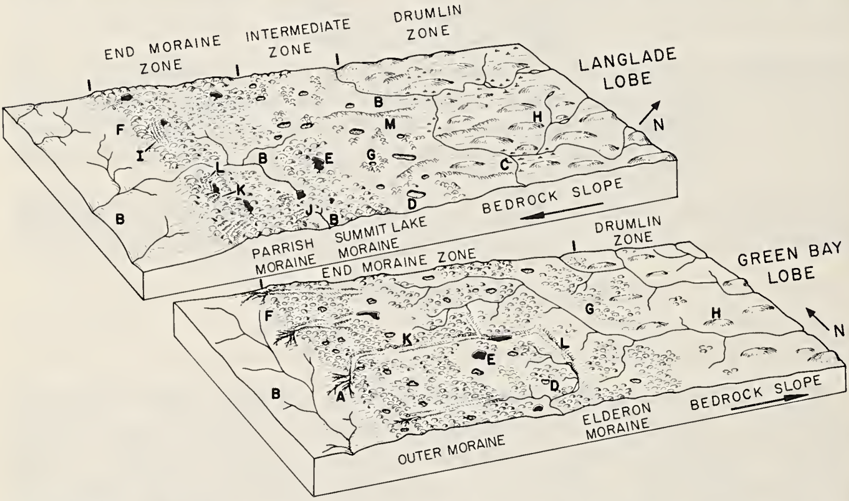

FIGURE 2. Physiographic diagrams of general landform distribution in the Langlade and Green Bay Lobes. The diagrams are not to scale, but are diagrammatic illustration of the landform zones and features (referenced by capital letters) found in each lobe.

A. Outwash fan
B. Outwash plain
C. Marsh Deposit
D. Kettle-hole (dry)
E. Kettle-hole lake
F. Outwash apron on moraine front
G. Kames
H. Drumlin
I. Ridges of till parallel to ice front (Type 1)
J. Ridges of till perpendicular to ice front (Type 2)
K. Ridges of sand and gravel perpendicular to ice front (Type 3)
L. Ridges of sand and gravel parallel to ice front (Type 4)
M. Esker

many recessional moraines and extensive outwash deposits, the end moraine zone of the Green Bay Lobe is wider (16 km), extending from the distal edge of the Outer Moraine to the drumlin zone, with no distinguishable intermediate zone of low ground moraine composed of till and ice-contact stratified drift, as in the Langlade Lobe.

The complex and widely distributed ridges which make up most features in the end moraine zones of each lobe can be divided into five types (Fig. 2): ridges composed dominantly of lodgement till and oriented parallel to the ice margin (Type 1), those made up of lodgement till and oriented perpendicular to the ice margin (Type 2), those made up of ablation till and stratified drift and oriented perpendicular to the ice margin (Type 3), those made up of ablation till and stratified drift and oriented parallel to the ice margin (Type 4), and those without particular orientation (Type 5).

Type 1 Ridges

Type 1 till ridges, oriented parallel to the former ice margin, average 1.2 km in length, 300 m in width, and 20 m in height in the Outer Moraine and are up to 1.5 km long, 400 m wide, and 30 m high in the Parrish Moraine (Fig. 3). Although they are lower and less continuous, these ridges are also present within the recessional moraines throughout the Green Bay Lobe. The higher relief in the Parrish and Summit Lake Moraines results in more exposures in these ridges, some of which contain lodgement till with pebble fabrics (Nelson, 1973) consistent with expected ice flow directions overlain by up to several meters of ablation till. The origin of these ridges, however, is uncertain. They may be due to increased deposition where till was sheared up along concentrations of shear planes near the ice margin, followed by meltout deposition of ablation till.

The smaller ridges containing lodgement till may have been formed in part by ice shove or stacking of till near the margin. Exposures are poor, however, and evidence for this is lacking. Another possibility is that most basal till deposition was taking place in a very narrow zone near the ice margin and that the ridges represent brief pauses in retreat of ice margin position or pulses in the rate of till deposition in time.

Type 2 Ridges

Although far less common than other ridge types in the Parrish and Summit Lake Moraines, Type 2 ridges, perpendicular to the ice

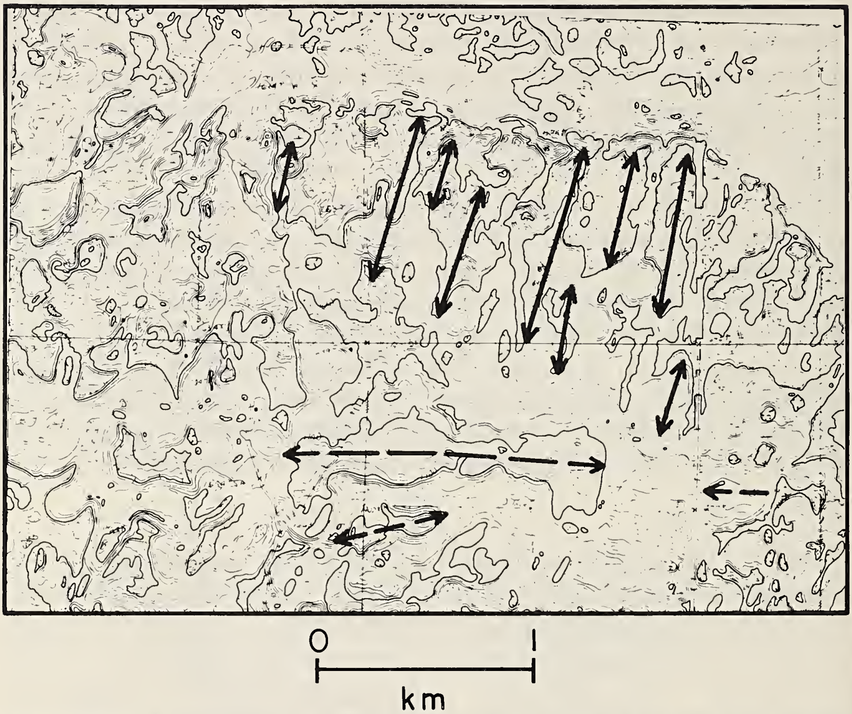

FIGURE 3. Lodgement till ridges oriented parallel to ice flow (solid arrows) and perpendicular to ice flow (dashed arrows) in the Parrish Moraine of the Langlade Lobe north of the town of Antigo (Fig. 1). North is at top of map (from USGS Elcho S. E. Quadrangle).

margin, occur in parts of the proximal side of the Parrish Moraine. Here parallel ridges of lodgement till (some with a 1 m veneer of ablation till) are about 10 m high and 100-150 m apart (Figs. 2 and 3). They begin abruptly at the proximal edge of the moraine and extend nearly to the crest. Mechanical analyses, till color, and a till fabric measurement indicate that these ridges are composed of basal till and represent large grooves on the till surface. No evidence was found for features of this type in the Green Bay Lobe, although similar ridges in this lobe could have been buried by later outwash.

Type 3 Ridges

Type 3 features are ice disintegration ridges as defined by Gravenor and Kupsch (1959). Most of those perpendicular to the former ice margin are probably ice channel fillings formed both above and beneath the ice. The largest ridges (700 m long, 200 m wide, and 10 m high) are found in the Langlade Lobe, primarily near the crest of the moraines and on their distal sides (Fig. 2). No flow direction studies have been done, but these ridges were probably deposited by water flowing toward the outer margin of the ice or by slumping of washed materials into longitudinal (splaying) crevasses.

Several much larger features found only in the Green Bay Lobe, are channels which have ice disintegration ridges 20 m high lining their sides, are up to 12 km long and 0.5 km wide and appear to be ice-contact drainageways which were meltwater outlets while the Green Bay Lobe was at the Outer Moraine (Figs. 2 and 4). The channels are the result of either subglacial drainage similar to the tunnel valleys of the Superior Lobe in Minnesota discussed by Wright (1973) or large englacial or supraglacial streams flowing

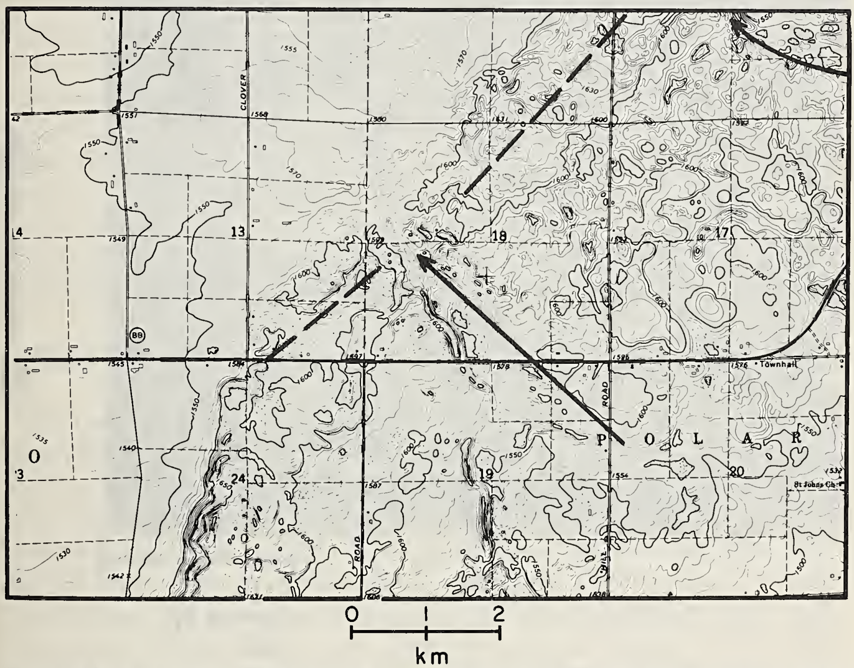

FIGURE 4. Two examples of large ice-contact drainageways (solid arrows) through the Outer Moraine (dashed line) of the Green Bay Lobe about 8 km northeast of the town of Antigo (Fig. 1). The drainageways were the primary outlets for meltwater while the ice was at the position of the Outer Moraine. North is at top of map (from USGS Antigo S. E. Quadrangle, 1976).

out of or off the ice. The hydrostatic head needed to develop channels flowing up the regional slope may have been supplied by a northwest sloping ice surface profile. Ice flowing to the northwest from the center of the lobe in Green Bay would have provided such a

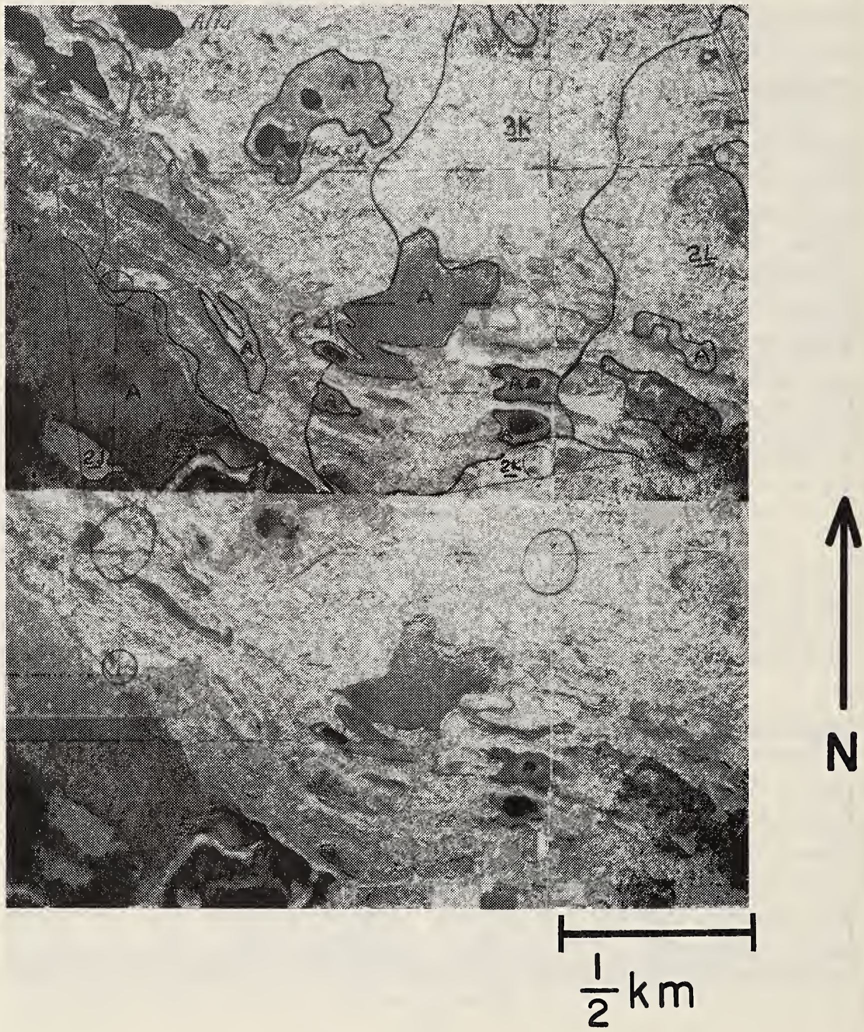

FIGURE 5. Air photo stereopair (photo no. BHW-5-44, 45, 1936) in the western part of the Parrish Moraine (NE 1/4, S24, T33N, R10E) showing parallel ridges of sand and gravel which are probably small coalescing outwash fans built synchronously along an ice margin. Symbols on the upper photo refer to an earlier soils mapping sheet.

gradient. That deposition of material was predominantly on or in ice can be seen by the collapsed nature of the deposits.

Type 4 Ridges

Ice disintegration ridges generally parallel to the ice margin occur discontinuously in the Parrish Moraine along its distal edge. South of Summit Lake the largest ridges are 4 km long and reach a height of 17 m. Five roughly parallel ridges occur *en echelon* in this part of the moraine (Figs. 2 and 5). Exposures in these features show inclined planar-bedded sand and gravel suggesting that the ridges are small coalescing outwash fans built synchronously along an ice margin.

In the Green Bay Lobe the smaller scale features of this type are not prominent, but thick, widespread sheets of outwash found in some areas of the Green Bay Lobe might have been spread over thin stagnant ice, thus hiding the evidence for disintegration ridges forming during deglaciation. In fact, the extensive pitted outwash in the Green Bay Lobe is probably analogous to these ridges in the Langlade Lobe. However, along the proximal edge of and within the Elderon Moraine (Fig. 1), large channels up to 5 km long and 0.5 km wide and oriented parallel with the moraine have been eroded in the drift (Fig. 2). Also noted by Thwaites (1943), these probably were developed along an ice margin between the higher areas of recessional moraine as the ice stagnated during retreat. No analogous channels have been identified in the Langlade Lobe.

Type 5 Deposits

The end moraine zones of both the Langlade and Green Bay Lobes also contain numerous smaller ice-contact forms (Type 5 deposits) such as ice-contact rings, kames, kettles, and moraine lake plateaus like those which have been described from other areas of ice stagnation (Parizek, 1969). The size of these features suggests that a debris layer several meters thick must have covered some areas of the ice near the terminus. Exposures in these deposits contain large blocks of slumped sediment, flow structures, blocks of till within stratified bodies of sand and gravel, and irregular thicknesses of ablation till due to topographic inversion during disintegration of the ice masses. The density and relief of these features in the Green Bay Lobe is less than in the Langlade Lobe due to partial burial by extensive, pitted outwash deposits. The moraine lakes which built the small circular plaeaus in the Parrish Moraine were of the "uncoalesced ice-walled" type proposed by Clayton and Cherry (1967) and were formed over a short period in a relatively unstable stagnant ice environment. Several small circular elevated plains found in the Outer Moraine south of Antigo may also have a moraine lake origin.

Outwash

Additional depositional contrasts are evident in the outwash areas in front of the end moraine zones of each lobe. A wedge-shaped apron of outwash was deposited along the Parrish Moraine of the Langlade Lobe, while the ice stood at the moraine. Exposures up to 15 m deep near the moraine contain coarse, bouldery outwash which gradually thins to the south. The gently rolling topography with a southerly bedrock slope enabled streams from the Langlade Lobe to spread this outwash over a wide area as far south as Antigo (Figs. 1 and 2).

The outwash in front of the Outer Moraine of the Green Bay Lobe is also quite extensive in the Antigo flats area, although the apron is not as thick and continuous near the moraine. The latest drainage from the ice carried water southward along the moraine front into the present Eau Claire River drainage south of Antigo. Drainage from the Parrish Moraine probably also contributed to the cutting of channels across the flats. The large ice-contact drainageways described under Type 3 ridges may have provided much of the outwash on the Antigo flats. Each of the drainageways deposited an outwash fan where it breaches the Outer Moraine (Figs. 2 and 4), suggesting that while the Green Bay Lobe stood at the Outer Moraine, large streams flowing from under or within the ice were depositing outwash over the Antigo plain. As the ice retreated from the moraine, the relief of the moraine and the southeast bedrock slope insured that later outwash was deposited within and between the later recessional moraines.

Intermediate Zone of Ground Moraine

The intermediate zone of ground moraine (Fig. 2), from 0 to 8 km wide, is present only in the Langlade Lobe where it consists of low, rolling ground moraine of thin till and ice-contact stratified drift with eskers up to 10 km long and numerous kames. These features were partially buried by outwash along the distal side of the

Summit Lake Moraine. Little ablation debris is present on the lodgement till in this zone. Sugden and John (1976) attribute the lack of ablation till in this zone of an ice sheet to the small amount of material carried into englacial positions because of reduced compressive flow away from the margin of the ice. Alternatively, if retreat was rapid in comparison with that of the ice margin as it stood at the terminal moraine, little ablation till would be deposited in this zone even from debris-rich ice. The advance of ice in the Green Bay Lobe to the Elderon and Bowler Moraines (Fig. 1) may have destroyed this zone if it existed during the formation of the Outer Moraine and many features may be covered with later outwash.

Zone of Drumlins

Numerous drumlins (in the sense of elongate hills) with a southwest orientation are present in the Langlade Lobe north and northeast of the intermediate and end moraine zones about 16 km behind the terminal moraine (Fig. 2). Dimensions average 600-1200 m by 100-300 m, but some drumlins are up to 2.5 km long. Although many drumlins are partially buried, heights reach 30 m above the surrounding outwash.

The internal characteristics of the majority of the Langlade Lobe drumlins were not examined, but cuts through and cores of about ten of them show outwash, flat-bedded where it can be seen, of the Green Bay Lobe. In one gravel pit in southern Forest County about 10 m of gravel is underlain by at least 18 m of sand. The gravel in the core of the drumlins is capped with 2-5 m of Langlade Lobe till. At the east edge of this pit a discontinuous line of boulders marks the till-gravel contact.

The thinness of the till, and the gravel-core character of these drumlins require that they be erosional rather than depositional. This type of drumlin has been described by many authors including Gravenor (1953), Aronow (1959), Flint (1971), Muller (1974), and Whittecar and Mickelson (1977), and that literature will not be reviewed here. From a hypothetical reconstruction of the ice surface profile of the Langlade Lobe, we suggest that these drumlins formed under wet-based ice approximately 1000 m thick (Nelson and Mickelson, 1974). Numerous reasons for the differential erosion of this type of drumlin have been suggested, but none have been demonstrated.

Only a few drumlins are found in the Green Bay Lobe in this region. They are less elongate and less symmetrical than the drumlins in the Langlade Lobe, but they begin at about the same distance behind the terminal moraine (16 km, Fig. 2). Widths are approximately 200-400 m, a few being more than 1 km long and 20 m high.

THE GLACIAL SEQUENCE AND LANDFORM DEVELOPMENT

We have shown that the Green Bay Lobe differs from lobes with a typical landform distribution such as the Langlade Lobe in having all zones dominated by extensive outwash and ice-contact stratified drift, having very large subglacial or englacial drainage channels extending through the end moraine zone, and lacking an intermediate ground moraine zone or extensive drumlin zone. From a general model of glacial advance and retreat similar to that proposed by Clayton and Moran (1974), these differences in landform development and distribution between two lobes could be attributed to the differing topography over which each lobe advanced. However, the present landform distribution is the product of several alternating advances and retreats of the ice of each lobe during Woodfordian times. The following chronology attempts to show how these differences in landform distribution developed during the sequence of glacial events in north-central Wisconsin. Because no radiocarbon dates directly associated with the moraines are available, relative ages were determined by cross-cutting moraine relationships (Mickelson, Nelson, and Stewart, 1974).

The earliest recorded advance during Woodfordian time is that of the Green Bay Lobe to the Outer Moraine. During this advance out of the Green Bay basin into north-central Wisconsin from the southeast, the ice must have overriden much of its own outwash and earlier drift deposits before reaching its terminal position. While the ice was at the Outer Moraine, lodgement and ablation till were deposited in the marginal zone forming ridge Types 1 and 2, and outwash was spread over a large area of the Antigo outwash plain by the ice-contact drainageways described under Type 3 ridges. The drumlins found 16 km southeast of the moraine were probably also developed while the ice was in this position. Stagnation within the moraine and retreat to the recessional Elderon Morainic System followed, producing small Types 3 and 5 ridges in the Outer Moraine.

Some time after the formation of the Outer Moraine and the deposition of the large outwash plain near Antigo, the Langlade Lobe advanced to its terminal position, building the Parrish Moraine. This advance also overrode older deposits and its own outwash before depositing a thick lodgement till in the marginal zone. However, unlike the Green Bay Lobe, the ice advanced down a gentle regional bedrock slope in an area of relatively shallow drift. While the ice was at the moraine, Types 1 and 2 ridges were formed extensively beneath the ice, and drift within the ice was carried to the surface in the marginal area of compressive flow. This mantle of super-glacial till then filled longitudinal crevasses and other openings in the ice, forming ridge Types 4 and 5. The drumlins in the area northeast of the terminal moraine were differentially eroded from previously deposited till and underlying Green Bay Lobe outwash at this time.

While the ice was at its terminal position an outwash apron was built along the north edge of the Antigo outwash plain and several branches of the Eau Claire River carried non-dolomitic Langlade Lobe outwash across the dolomitic outwash of the Green Bay Lobe. Although dead ice buried by debris may have been present in the Outer Moraine when the Parrish Moraine was built, the main ice mass of the Green Bay Lobe had retreated at least back to the Elderon Morainic System. Outwash flowing from this ice margin was trapped behind the Outer Moraine without reaching the Antigo plain and the channels parallel to the margin described under Type 4 ridges may have been eroded at this time.

Ice remained in the Parrish Moraine until after retreat of the Green Bay Lobe ice from the Elderon Morainic System. That the two ice lobes were joined during the building of the outer Elderon Moraine can be seen by the change in orientation of morainal features in the area of contact between the two lobes. Here, parallel Type 4 ridges of ice contact drift from both lobes are found in the moraine. From the composition (intermixed dolomite contents) and northeast orientation of the ridges, we suggest that they were built by debris brought into the ice by shear planes due to compressional flow in both lobes, and then let down as partially washed ice-contact debris.

Ice, probably debris covered, remained in the Parrish Moraine and in the interlobate part of the Elderon Moraine after the retreat of Green Bay Lobe ice. Outwash streams carried gravel with a low

(< 5%) dolomite content (suggesting a Langlade Lobe source) southeastward to the outer Bowler Moraine of the Green Bay Lobe.

After the formation of the Parrish and Elderon Moraines, both lobes retreated an unknown distance, depositing superglacial drift on locally grooved lodgement till, covering it in many places. As the ice masses separated from the margin, meltout deposits (Type 3 ridges and Type 5) were formed and Type 4 ridges developed along some areas of the retreating ice margin. Little outwash is present between the Parrish and Summit Lake Moraines, although outwash valleys carried water across the Antigo outwash plain in the Eau Claire River and into the Wolf River to the south and east. Extensive dolomitic (up to 30%) outwash, much of it pitted, was deposited behind the Elderon Moraine by the Green Bay Lobe ice as it retreated down slope, burying many features.

The ice of the Langlade Lobe readvanced to, or remained at, the Summit Lake Moraine while ice in the Green Bay Lobe retreated down slope beyond the outer Bowler Moraine. Marginal processes of till deposition in the recessional moraines resulted in the same types of landforms that were produced in the terminal moraines, but on a smaller scale.

Large amounts of outwash from the Langlade Lobe were deposited along the Wolf River, and as an outwash apron extending from at least 13 km east of Antigo to the front of the Bowler Moraine. At the reentrant between the two moraines, an area of kettled interlobate deposits formed which contained stagnant ice for some time after the retreat of both lobes from these moraines.

As the margin of the Langlade Lobe retreated from the Summit Lake Moraine into the zone of ground moraine, eskers and kames were deposited over a thin lodgement till. The ice margin then retreated over the drumlins, depositing a thin lodgement till over the shaped gravels. Outwash streams such as the Wolf and Pelican Rivers buried much of this zone with outwash. As the ice margin continued to retreat up slope, thin lodgement and ablation till were deposited on the eroded bedrock and drift surface north of the drumlins. No other recessional moraines of the Langlade Lobe were formed between the Summit Lake Moraine and the very small, discontinuous Laona Moraine (Thwaites, 1943) 40 km to the north.

As the ice of the Green Bay Lobe retreated from the Bowler Moraine, small, discontinuous recessional moraines, mainly composed of ice-contact sand and gravel, were built at least as far southeast as the Mountain Moraine. Also during this time an outwash plain was spread from the ice in the interlobate area onto Green Bay Lobe drift between the Bowler and Mountain Moraines.

After an unknown interval following the retreat of the Green Bay Lobe ice from the Bowler Moraine, ice advanced to the Mountain Moraine. There is no evidence that ice was present during this advance in areas previously covered by ice, even in the interlobate area, and the position of the Langlade Lobe margin at this time is unknown.

CONCLUSIONS

While the location and size of landform zones within a glacial lobe are probably most dependent on the scale and thermal regime of the ice lobe, the differences in landform distribution and character between the Langlade and Green Bay Lobes is due primarily to the differing slopes of the glacier bed and secondarily to the pattern of advances and retreats of each lobe. A bedrock and older drift surface sloping opposite to the direction of ice flow in the Green Bay Lobe prevented meltwater from rapidly draining away from the ice margin which allowed ice-contact features to be extensively dissected by glaciofluvial streams and partially buried by outwash. The large meltwater channels eroded in the drift of the Green Bay Lobe both perpendicular and parallel to the end moraines are also the result of large amounts of meltwater with extensive contemporaneous outwash deposition. The repetitive advance and retreat history with relatively long-lasting stagnant ice in the moraines of the Green Bay Lobe accentuated the dissection and reworking of ice-contact sediments and deposition of outwash by providing more episodes of meltwater production over a longer period of time than in the Langlade Lobe. The much better drainage of the latter with a single short-lived readvance to the Summit Lake Moraine prevented the glacial features formed during the building of the Parrish Moraine from being greatly modified by glaciofluvial processes, thus preserving the classic zonal landform distribution in the Langlade Lobe.

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CAMBRIAN CONGLOMERATE EXPOSURE IN NORTHWESTERN WISCONSIN: A NEW INTERPRETATION

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ABSTRACT

A large exposure of conglomerate previously assigned a Late Precambrian age is re-interpreted as basal Cambrian. Nearby Precambrian quartzite exposures provided the quartzite pebbles in the conglomerate. Deposition of the conglomerate apparently occurred in shallow waters near more resistant quartzite islands as the Cambrian sea transgressed on to the Wisconsin Arch.

INTRODUCTION

An exposure of quartzite pebble conglomerate in northern Wisconsin may represent the northernmost exposure of Cambrian deposits in Wisconsin. The exposure lies near the northern end of the River Falls Syncline, where a tongue of Cambrian sedimentary rocks extends northward onto the Precambrian rocks of the Wisconsin Arch (Fig. 1). The Precambrian rocks of the area consist of the Late Precambrian Keweenawan series of lava flows and red beds, a Pre-Keweenawan Late Precambrian quartzite unit named the Barron Formation, and an undifferentiated group of Early and Middle Precambrian igneous and metamorphic rocks.

Because of the presence of widespread thick glacial deposits, outcroppings are not common in the area. The exposures examined in this project are the only known exposures in a 144 square mile area of four townships. Information about the bedrock geology of the area comes from well logs and geophysical data. These reports indicate that Cambrian sandstone underlies most of the area.

FIELD RELATIONSHIPS AND PETROLOGY

The exposures examined lie in Sections 1 and 12, T39N, R11W, Washburn County, Wisconsin (Fig. 2). The exposures were previously described during a mineral survey by the Wisconsin Geological and Natural History Survey (Hotchkiss, 1915), and assigned a Precambrian age. This interpretation called for two

FIGURE 1. Generalized geologic map of Wisconsin.

episodes of quartzite deposition during the Late Precambrian: 1) Deposition of the Barron Formation, which was weathered to produce the quartzite clasts in the conglomerate, and 2) The later deposition of the conglomerate. Regional evidence for two periods of quartzite deposition during the Late Precambrian does not appear to exist. A more reasonable interpretation appears to be that the clasts in the conglomerate were derived from the nearby Late Precambrian Barron Formation, and that the conglomerate represents basal Cambrian deposition. A similar interpretation has been made for a quartzite breccia 30 miles to the south near Canton, Wisconsin (Hotchkiss, 1915).

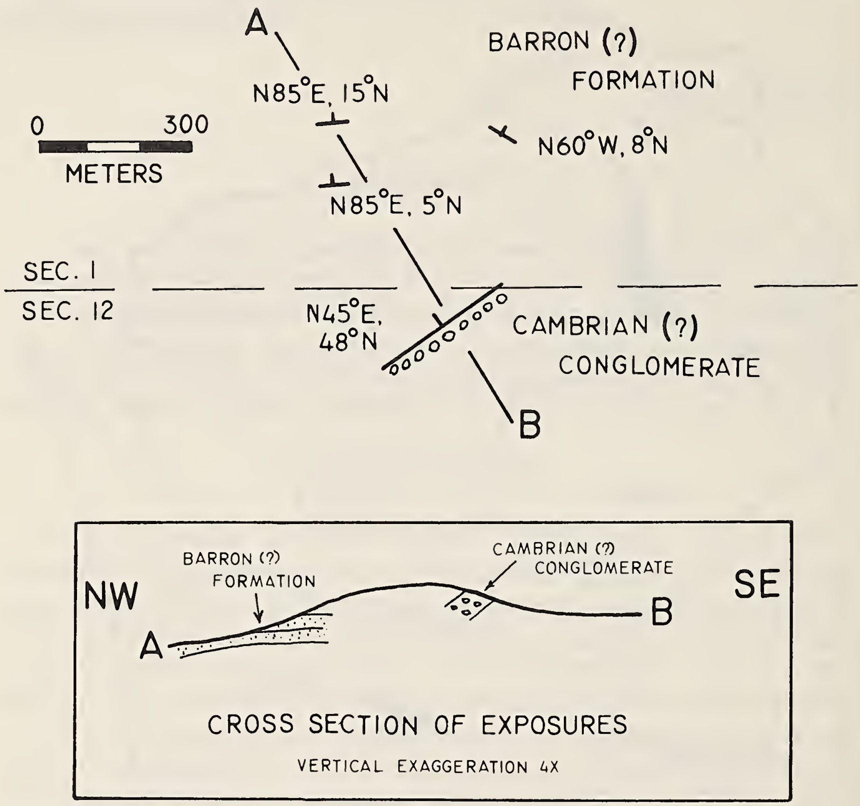

FIGURE 2. Map of exposures in Sections 1 and 12, T39N, R11W, Washburn County, Wisconsin.

The exposures examined in this investigation lie on a prominent hill which overlooks MacKay Valley. At the base of the north side of the hill, a series of quartzite ledges are exposed with an attitude of N85°E, 15°N. Near the top of the north side of the hill, several ledges with an attitude of N85°E, 5°N are exposed. On the northeast side of the hill, a quartzite ledge with an attitude of N60°W, 8°N is exposed. All of these exposures consist of well cemented pink to light red quartzite, which breaks across the individual well-sorted, well-rounded grains. Modal analyses of thin sections (Table 1) indicate an orthoquartzite composition for the exposure. The exposed ledges indicate a thickness of at least 35 m for the quartzite.

On the southeast side of the hill, an exposure of 16 m of conglomerate with an attitude of N45°E, 48°N is present. This conglomerate consists of very well rounded pebbles of light pink quartzite and vein quartz in a yellow sandstone matrix. The pebbles

TABLE 1. MODAL ANALYSES OF QUARTZITE, NORTH SIDE OF HILL.

Sample No.	Location	Polycrystalline Quartz	Monocrystalline Quartz	Felsic Volcanic Fragments	Chert	Feldspar	Granulated Quartz*	Silica Cement	Hematite Cement	Pore Space
MV-1	Hill base, N	1	81	-	x	-	-	16	-	2
MV-2	Hill base, N	16	56	1	-	-	6	15	3	3
MV-3	Hill base, N	5	79	-	-	-	4	18	-	2
MV-4	Hill top, N	2	76	x	x	-	-	17	1	3
MV-5	Hill top, N	7	70	x	x	x	4	13	1	4
MV-6	Hill base, NE	9	74	-	-	-	1	12	-	4
	AVERAGE	7	73	x	x	x	2	15	x	3

*Granulated quartz formed by crushing of silica overgrowths and cement during folding. Figures are %, x = < 1%.

have a maximum diameter of 20 cm, with average of about 4 cm. A pebble count indicates that the conglomerate is composed of 81% quartzite clasts, 1% quartz clasts, and 18% sandstone matrix. The pebbles are in contact with each other, and form a solid framework. The conglomerate is poorly bedded, and the clasts do not exhibit preferred orientation. Both the clasts and the matrix have been fractured by a later event. Modal analyses of thin sections of the clasts (Table 2) indicate an orthoquartzite composition, and compare very closely to the quartzite exposures on the north side of the hill. Both the pebbles and the quartzite exposures on the north side of the hill are similar in composition (Table 3) to the Late Precambrian Barron Formation which is exposed in the area. It appears that the quartzite exposures on the north side of the hill are Barron Formation, and that the pebbles in the conglomerate on the

TABLE 2. MODAL ANALYSES OF PEBBLES FROM CONGLOMERATE, SOUTHEAST SIDE OF HILL.

Sample No.	Location	Polycrystalline Quartz	Monocrystalline Quartz	Felsic Volcanic Fragments	Chert	Granulated Quartz*	Silica Cement	Pore Space
P-1	Conglomerate exposure, SE of hill	6	76	1	-	-	16	1
P-2	Conglomerate exposure, SE of hill	13	73	x	x	-	10	3
PM-1	Conglomerate exposure, SE of hill	6	75	2	-	2	13	2
PM-2	Conglomerate exposure, SE of hill	2	79	-	-	1	16	2
PM-3	Conglomerate exposure, SE of hill	7	73	2	x	-	14	3
PM-4	Conglomerate exposure, SE of hill	7	73	2	-	1	15	2
PM-5	Conglomerate exposure, SE of hill	10	69	2	-	1	17	1
	AVERAGE	7	74	1	x	x	15	2

*Granulated quartz formed by crushing of silica overgrowths and cement during folding. Figures are %, x = < 1%.

southeast side of the hill were derived from this formation.

The matrix of the conglomerate differs from the clasts in several ways. The matrix consists of moderately rounded, coarse grained sandstone, whereas the clasts are composed of medium grained, well-rounded, well-sorted quartzite. The matrix ranges from yellow to buff in color, whereas the quartzite clasts are pink to light red. Modal analyses of thin sections (Table 4) indicate several other differences between the conglomerate matrix and the quartzite

TABLE 3. MODAL ANALYSES OF BARRON FORMATION, NORTHWESTERN WISCONSIN.

Sample No.	Location	Polycrystalline Quartz	Monocrystalline Quartz	Felsic Volcanic Fragments	Chert	Silica Cement	Pore Space
BR-1	Sec. 13, T38N, R9W, Sawyer Co., Wis.	4	79	2	-	15	x
BB-1	Sec. 12, T38N, R9W, Sawyer Co., Wis.	8	73	x	-	18	x
B-1	Sec. 12, T38N, R9W, Sawyer Co., Wis.	12	76	-	-	12	-
BB-3	Sec. 21, T38N, R8W, Sawyer Co., Wis.	14	71	-	-	14	x
B-3	Sec. 21, T38N, R8W, Sawyer Co., Wis.	15	71	x	-	14	-
BB-8	Sec. 1, T37N, R9W, Sawyer Co., Wis.	14	70	3	-	13	x
B-8	Sec. 1, T37N, R9W, Sawyer Co., Wis.	12	76	x	x	11	-
	BARRON AVERAGE	11	74	x	x	14	x

Figures are %, x = < 1%.

clasts. The matrix is not as well cemented as the quartzite, and contains an average of 12% pore space. Also, minor amounts of quartzite fragments are present in the matrix.

These data and field relationships are the basis for this new interpretation of these exposures. Because the attitude and composition of the exposures on the north side of the hill are all similar, these exposures are interpreted as being portions of the same formation or unit. The similarity between this unit and the

TABLE 4. MODAL ANALYSES OF CAMBRIAN (?) CONGLOMERATE MATRIX, SECTIONS 1 AND 12, T39N, R11W, WASHBURN COUNTY, WISCONSIN.

Sample No.	Location	Polycrystalline Quartz	Monocrystalline Quartz	Quartzite Fragments	Felsic Volcanic Fragments	Feldspar	Granulated Quartz*	Silica Cement	Hematite Cement	Pore Space
M-2	SE side of hill	14	59	1	-	-	-	14	-	12
M-4	SE side of hill	6	69	-	1	x	3	11	x	10
M-5	SE side of hill	8	65	1	-	-	-	15	-	11
M-2b	SE side of hill	5	67	2	1	-	3	10	-	12
M-4b	SE side of hill	3	67	1	1	-	6	9	-	13
M-5b	SE side of hill	7	64	-	1	-	1	13	-	14
	AVERAGE	8	65	x	x	x	2	12	x	12

*Granulated quartz formed by crushing of silica overgrowths and cement during folding. Figures are %, x = < 1%.

nearby Barron Formation strongly suggests that this quartzite unit is correlative with the Barron Formation. The nearly identical composition of this quartzite unit and the clasts in the conglomerate on the southeast side of the hill also strongly suggests that the clasts were derived from this quartzite, of presumably Late Precambrian age. The significant difference in attitude between the conglomerate and the quartzite indicates that a tectonic episode apparently occurred during the time interval between deposition of these two units. The age of the conglomerate then must post-date the deposition of the quartzite and the later folding, and is therefore interpreted as being Cambrian.

CAMBRIAN SEDIMENTATION AND PALEOGEOGRAPHY

Because of the lack of fossils and indicative sedimentary features, only general inferences about the Cambrian sedimentation and paleogeography may be made. The rather large clast size in the conglomerate indicates the existence of a nearby source area, probably a high hill of resistant Barron Formation. Such resistant hills would have projected above the Late Cambrian sea as it transgressed onto the Wisconsin Arch. These islands would have shed quartzite debris into the surrounding sea, in a manner similar to that described by Dott (1974) near islands in the Cambrian sea of the Baraboo District, Wisconsin. The solid framework of the clasts in the conglomerate indicates the presence of rather high velocity currents during deposition. These currents swept away the sand and finer grained sediment, leaving behind the solid framework of cobbles and pebbles. Sand later filtered in between the clasts. The environment necessary to produce such a sequence of events would exist in the turbulent nearshore waters of a group of islands, particularly within the tropical latitudes which existed in Wisconsin during Cambrian time (Dott, 1974).

It is very difficult to determine the exact correlation of the conglomerate unit with the well exposed Cambrian strata of the Upper Mississippi Valley 80 km to the south (Twenhofel et al., 1935). Because of similar difficulties, Dalziel and Dott (1970) designated a conglomerate facies around the islands which existed in the Baraboo District during the Cambrian, and made no attempt to precisely correlate the Baraboo conglomerate deposits with the more widespread Cambrian strata of the Upper Mississippi Valley. It seems most probable that the conglomerate exposures of the MacKay Valley area are a high energy, nearshore facies of the shallow water marine Dresbach Formation, which thins northward from the Upper Mississippi Valley as it passes over the Wisconsin Arch (Hamblin, 1961).

The lack of Cambrian exposures in the northern end of the River Falls Syncline makes it difficult to accurately reconstruct Cambrian paleogeography. The varying Precambrian rock types of the region were no doubt expressed topographically, with the more resistant rocks such as the Barron Formation forming hills. As the Late Cambrian sea transgressed onto the Wisconsin Arch, the low areas were inundated, and the hills became islands. The resulting shallow water deposition left a thin widespread blanket of sandstone and conglomerate over the region.

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DEWEY AND NIETZSCHE: THEIR INSTRUMENTALISM COMPARED

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Careful comparative scholarship has shown clearly that John Dewey's instrumentalism is not a peculiarly unique formal articulation of the realistic and democratic temper of the American people. Students of the "internal" history of ideas, i.e. those who examine the "relationship between what some men write or say and what other men write or say,"[1] have noted similarities between Dewey's experimentalism and Hume's empirical analysis, Kant's phenomena (but not the noumena), Hegel's phenomenology, the social orientation of the Utilitarians, the positivism of Comte and Haeckel, and Bergson's emphasis on activity.[2] Dewey himself recognized and expounded upon the logical connections between his brand of pragmatism and the separate thought of several European philosophers.[3] Although many comparative studies have discouraged the parochial misprizoning of instrumentalism, further work needs to be done. No account of experimentalism's European resemblances can be complete without the recognition of similarities with the thought of Friedrich Nietzsche. The purpose of this paper is to demonstrate likeness of thought in three areas: attitude toward metaphysics, concepts of truth, and ideas on the nature of value. My hope is that such a demonstration will enlarge the conceptual Euro-American background against which instrumentalism must be understood.

John Dewey's claim that ideas are instruments of action and that their usefulness determines their truth had profound implications for his view toward metaphysics. He agreed with Arthur Lovejoy that metaphysical constructions have been the dominant concern of intellectual mankind throughout history[4] but found this pursuit to be rooted in man's deep sense of insecurity. Man, long before the Heideggerian *angst* became fashionable, had found himself confronted with a dark, uncertain world infused with peril and mystery. Such a cosmos demanded appeasement but the available manipulative arts were often futile. Tools were often inadequate and the senses never fully reliable. In reaction to his natural condition, early man compensated with myth, ritual, and most importantly, protometaphysics. This latter device would contribute an *a priori* order and rationale to the fanciful belief systems and practices of mankind. As Dewey tells it, "Exaltation of pure intellect and its activity above practical affairs is fundamentally connected with the quest for a certainty which shall be absolute and unshakeable."[5] Significantly, then, these beliefs and practices attempted to deal with the vicissitudes of secular life by celebrating the transtemporal perfections of another life.

Construction of such a perfect world provided early humans with access to a secure arena of action (Dewey might say "non-action"). Correlative to this construction was the establishment of special techniques which would allow knowing that was sure, universal, and revelatory; such knowledge was quite different from the fumbling way of the senses used by artisan and eoscientist who were involved in a world of mere fact, imperfection, and uncertainty.[6] The methods of attaining to this genuine reality, then, were extraordinary and purificatory. Dewey finds evidence of such catharizing methodology in early Greek philosophy:

> If one looks at the foundations of the philosophies of Plato and Aristotle as an anthropologist looks at his material, that is, as cultural subject-matter, it is clear that these philosophies were systematizations in rational form of the content of Greek religious and artistic beliefs. The systematization involved a purification. Logic provided the patterns to which ultimately real objects had to conform, while physical science was possible in the degree in which the natural world, even in its mutabilities, exhibited exemplification of ultimate immutable rational objects. Thus, along with the elimination of myths and grosser superstitions, there were set up the ideals of science and a life of reason. Ends which could justify themselves to reason were to take the place of custom as the guide of conduct. These two ideals form a permanent contribution to western civilization.
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> But . . . they brought with them the . . . notion, which has ruled philosophy ever since the time of the Greeks, that the office of knowledge is to uncover the antecedently real, rather than, as is the case with our practical judgments, to gain the kind of understanding which is necessary to deal with problems as they arise.[7]

Hence, for our instrumentalist, metaphysical systems are a response to a complex of culturally conditioned experiences. The search for reliable knowledge must rest elsewhere.

Though it was clear to Dewey that metaphysics could be "reduced" to the perennial quest for certainty, he realized that instrumentalism must still deal in its own way with questions traditionally addressed by the former "official philosophy." The questions about what is most important in life and what is most real could be "explained" by his antimetaphysical reduction but not answered *per se*. Dewey, assuming that humans live in and adjust to their social and physical environment experientially, felt that most metaphysical questions could be "answered" by distinguishing between events and objects. These two terms are the key to his characteristic experimentalist approach to pseudo-problems long agonized over by "first philosophy."

Dewey distinguishes between "events" (or "existences") and meanings. An event is "ongoing" and its nature is revealed in experience "as the immediately felt qualities of things."[9] Thus events are the ingredients of ordinary experience. (Dewey felt that science also conceptualizes in terms of events.) An object is defined as an event with meaning. We are asked to consider tables, the Milky Way, chairs, dogs, electrons, and to appreciate them as examples of "objects." Dewey would have us further appreciate that every event may have numerous explicit meanings with differing consequences for action. The best example he himself elucidates is that of paper.

> Thus an existence identified as 'paper,' because the meaning uppermost at the moment is 'something to be written upon,' has as many other explicit meanings as it has important consequences recognized in the various connective interactions into which it enters. Since possibilities of conjunction are endless, and since the consequences of any of them may at some time be significant, its potential meanings are endless. It signifies something to start a fire with; something like snow; made of wood-pulp; manufactured for profit; property in the legal sense; a definite combination illustrative of certain principles of chemical science; an article the invention of which has made a tremendous difference in human history; and so on indefinitely . . . We are saying in effect that its existence is not exhausted in its being paper.[10]

In experimentalism, then we are introduced to a tool that can powerfully respond to the traditive metaphysical conundrums. Perhaps one example of such a response will suffice. Beginning with Plato, philosophers of various intellectual persuasions have attempted to reason with the concept of essence. But for John Dewey, these philosophers (including some Existentialists with whom he has important points in common) have been pursuing a chimera. "Essence," we are told, "is but a pronounced instance of meaning; to be partial, and to assign a meaning to a thing as the meaning is but to evince human subjection to bias."[11] Hence, there is no reason why the traditive explanation of essence as one, immutable, and constitutive of a thing should exhaust the various meanings the word may have. The traditive claim for legitimacy only reflects the interest that the definer happens to have in the concept. Dewey concludes as follows:

> Since the consequences which are liked have an emphatic quality, it is not surprising that many consequences, even though recognized to be inevitable, are regarded as if they were accidental and alien. Thus the very essence of a thing is identified with those consummatory consequences which the thing has when conditions are felicitous.[12]

Thus this pragmatist argues that we are in error when we repose in ideas and concepts; all ideas and meanings are instruments for dealing with concrete problems. If this be deemed a delitescent metaphysic, it is at the least an unusually "open" and flexible one.

Nietzsche was never as systematic or methodical as Dewey. Often his ideas on metaphysics are inconsistent, although we know that he, like Dewey, was hostile to such traditional notions as substance, cause, effect, and Being. The difficulty for the scholar wishing to analyze Nietzsche's own brand of antimetaphysics is due in part to his peculiar *modus operandi*. Unlike Dewey, he never fights thoroughly or scientifically but rather assumes the role of intellectual warrior using clubs and sledge-hammers to impress the truth upon his readers.[13] Despite these differences in style, however, both men were very similar in their anthropological and psychological analysis of metaphysics.

Nietzsche, like Dewey, felt strongly that the entire metaphysical enterprise results from a maladjustment to a changing environment. "First philosophy" develops when, in the pursuit of security, man avoids the world of Becoming for an absolute world of Being. Man seeks the "true world," a world where there can be no suffering. Nietzsche believes that the unique psychological mind of the average human propends toward happiness. This happiness, as most men see it, can be achieved only in the realm of Being since change and happiness exclude each other.[14] Pain is a leading inspiration for these fanciful conclusions: at bottom they are wishes that such a world might exist because of the hatred men feel toward a world full of suffering. As with Dewey, Nietzsche takes Plato to task for indulging the "metaphysical need."

> An artist cannot endure reality; he turns away or back from it: his earnest opinion is that the worth of a thing consists in that nebulous residue of it which one derives from colour, form, sound, and thought; he believes that the more subtle, attenuated, and volatile a thing or a man becomes, *the more valuable he becomes: the less real*, the greater the worth. This is Platonism: but Plato was guilty of yet further audacity in the matter of turning tables — he measured the degree of reality according to the degree of value and said: The more there is of 'idea' the more there is of Being . . . . At bottom, Plato, like the artist he was, placed appearance before Being! and therefore lies and fiction before truth! unreality before actuality![15]

Thus, metaphysics is a sign of "ill health" or at the least a pernicious weakness in the human psyche. As such, it may be designated as the "science which treats of the fundamental errors of mankind but treats of them as if they were fundamental truths."[16] Clearly Dewey and Nietzsche are in agreement here.

Both philosophers also claimed that metaphysical structures were too often caused by linguistic traps that tend to rigidify concepts. Dewey, for example, criticized thinkers for allowing the concepts of "essence," "universals," "appearance," and "reality" to become static entities each endowed with but one meaning. Nietzsche also excoriated the rigid use of such concepts as "true," "apparent," and "reality."[17] Finally, both men felt that the solutions to many of the old metaphysical puzzles would be forthcoming if the philosopher accepted man as *active* and not passively receptive. For both men, thinking and perceiving are acts of interpretation in which our desires, memories, and passions do affect the object that we perceive or contemplate.

Although many thinkers today, particularly the sociologist of knowledge, take for granted that men's subjective interests and expectations influence their perception, Nietzsche was one of the first to use such information to attack the petrified concepts of metaphysics. Like Dewey, he argued that once we have achieved a conceptual framework, we tend to persist in interpreting our experiences statically even though circumstances inevitably change. This sort of "laziness" increases when the conceptual framework is given a linguistic formula. When this occurs, the concept becomes a closed "self-evident" structure that all experience of the world is required to fit.[18]

To obviate the problems posed by such a conceptology, Nietzsche would have us remember that meaning (like life) is fluid and can take almost illimitable forms. The "interested" subjective thinker should become aware of the intellectual *cul-de-sac* he prepares for himself when he employs ossified thoughts. For example, Nietzsche panned Kant's stringent bifurcation between a "thing-in-itself" and mere appearance. This stiff ontological schism was absurd because of the reasons indicated below.

> A 'thing-in-itself' is just as absurd as a 'sense-in-itself,' a 'meaning-in-itself.' There is no such thing as a 'fact-in-itself,' for a meaning must always be given to it before it can become a fact.
>
> The answer to the question, 'What is that?' is a process of *fixing a meaning* from a different standpoint. The 'essence,' the essential factor, is something which is only seen as a whole in perspective, and which presupposes a basis which is multifarious. Fundamentally the question is 'What is that for me?' (for us, for everything that lives, etc., etc.).
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> . . . In short: the essence of a thing is really only an *opinion* concerning that 'thing' or, better still; *'it is worth'* is actually what is meant by *'it is'* or by 'that is.'[19]

For Nietzsche, then, the putative independently existing object that rigid concepts attempt to mirror is an enduring myth perpetuated by linguistics and human psychology. An uninterpreted "original" is never available to an ideally objective mind;[20] there are only the various "meanings" that an existent can have at different times and for different individuals. For both Dewey and Nietzsche, cognition of metaphysical absolutes must of necessity be a subjective on-going process.

Further similarities of thought are evinced in their theories of truth, although the correspondences are not exact ones. In general, both men argued against the validity of objective truth and argued for the beneficial nature of subjective truth, consciously arrived at. As might be expected, much of what they say about truth follows from their analysis of "first philosophy."

John Dewey's attack on "inexpugnable" objective truth took the form of criticizing two widely held theories. One of these theories avers that there is little distinction between truth and reality. In other words, this Platonic concept claims that truth already exists (as does reality) whether one comes upon it or not. Attendant to this belief is the notion that there is but one truth for everyone at any given time. Dewey answers this by pointing out the obvious empirical refutation that various people do not attain to the same truths. Another difficulty with this former hoary argument is that it finds the subject matter of truth to be reality at large, "a metaphysical heaven to be mimeographed at many removes upon a badly constructed mental carbon copy which yields at best only fragmentary, blurred, and erroneous copies."[21] The only proper object of truth is and must be that relationship of organism and environment in which functioning is most amply and effectively attained.[22] Truth can not be monistic as the Platonist asserts.

The second attack on "objective" verity is against another major defense: the correspondence theory of truth. This is the idea that truth is a duplicate or copy of an independent reality. Dewey admits the innate plausibility of this account because it does distinguish between truth and reality. Since such a distinction is made, the correspondence theory does include statements men make about the world. As such, it involves meaning or discourse and refers to ideas and their validity. However, Dewey complains, the claim that veracity equals a one-to-one relation with objective existents opens up the old (and still unsolved) Descartean problem of dualism.[23] The correspondence theory can not explain how mind, world, and body interact to produce knowledge and "truth." He further argues that even if this theory could explain the ontological abyss between facts and ideas, we would still not know *why* the mind should make a copy of the world at all.[24] Hence, Dewey finds two venerable supports for objective truth to be unconvincing. Not content to merely analyze, he has synthesized a positive, subjective approach to truth.

Such an approach he calls the instrumental or consequence theory. Dewey states that truth or falseness is a property of ideas. This property is chiefly one of predictions of what consequences will follow if any given plan of action, communicated by an idea, is carried out. All ideas are hypotheses continually being verified or disverified in the light of predictable results. The particular consequences or results are those in terms of which a problem has arisen.[25] Pretend, for example, that you hear a noise in the street. The meaning suggested to you is that a street-car has caused the sound. To test the idea you walk to the window and through observation organize into a unity elements of existence and meaning which previously were disconnected. In this way your idea is rendered true; that which was a proposal or hypothesis is no longer a mere educated speculation. Apart from your forming and considering some interpretation, the category of truth has neither meaning nor existence. Your idea, in other words, had to be acted upon to become a truth.[26] As Dewey concludes about his "non-objective" theory,

> Truth . . . is a just name for an experienced relation among the things of experience: that sort of relation in which intents are retrospectively viewed from the standpoint of the fulfillment which they secure through their own natural operation or incitement. Thus the experimental theory explains directly and simply the absolutistic tendency to translate concrete true things into the general relationship, Truth, and then to hypostatize this abstraction into identity with real being, Truth *per se* and *in se*, of which all transistory things and events—that is, all experienced realities—are only shadowy futile approximations.[27]

In conclusion, truth belongs to humans actively engaged in a changing world. Verity, as Dewey sees it, is a satisfactory response to a problem originating in the world. Because truths are not monolithic or fixed in a rigid matrix forever, they can be transformed by the subjective, interested thinker who must consciously and continuously strive to cope with his environment. Since there is no final and absolute truth, there can be no further test of veracity other than its ability to work and to organize facts.[28] Objective truth, moreover, must be recognized as yet another symptom of man's quixotism and quest for security; subjective truth must be recognized as successful and dynamic "interpretations" proposed tentatively by adaptive and creative individuals.

Nietzsche would appear to agree fully with the above conclusions of Dewey. He, too, devastated pretensions to objective truth by revealing the psychology on which they are based and the thin reasoning which disguises them. He too relativized truth to a context of person, world, and problem. And he too, though less carefully and systematically, posited a subjective brand of truth to replace impossible, surreal objectivity. Nietzsche is perhaps most effective in analyzing the psychological bases of cognition and truth.

Even the greatest philosophers, we are told, think that they can achieve *the* Truth through elaborate reasoning. But the theories of men like Spinoza, Wolff, Descartes, and Plato are only fatuous efforts to justify the beliefs they hold on instinctive or pre-reflective grounds. Behind even the purest logic, there are subjective prejudices and physiological demands.[29] Far from being disinterested and objective, Nietzsche sees the intellect as the instrument of something nonintellectual;

> The unconscious disguising of physiological requirements under the cloak of the objective, the ideal, the purely spiritual, is carried on

> to an alarming extent, and I have often enough asked myself, whether on the whole, philosophy hitherto has not generally been merely an interpretation of the body, and a *misunderstanding of the body.*[30]

The concept of transcendent and final truth must, then, be an illusion.

In addition, Nietzsche uses an epistemological argument to attack any claims that "objective" truth can be supported by a strictly empirical outlook. His argument is that we have the kinds of sensations and perceptions we do because of their "utility." The product of our senses reflects our values, and the senses are pragmatic just as our conceptual abilities are. He denies, furthermore, that our sensations and perceptions are uninfluenced by the concepts and prejudgments which we all hold; our conceptual life mandates, in large part, our sensory life.[31] Hence, in contraposition to empiricists such as Locke, the senses cannot absolutely and objectively verify the concepts we may hold as the senses are pre-influenced by beliefs and values. Nietzsche tells us that "faith is the primal beginning even in every sense impression."[32] Consequently, the quest for the Platonic realist version of truth as static and independent of humans may not rest on our conceptual or empirical abilities. No "truth" about the "world of appearances" or phenomena can be any more than a perspectival interpretation.

Finally, Nietzsche shares Dewey's odium for the Kantian noumenon or absolute "thing-in-itself" (or "Truth-in-itself") which so many thinkers for centuries had pursued. Nietzsche in his writings not only denies that our knowledge could transcend the limitations of the senses, but also writes that the very concept of noumenon which we seek to know is an *ignis fatuus.* First, he offers the now familiar psychological explanation (and reduction) of the origin of the notion: the realm of absolute reality was concocted by weak intellects who do not dare to live and adjust in a changing world. The quest for the fictional transcendent and inaccessible noumenon serves as an escape mechanism for such weak spirits.[33] Secondly, he finds the Kantian belief in noumenon useless and superfluous and therefore refuted.[34] Although many reasons are given for the contradictory character of an objective realm of truth, Nietzsche's greatest complaint is that it makes no difference for our quotidian engaged life. With Dewey, he believes that nothing possesses a constitution in itself apart from active interpretation and subjectivity. As Nietzsche understands it,

> Every centre of energy has its point of view of the whole of the remainder of the world—that is to say, its perfectly definite valuation, its mode of action, its mode of resistance. The 'world of appearance' is thus reduced to a specific kind of action on the world proceeding from a centre.
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> But there is no other kind of action: and the 'world' is only a word for the collective play of these actions. *Reality* consists precisely in this particular action and reaction of every isolated factor against the whole.[35]

Consequently, there can be no truth apart from the subjective engaged thinker.

Although denying the possibility of inaccessible verity, Nietzsche proposed that a subjective truth could yet be very instrumental to the man who has the courage to live with perspectivism. Interpretative truths, the only ones we are really capable of, can still give us practical guidance in life. Subjective truth is or can be a useful tool. It can observe how elements in the world affect us, noting their actual benevolence or malevolence, and can draw up from this very personal angle of vision a picture or scheme of the world. With the aid of ideas we can make our way through life's mazes with more confidence because we can handle the empirical world more easily.[36] Those ideas which have life-preserving consequences should be labeled as "truths", while ideas which decrease our chances of coping with the environment should be abandoned as "lies." Truth is human and only individuals who possess it give it importance. With Dewey, Nietzsche concludes that this importance lies in our confrontation with a problematic world. For both men, there is no shame in the fact that we do not have entry into the fictive mansion of static and transcendent verity. Alethiology belongs only and fully to mankind.

The last general area of substantive agreement lies in their axiology. Although their ideas do not correspond exactly in this field of inquiry or any other, we can discern important similarities. Dewey and Nietzsche tended to understand value and experience as inextricably mixed; for both discovered that value cannot exist independently of nature. Lastly, they thought that what was valuable was a practical and not a metaphysical problem. "Solutions" for traditional axiological questions rested in an empirical methodology and were always considered tentative by our two philosophers.

John Dewey's discussions of value parallel his writings on *philosophia prima;* he characteristically saw most of the traditional questions about values as mere pseudo-problems. According to this pragmatist, too many philosophers have agonized over the "status" of value or about the rank of values in some transempirical hierarchy. That these false problems seemed real to metaphysicians was because of the ancient search for certainty and security. The conatus to build a "realm of values" which would contain especially sublime goods caused the nettling split between this world of shadows and the "real" world of sempiternal worth. With this division the philosopher has a new problem with which to deal: what is the relationship between such different domains? Is the transcendent domain that of ultimate Being from which the life we know is but an unfortunate fall? Or is the world of "real" value a mere subjective creation of minds desperate to order their world, as William of Ockham averred?[37] The metaphysicians who select the first alternative usually spend the rest of their intellectualizing on determining the special and fixed order of values in the transcendent realm; their concern for actual choice in mundane life is neglected. Other scholars choose the second alternative, thus rendering values completely subjective and therefore unable to provide a criterion for successful choice among current options. Both choices are meaningless because the problem is arbitrary.[38] Characteristically, Dewey's approach to axiology was empirical and antimetaphysical.

What then is a proper approach to axiology? Dewey's theory is, as might now be anticipated, existential in that he emphasizes the concrete context in which value judgments proceed. Humans are continually faced with situations in which lie conflicts and they are forced to decide which course of action should be pursued. The fundamental question of an involved individual is not what is the "eternal good" that he should emulate but rather what should he do? Typically, value is rendered dynamic and experiential.

To elucidate the *process* of valuation Dewey distinguishes two meanings of "to value." First, like Ralph Barton Perry, Dewey says we value something when we take an interest in it; to value in this manner signifies an immediate experience. However, such a rendition of value is incomplete as a prizing in itself does not specify any course of action; it provides no means of determining what the consequences of pursuing it will be. Therefore, Dewey advances an additional and vital meaning for value.[39] The alternate meaning of "to value" means to judge or to evaluate. Clearly, it is a *process* ending in a value judgment. It is an endless proceeding just as change in our environment is perpetual.[40]

Dewey suggests that this process of valuation is similar in many ways to scientific judgment.[41] Valuation arises when there is conflict within the course of experience and we must attempt to understand the nature of the conflict, suggest various alternative actions, and judge the consequences of each. As in science the existential results of a given course of an action can verify or disprove a given value judgment. Also, as in science, the leading principles used in a given valuation are derived from past experience.[42] Hence, valuation proceeds during conflicts of our immediate values and of what we directly prize. It is a reflective process in which we must decide what we should desire. In making a value judgment we ascribe worth to something rather than merely describe a hierarchy of values.[43] To repeat, "value" for Dewey is a dynamic idea.

Significantly, Dewey argued that values are not greatly different from other facts in the world. There are initial enjoyings just as there are initial impressions of physical objects. Insofar as and only as long as the initial enjoyings are enjoyed, they are good. Naturally experience may come to show some initial enjoyments as deceptive just as it may find some immediate sense experiences deceptive. Just as initial sense data that survive the subsequent empirical testing become "facts" so immediate enjoyments that survive the same test become values.[44]

Finally, Dewey's axiology includes the notion that values are as unstable as clouds; we can never be sure that what we value as good will continue to be desirable. Good things vanish not only with alterations in the environment but with changes in ourselves.[45] Be that as it may, knowledge that a particular object or experience is good—that is, it has survived the best available examinations—will have to be sufficient. Such knowledge will be a reasonable rule for directing behavior. In any case, it is far more usable and trustworthy than depending on revelation or waiting for the philosopher-king to re-enter the reechy cave. The rational, courageous man, Dewey reminds us, will face up to the lack of absolute merit and will strive to improve criteria for choice. In a world of becoming, any other approach would be fatal.

> Since it is relative to the intersection in existence of hazard and rule, of contingency and order, faith in a wholesale and final triumph is fantastic. But some procedure has to be tried; for life itself is a sequence of trials. Carelessness and routine, Olympian aloofness, secluded contemplation are themselves choices. To claim that intelligence is a better method than its alternatives, authority,

> imitation, caprice and ignorance, prejudice and passion, is hardly an excessive claim. These procedures have been tried and have worked their will. The result is not such as to make it clear that the method of intelligence, the use of science in criticizing and recreating the casual goods of nature into intentional and conclusive goods of art, the union of knowledge and values in production, is not worth trying.[46]

Perhaps this implies an ability only found in the strangest kind of individual, but Dewey believed it an ability that any reasonable man could possess.

The idea that values are by and for men appealed also to the mind of Nietzsche. He states often that there is no absolute, self-existent, supreme standard of valuation distinct from volition.[47] Not surprisingly he attacks any belief concerning independent, objective merit as yet another sign of mediocrity and bestial fear in the face of relentless change. Men, as is the consuetude, gladly accept the proposition that values have an independent origin and sustenance.[48] In addition to this familiar posture, he also asserts that the only world which exists for the individual is the empirical one. For the reason discussed above there can be no Kantian thing-in-itself or in this case value-in-itself. For example, Christian theology is wrong most egregiously because it demands complete acceptance of an empyrean realm of objective value. As Nietzsche puts it,

> In Christianity neither morality nor religion has even a single point of contact with reality. Nothing but imaginary *causes* . . . nothing but imaginary *effects* . . . intercourse between imaginary *beings* . . . an imaginary natural science . . . an imaginary psychology.
>
> This *world of pure fiction* is vastly inferior to the world of dreams insofar as the latter mirrors reality, whereas the former falsifies, devalues, and negates reality. Once the concept of 'nature' had been invented as the opposite of 'God,' 'natural' had to become a synonym of 'reprehensible': this whole world of fiction is rooted in hatred of the natural . . . it is the expression of a profound vexation at the sight of reality.[49]

No values can exist outside of the phenomenal world and man's active confrontation with it.

Another major reason why Nietzsche refused to grant values an individual ontological status is his much discussed theory of psychology and morals. He deflated the claims of absolute value systems by arguing that such systems are actually based on human psychological propensities and should be adjudged as artificial self-justifying superstructures (Nietzsche sounds more like Pareto than

Dewey here). The desire for something is the primal ground that "independent" ethical systems cover, consciously or otherwise.[50] Nietzsche says that he can account for the differences in valuational constructions whereas seekers after absolute and fixed systems can not. He tells us that there are as many moralities or values as there are human psychological desires because all moralities are tied to them. In his book, *Human, All to Human* he gives numerous examples of values which are tied to human needs; these needs have, in effect, "chosen" a moral rationalization in order to realize a goal. In one such example he informs the reader that the quality of pity we are given to admire is not disinterested:

> All those who are not sufficiently masters of themselves and do not know morality as a self-control and self-conquest continuously exercised in things great and small, unconsciously come to glorify the good, compassionate, benevolent impulses of that instinctive morality which has no head, but seems merely to consist of a heart and helpful hands. It is to their interest even to cast suspicion upon a morality of reason and to set up the other as the sole morality.[51]

In another example, Nietzsche exposes one instance of philanthropy as also related to ulterior motives:

> Why beggars still live—If all alms were given only out of compassion, the whole tribe of beggars would long since have died of starvation . . . The greatest of almsgivers is cowardice.[52]

Hence, all morality is subjective and interlocked inextricably with secular experiences. Nietzsche, it should be noted, did not deplore this fact as such because he claims that apart from the involved subject, no value could exist. With Dewey, he deplores those who would not have the intellectual integrity to face the ultimate connection between value and experience. For both men, valuation becomes most meaningful when employed consciously by individuals engaged in an active confrontation with a changing world.

Like Dewey, Nietzsche advanced a reconstruction of a sounder ethic which would be based on subjectivity. The function of anyone courageous enough to face existential connection between psychological inclinations and value is to create or to will a value system which corresponds to the needs of the subject. The most fundamental instinct which requires realization is the "will to power" or the desire of the subject to control his personal and external world. This presupposition, roughly similar to Dewey's belief that humans seek to form a propitious environment for their actions, provides the substructure for any realistic value. If Nietzsche is correct, we can call an event or an experience "valuable" only if it aids us in preserving and furthering our life and our ability to successfully manipulate the world.[53] No ethics can subsist independently of individuals in posssession (or possessed) of a subjective consciousness which above all includes a drive of "power" striving for self-realization. Hence values are always to be judged by their relations to active subjects.

Furthermore, Nietzsche agrees that values are transient and a continual challenge to a person. He too feels that an ethic is dynamic and process oriented. An engaged subject must repeatedly experiment with values in order to increase his ability to "build" a world in a favorable image, i.e. to facilitate the realization of personal strength and power.[54] Those goods which are *instrumental* in furthering one's capacity to realize personal goals in the world should be retained until better goods are discovered through experimentation. Significantly, there is no ethical repose here. As the world alters, so must our means to achieving our goals. It is indeed even possible that the interpretation of our instinctive needs and their attendant values will be transmogrified in the future. The rational and practical thinker will accept this possibility and yet affirm the existence of a meaningful ethical system. Such an individual would have

> the means of *enduring* it: the transvaluation of all values. Pleasure no longer to be found in certainty, but in uncertainty; no longer 'cause and effect,' but continual creativeness; . . . no longer the modest expression 'it is *only* subjective' but 'it is all our work! let us be proud of it.'[55]

Thus for Nietzsche, as for Dewey, the best valuations we can have are grounded in humanity. However, far from being an excuse for an aporetic nihilism, this fact can be a beginning for a new and more efficacious concept of value.

The conclusion to this comparative study should not imply that Dewey and Nietzsche possessed identical thoughts, attitudes, or styles of expression. In regard to the three areas of interest discussed above, the major difference between the two men was attitudinal. They particularly differed in their emotional response toward and expression of the over-arching discovery that life is insecure. Nietzsche's style of expression was, characteristically, metaphysical, eristic, and idiosyncratic. His emotional reaction was typically (particularly as seen in his later writings) as semi-hysterical affirmation of life and meaning despite its horror and objective purposelessness. Paroxysmally he urges us to bite the snake of nihilism that crawls into our throats, while we wax complacent in our fictional metaphysical explanations.[56] In contradistinction, Dewey's communication of the ground of metaphysics was calm, scholarly, and exact. Since he did not feel an abyss within himself he was not personally involved with the threat of insecurity. As was his wont, he viewed man's commerce with insecurity as a physician might.[57] Perhaps he also felt that the "cure" for insecurity (i.e. the use of instrumentalism to effect proximate solutions) was not overly difficult; no overman would be necessary to implement a realistic axiology or alethiology. In any case, no desperate ophiophagous measures need be taken to create a solid niche for mankind.

Be this as it may, the discovery of important generic correspondences of substantial thought in Dewey, an American, and Nietzsche, a German, forces us to broaden the view we take of formal instrumentalism. The similarities in their ideas on the nature of metaphysics, truth, and value are no less remarkable for their developing independently of one another. Indeed, their ideational correspondences provide an eloquent instance of congruence in Hesperian thought. Nietzsche's ideas should, then, be added to the conceptual Euro-American community in which the Experimentalism of Dewey grew and prospered. The intellectual historian, in a continuing effort to obtain full understanding of the possible novelty of "Dewey's theory," should not then ignore the reality of shared beliefs between two of the Occident's finest thinkers.

NOTATIONS

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THERMAL PLUMES ALONG THE WISCONSIN SHORE OF LAKE MICHIGAN

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ABSTRACT

The surface temperature characteristics of the thermal plumes associated with Wisconsin power plants on Lake Michigan were measured by an aircraft mounted, thermal line scanner. Approximately 100 images of each of the heated water discharges were acquired and calibrated during a two year project. A pictorial representation of more than 300 of these thermal images are included in the report. The use of these images by the Wisconsin Department of Natural Resources for regulatory purposes is discussed. Recommendations for future operational remote sensing of thermal discharges are made.

INTRODUCTION

Over the past decade, a good deal of both scientific and political controversy has centered on the use of water taken from the Great Lakes to cool large condensers associated with steam-electric power plants. Great Lakes water is abundant, and the cooling process relatively inexpensive. However, the water is warmed from 10F to 40F before being returned to the lake. This warmed water forms a "thermal plume:" a body of water distinguishable from the surrounding, natural lake water by reason of its increased temperature.

Thermal plumes may harm the ecosystem in the nearshore area. Fish behavior is changed noticeably by the plume.[1], [2], [3] Benthic life, including fish eggs, cannot escape the higher temperatures. While such effects can be loosely estimated from laboratory and theoretical studies, field measurements must form the basis of any meaningful assessments of environmental impact at a particular location. Since the amount of warm water in a thermal plume must be a key parameter in measuring and understanding the plume's effect, the plume size and shape should be determined as part of the measurement program. Because the surface area of the plume is often larger than the deeper warm water area, aerial remote-sensing techniques, combined with a few suitable temperature measurements taken in the water, can be used in both monitoring and assessing the effects of thermal plumes.[4]

The thermal plumes associated with five large power plants along the Wisconsin shore of Lake Michigan and one power plant in Green Bay were studied. The description is designed to give an overview of water-surface temperatures in the vicinity of these power plants, together with a feeling for the average sizes and shapes of the plumes and their variations with important environmental parameters. The more technical supporting data are referenced where this is appropriate.

BACKGROUND

Studies of thermal plumes on Lake Michigan before 1972 were mainly performed by the Argonne National Laboratory, and by various university groups interested in particular aspects of the plumes. In 1972, the Wisconsin Department of Natural Resources (DNR) issued a directive requiring that all important aspects of the thermal plumes associated with heat discharges greater than 500×10^6 Btus per hour* be studied intensively over all seasons of the year.[5] The results of these studies were to be used by DNR to guide the establishment of "mixing zones" within which the thermal water-quality standards set forth in the Wisconsin Administrative Code (section NR 102) would *not* apply.

Three power companies were affected by this directive:
Wisconsin Electric Power Company (WEPC), Wisconsin Public Service Corporation (WPSC), and Wisconsin Power and Light (WPL).

The power plants exceeding the heat-discharge minimum are:

Oak Creek (1670 MW**; WEPC)	Edgewater (477 MW; WPL)
Point Beach (1048 MW; WEPC)	Pulliam (393 MW, WPSC)
Kewaunee (540 MW; WPSC, WPL)	Lakeside (311 MW, WEPC)

*A Btu is a British Thermal Unit: The heat required to raise the temperature of one pound of water 1F.

**Peak electrical generating capacity in megawatts (MW).

The locations of these plants are shown in Fig. 1. The Kewaunee plant came on line quite recently, and plume studies at that plant are not very extensive.

One outcome of the DNR directive was a grant from the three power companies to the University of Wisconsin Institute for Environmental Studies, under which the university was to conduct an extended series of aerial remote sensing missions to measure the surface characteristics of the above-mentioned thermal plumes. One hundred "thermal scans" (see below) were to be taken of each plume, over a study period of at least one year.

Each thermal scan provides a picture of the surface character of a thermal plume at an instant in time. A large number of these scans provides a "plume climatology," which shows how each thermal plume usually looks and how it changes with variations in both load and weather conditions.

The resources to conduct this program came from a number of groups:

i. The DNR provided the aircraft and flight crew, and much of the funding for data analysis.

ii. The three power companies provided much of the remote

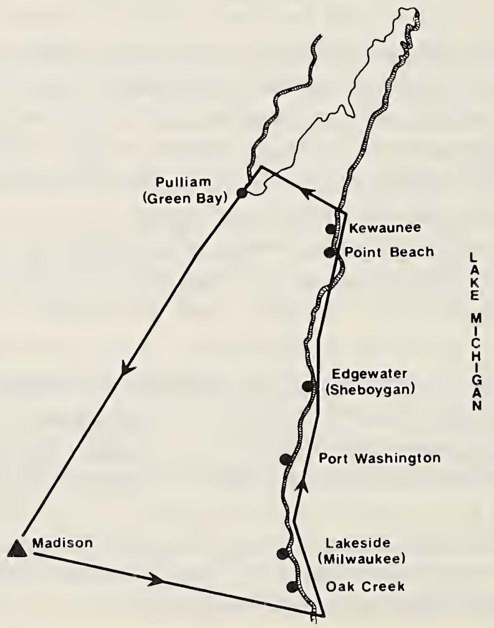

FIGURE 1. Route flown for routine thermal plume monitoring.

sensing equipment, partial maintenance funding for the aircraft, and surface temperature measurements during the thermal scanning missions.

iii. The University provided experienced equipment operators and the data recording equipment, and performed the data analysis. Much of the support for this work came indirectly from NASA, NSF (RANN), the Sea Grant Program, and the University of Wisconsin-Madison Graduate School.

As the scanning missions were being performed, consulting firms and other groups were sampling both the subsurface temperatures associated with the thermal plumes, and the effect of these elevated temperatures on lake biota. Similar work, but along more scientific lines, was carried out by Argonne National Laboratories, and by various University groups under the Sea Grant Program and the Office of Water Resources Research.

THERMAL SCANNING: A Brief Introduction

All bodies radiate energy. Broadly speaking, this energy varies with body temperature, and with the molecular character of the body (its "emissivity"). Water is relatively cool (compared to the sun, for example). Because of this, the radiated energy is almost entirely in wavelengths long compared to those that the eye can detect. Because of absorption, the energy radiated into the atmosphere from a body of water comes only from the water surface. Water has an emissivity which is always very close to one, so that the radiated energy is proportional to the temperature of the water surface.

Certain devices react to this long-wave radiation. For example, a detector made of mercury, cadmium, and telluride which is kept extremely cold will generate a voltage roughly proportional to the amount of long-wave energy falling on it. Thus, it generates an electrical signal which is proportional to surface-water temperatures.

The detector is mounted in an aircraft, and used in conjunction with a set of mirrors which collect the radiation emitted from a spot on the water surface and focus it on the detector. (Fig. 3) The mirrors rotate so that the spot sweeps out a path perpendicular to the direction of flight. The assemblage, together with the associated motors, electronics, and a detector cooling system is a thermal scanner. (Fig. 2)

The signal from the detector is recorded on magnetic tape, which can be played back later through a special film-maker to give a TV-like picture or "thermal scan" of the temperature of the water surface. It is important to remember that light and dark tones in such a "thermal image" correspond only to *water surface temperature.* The shore usually appears much different than the water surface because of a large difference in emissivity. Throughout this paper, light tones on the thermal image denote warm surface water, and dark tones cool surface water. The maximum water-temperature difference is usually about 20F.

Because of atmospheric effects and problems associated with radiative devices within the scanner used to obtain reference temperatures, thermal images can only rarely be interpreted to

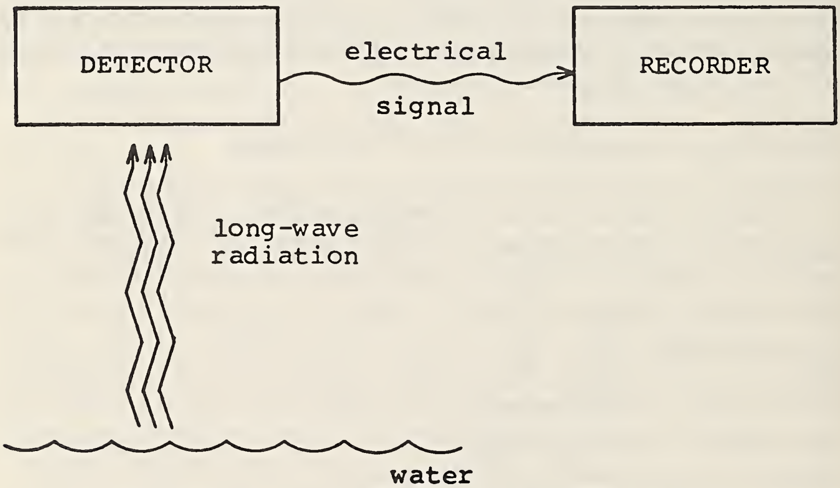

FIGURE 2. Block Diagram of a Thermal Scanner

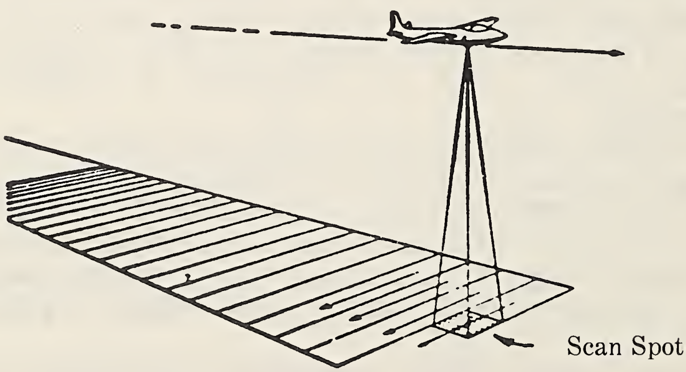

FIGURE 3. Airborne Thermal Scanning

give actual water-surface temperatures unless at least two different water temperatures are measured by more direct methods (eg, with a standard thermometer). With these, the entire image can be calibrated so that the temperature at any point on the water surface is known. Similarly, one should know the important physical parameters governing the character of the thermal plume, in order to rationally interpret the thermal image. The plant load, the pumping rate of cooling water, surface wind, waves, and nearshore lake currents are usually the most important factors. Measurements such as those described above are often called "ground truth." A more complete description of the ground truth used to calibrate a thermal image is given by Scarpace et al.[4]

THE OPERATION

(a) *The Scanning Flights*

The flight path normally used to monitor the Lake Michigan thermal plumes is shown in Fig. 1. The flight lines were always straight in the vicinity of the power plants. They were usually positioned so that from 10% to 20% of the thermal image was of the shore; thus the image could be easily scaled during data analysis. The flying height was generally chosen to maximize thermal detail, while still including the entire plume in the thermal image, and was almost always between 2,000 feet and 5,000 feet above the lake. Scanning was done only near the power plants unless interesting thermal structure such as lake upwelling was noticed at other locations.

The flight line shown in Fig. 1 takes about 2.5 hours to complete. Occasionally, two scans of each plume were obtained by returning southward along the lake shore instead of returning directly to Madison. This altered flight line took about 3.5 hr. Before a flight was begun weather conditions had to be suitable over all the power plants. Occasionally conditions worsened during a flight, forcing part of the flight to be cancelled.

(b) *On Site Measurements*

Shortly before takeoff each power company was notified of the expected flyover time at each plant. The companies relayed this information to the individual plants, and ground truth data were usually taken within a half hour of the actual flyover. This information generally included two water-surface temperatures, pumping rate and estimates of wind and surface waves at the site.

The type of temperature measurements at each plant varied according to the degree of involvement in the project and the nature of the power plant intake and discharge. Details for each plant are given in Fig. 4.

Oak Creek: Bucket* temperatures taken at points A and B provided the necessary scanner calibration points. Point A is near one of the subsurface discharges and point B is near the cooling water intake. At times the temperatures in these areas were not uniform over one scan spot size. This non-uniformity was typical of shore based efforts; the problem could only be alleviated by measuring offshore temperatures from a boat. The submerged discharges add to the problem.

Lakeside: Bucket temperatures were taken in the south discharge channel at point G and at point H. At times the temperature at point H was not uniform over one scan spot size. The water in the surface discharge canal was well mixed and gave good results.

Edgewater: Recorded thermocouple data provided the thermal scanner calibration temperatures at Edgewater. One subsurface intake and two surface discharge temperatures were monitored. Unit 3 and 4 discharge temperatures were recorded at the discharge and at the condenser for each unit. Unit 1 and 2 discharge temperatures were recorded at the condenser for each unit. Occasionally, the discharge temperature for units 3 and 4 disagreed by several degrees F from the weighted average of the individual condenser temperatures. WPL personnel indicated that this was due to recirculating some discharge water through the intake to prevent freezing. Since units 1 and 2 were not used for recirculation it was assumed that the averaged condenser discharge temperatures represented the surface discharge temperature at point Y. The temperature monitored at point Z (Units 3 and 4) was used for that discharge. The weighted average from units 3 and 4 was used only when data were not available at point Z. The weighted average was not used when the possibility of recirculation existed. Where possible the two calibration points were taken at points Z and Y with the intake, X, as a check.

Point Beach: Near the time of flyover power plant personnel, using the bucket technique, measured the temperature at points J

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*See Page 96 for calibration.

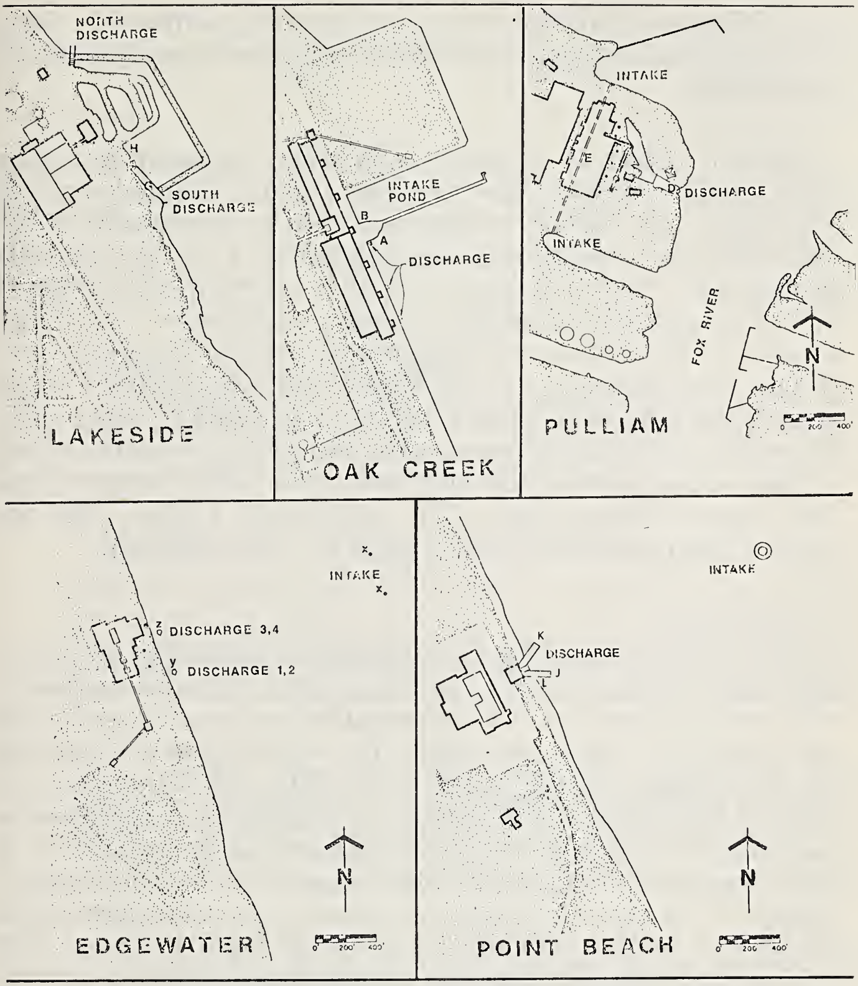


FIGURE 4. Schematics of the power plants.

and L (Fig.4). Usually these two temperatures were sufficient for scanner calibration. When unit 1 (point J) was down, the south discharge temperature differed little from the temperature at L. For these occurrences the recorded discharge temperature for unit 2 (point K) was used as the high temperature calibration point. Tests on unit 1 indicated negligible temperature drop from the recorded discharge temperature and the bucket temperature at point J. Thus point K is shown at the end of the unit 2 outfall. Usually the temperature at point L was uniform over at least one scan spot size. This seems fortuitous; frequently one must go offshore in a boat to find a large enough area of uniform temperature for scanner calibration.

Pulliam: Thermal scanner calibration temperatures were measured by recording thermocouples at points E (intake) and D (discharge). The highest temperature seen by the scanner in the discharge canal was taken as representative of the thermocouple temperature. The temperature at point E is a weighted average of the temperatures at the north and south water intakes. The average depends on the units operating and their relative location to each intake. According to power plant personnel, the amount of water drawn through each intake cannot be readily determined. Therefore, analysis of Pulliam scanner data was necessarily limited to those occasions when the north and south intake temperatures were approximately equal. The temperature change from the surface water near the intake to point E is also unknown.

(c) *Equipment*

Only limited descriptions of the equipment used are given below. More detailed descriptions can be found in the manufacturers' technical specifications. All equipment in the aircraft was checked out in operation before each flight. The aircraft used to obtain the thermal images in this report is the *Wisconsin Department of Natural Resources DC-3.* The DC-3 is relatively large compared to most aircraft used for thermal scanning, and can fly quite slowly. A well tuned area navigation system together with a downward-looking TV viewer which can be monitored by the pilot allowed us to set up and easily reproduce an optimum flight line over each thermal plume. It would be extremely difficult to find an aircraft more suitable to the scanning operation.

Two thermal scanners were used in this work. A prototype *Texas Instruments RS-300* scanner was used in the initial stages, but was replaced by a more accurate *Texas Instruments RS-18A* scanner in late May, 1973. This latter scanner is electronically roll stabilized, and is thus much lighter. Its mercury-cadmium telluride detector is cooled by liquid nitrogen, and is sensitive to radiation in the 8-14 micron waveband.

The signal from the scanner was displayed, recorded, and reconstructed for analysis using the four devices shown schematically in Fig. 5.

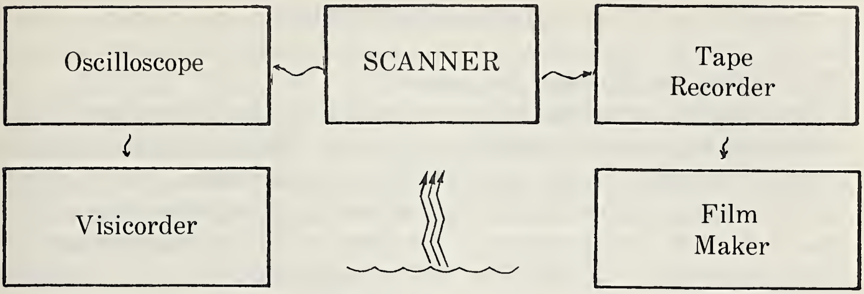


FIGURE 5. Data Acquisition and Display

(a) *Oscilloscope:* Tektronix 5B10N

This displayed the voltage trace resulting from one sweep of the scan spot across the water surface. It allowed the scanner operator to monitor the signal from the detector both before and after being recorded, and to check the aircraft flight line.

(b) *Tape Recorder:* Sangamo Saber III (FM)

The Saber III is a wideband group II FM instrument. It has a frequency response of DC to 250 kiloherz at a record speed of 60 inches per second. The signal to noise ratio at this speed is 33 decibels. The raw data are recorded in an analog made on this instrument in the aircraft. The tape recorder is then returned to the laboratory and used with the analog tapes to produce film imagery and digital computer compatible tapes.

(c) *Visicorder:* Honeywell 1856 fiber-optics cathode-ray tube visicorder oscillograph. This was used with nonpermanent light-sensitive visicorder paper to produce a crude thermal image a few seconds after the aircraft passed over a plume, with which to insure proper coverage of each plume. This imagery was not used for data analysis.

The visicorder was also used to make thermal imagery on film from the data on magnetic tape. The quality of this imagery, however, was below that obtained with the film-maker discussed below.

(d) *Film-maker:* Texas Instruments RFR-70

This instrument makes thermal imagery on standard 70 mm photographic film from a magnetic tape. The result is a negative from which photographic prints can be made. The imagery is corrected for the inherent tangential distortion of the scanner. All imagery in this paper was made with the RFR-70.

(e) *Computers:*

The analog imagery was converted to digital form on a PDP-11 computer. The digital tapes were then interactively processed on a PEP 801 remote terminal connected with the UW-MSN Univac 1110 computer.[6]

DATA ANALYSIS

Calibrating the Thermal Imagery

The quality of the thermal scanner data is limited mainly by the quality of the ground-truth temperatures. We must first relate the scanner output voltage, converted to digital values, to the water-surface temperature. Experimental tests and radiation theory have shown that, for the temperature range in which we are working, the scanner output voltage V is very closely related to the absolute water temperature T (in degrees Kelvin) by the equation:

$$V = A + B\,T^4$$

Here, A and B are constants, which are ascertained from the two ground-truth temperatures.[4] This equation is accurate to within 0.1F if the two ground-truth temperatures span the water-surface temperatures range. A cooling-water outfall temperature and an ambient (i.e., outside the plume) lake temperature usually meet this criterion. Also, the parcel of water used as a ground-truth "point" should be isothermal over an area somewhat greater than that of the scan spot, due to the response time of the scanner electronics. This is an area of about 400 square feet at a flying height of 2,000 feet. Finally, the water temperatures should be measured at the water surface, or at least near the surface, and in well mixed water.

Two temperature-measuring techniques were used in our program. One was to use the intake and outfall temperatures recorded routinely by the power plant, usually with thermocouples. However, these temperatures are often unsatisfactory because they are taken well beneath the water surface, and can differ by several degrees from those sensed by the scanner. A more reliable technique involved taking two "bucket" temperatures near the time of flyover. At two designated locations, a tethered bucket was lowered, filled with "surface" water, and retrieved. The temperature of this water was measured with a standard thermometer. Three problems were associated with this shore-based technique: the isothermal area near shore was sometimes smaller in size than the scan spot; the bucket temperatures on occasion did not span the full water-surface temperature range; the water was on occasion not well mixed, so that a surface skin may have been present.

The size of the isothermal area was checked during analysis by looking at digital values adjacent to the selected calibration value. For 90% of the plumes analyzed the calibration points were isothermal to within 0.3F. The bucket temperature for analyzed data spanned a temperature range adequate to insure negligible error; for those instances where this was not true the data could not be analyzed. The hot calibration temperature was usually measured in the plume discharge, a well mixed area. The skin effect could, however, affect the cold calibration temperature. Comparisons of in situ temperature mapping from a boat, and airborne thermal scanning under a variety of environmental conditions indicated good agreement with one exception (Point Beach, June 6, 1973).[7] It was felt that the surface skin effect contributed to the differences in this exception. Of all the plumes analyzed less than 5% exhibited the unusual characteristics of the June 6, 1973 scan. Errors as large as 1F or 2F could be present in those analyses. Some ground truth data were obtained from consulting firms working for the power companies. However, attempts to coordinate measurement efforts with these firms were largely unsuccessful, so that overlapping data are sparse. At Point Beach, several plume-measuring efforts were coordinated with the Argonne National Laboratory.[7]

Finding the Size of the Thermal Plumes

The scanner output voltage recorded on tape in the aircraft was converted to digital values in the laboratory on a PDP-11 computer together with an analog-to-digital converter. The digital tapes were then analyzed interactively with a graphics display terminal to connect the operator with the University of Wisconsin-Madison Univac 1110 computer.[6] The terminal displayed a digital representation of the thermal image. The operator used this image to select ground truth locations and isolate the digital values associated with the plume and ambient lake water from extraneous heat sources. The digital scanner voltage values were then converted to water surface temperatures by the above equation, and areas enclosed within various isotherms calculated. A schematic example is shown in Fig. 6. One should recall that the normal definition of a mixing zone is equivalent to the area contained with the 3F (above ambient) isotherm.[8]

Assigning an area to the digital values requires knowledge of the aircraft groundspeed and its flying height. To obtain greater accuracy the tangential distortion-corrected film image of the scan was scaled with aerial photographs and power plant scale drawings as references. Corrected aircraft speeds and altitudes were then calculated. Slight variations in speed and altitude during the scan were not corrected. Together these variations could introduce as much as 7% error in the calculated areas. This occurred only on very turbulent days; for most of the scans the error was much less.

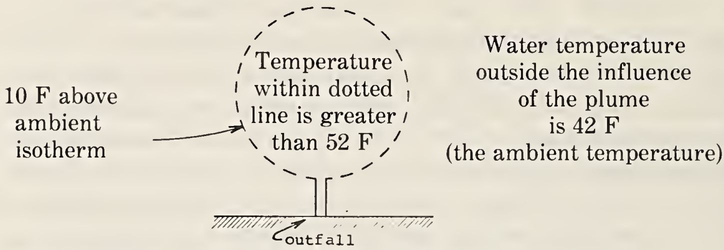


FIGURE 6. Schematic of Thermal Plume Isotherm

RESULTS

A photographic print was made of each RFR-70 thermal image, with careful quality control to enhance the thermal plume. The prints for each power plant were arranged as a mosaic and photographically reduced. For each of these pages of thermal images a corresponding page with pertinent information was made. The typewritten pages are arranged so that the data pertaining to each thermal image are in the corresponding frame. These pairs of typewritten/thermal image pages are Figs. 8 through 16. To further save space the data are presented without units. After a brief perusal of Fig. 7, an example with units included, the reader will find this "mosaic tabulation" easy to comprehend.In some cases not all the environmental and/or plant data were available. Dashes are used in these instances. No areas are listed where the surface calibration temperatures are missing. The metric system was not used because DNR requested surface areas in square feet enclosed within the 3F, 6F and 10F isotherms (the pertinent regulations are

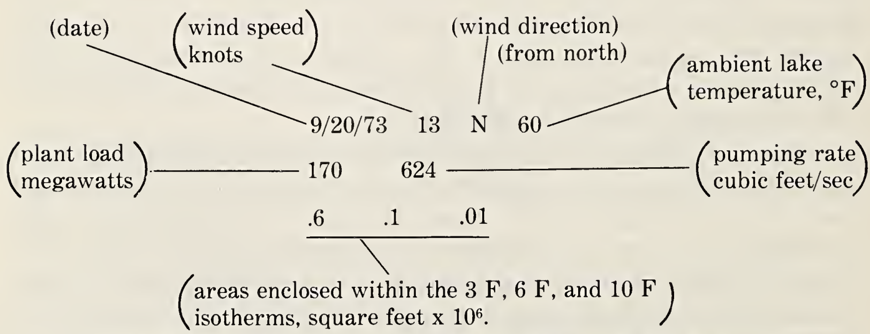


FIGURE 7. Interpretation of Data Presentation Legend.

written in degrees F). It would be possible of course to list areas in square meters enclosed within the 1.67C, 3.33C, and 5.55C isotherms. However, in view of the fact that the state regulations regarding mixing zones are formulated in English units the authors have decided to avoid confusion in one realm, at the risk of creating it in another.

Error Summary

Error sources stemming from temperature calibration and scaling of the imagery have been discussed. The maximum expected error in either case is less than 10% for the plumes analyzed. For most of the plumes the errors should be considerably less. Temperature and scale calculations both contribute to the error in the final result, the area enclosed within isotherms. Assessing the contribution due to scale errors is straightforward; assessing that due to temperature is more complex. Area uncertainties due to errors in temperature are modulated by the temperature gradient. That is, where the slope of the area vs. temperature curve is the steepest, the effect of temperature errors will be the greatest. The wide variability in the structure of thermal plumes demands each plume be evaluated individually. In general, however, we feel a conservative estimate of the error bounds on the results presented here is 10 ± %.

CONCLUSIONS AND RECOMMENDATIONS

It is impossible to conclude this report without a brief set of recommendations based on the misgivings, frustrations, and hindsight associated with two years of work. The authors offer the recommendations below in the hope that they may be incorporated as part of a cost-effective, regional remote sensing program serving the needs of the State of Wisconsin.

Ground Truth The weakest link in the process of generating high quality thermal contour maps from raw thermal scanner data is the measurement of water surface temperatures required for calibration. Although the authors were not satisfied with the ground truth effort described above, it would be difficult to (inexpensively) improve upon it on an operational basis. Two techniques of improving future ground truth are worth investigating. These are:

1. Developing specially painted, large, heated panels of known emissivity. These panels would be strategically placed near

the plume and frequently thermally calibrated. For routine work, they would only need to be uncovered prior to flyover and their temperature monitored.

2. Changing the scanner wavelength sensitivity from a range of 8 to 14 microns to one of 10 to 11.5 microns. Atmospheric effects are considerably reduced in the latter range.[9] It may then be feasible to calibrate the scanner in the laboratory, and

9/20/73 13 N 60 170 624 .6 .1 .01	1/30/74 16 SW -- -------- ------------	10/17/73 10 N 53 190 716 3.4 .9 .2	11/5/73 15 N 49 66 251 .3 .2 .1

2/9/73 13 W 34 220 919 .8 .2 .01	2/12/73 13 SE 33 240 949 2.8 1.7 .3	10/5/73 10 WSW 60 24 0 9.8 2.2 .2

2/21/73 16 NW 34 210 830 1/4 .8 .2	10/18/73 11 NW 52 34 362 .3 .01 .01	1/30/73 7 WSW 33 201 978 1.2 .8 .1

2/20/74 5 SW 34 220 234 .3 .2 .1	3/27/74 9 SE 37 188 633 .4 .04 .01	3/13/74 --- --- 175 596 -----------	2/22/73 13 W 34 235 950 1.8 .6 .3

3/21/74 15 WSW 36 226 716 2.1 .7 .01	2/5/73 14 NE 35 160 949 2.1 .8 .3	3/12/74 17 NNE 35 148 512 1.4 .4 .1	2/18/74 13 SSW 33 185 605 .5 .3 .2

2/18/74 11 S 35 58 399 .1 .02 .01	4/11/73 13 WSW 37 220 978 2.0 .4 .1	4/12/73 9 N 39 240 918 1.9 1.2 .3	5/30/74 10 NNE 49 160 1496 4.9 1.2 .1

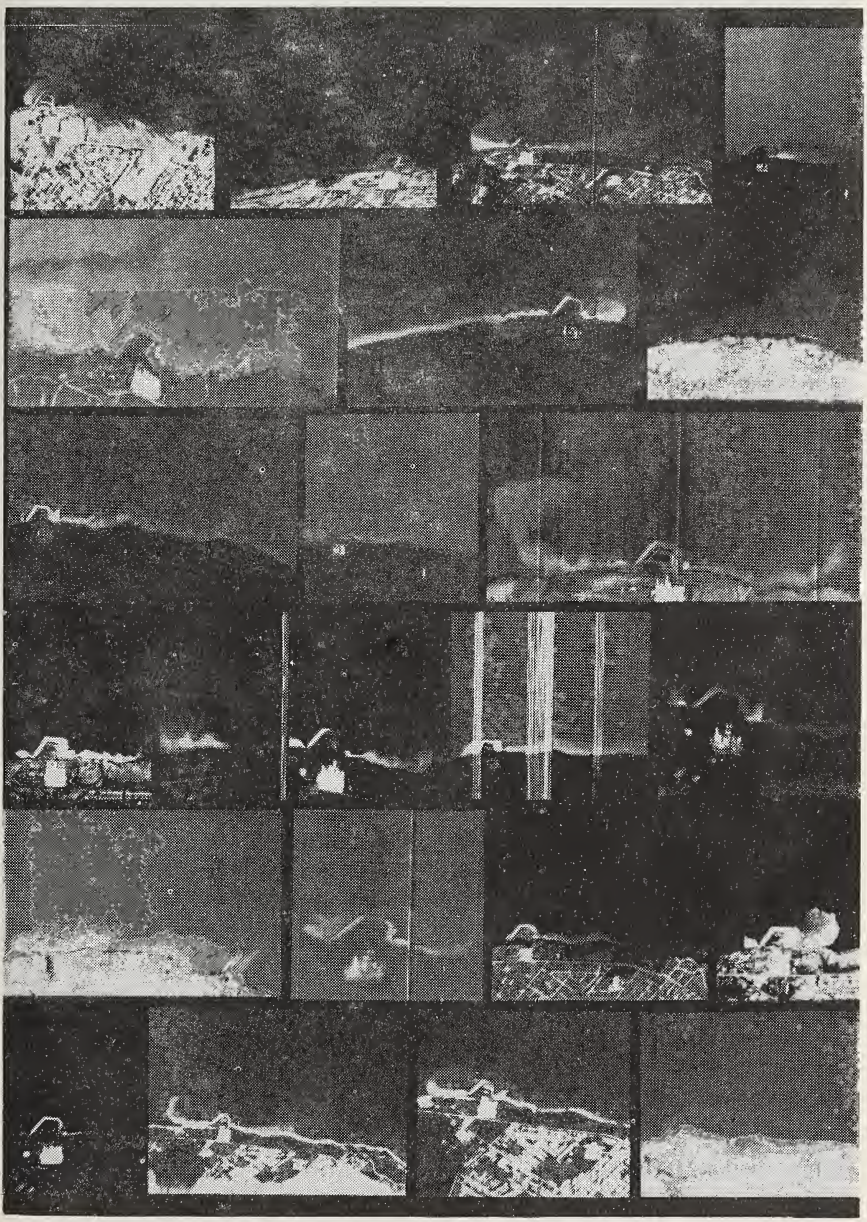


FIGURE 8. Thermal images and data fcr the Lakeside power plant.

neglect atmospheric effects altogether. The effects of the surface skin are not well understood.[10] Field experiments under various environmental conditions would be useful to ascertain under what conditions serious discrepancies occur between scanner-derived surface water temperatures and the actual near-surface water temperatures.

1/30/73 7 SW 34 1072 1907 3.0 2.1 .9	2/9/73 10 W 34 1040 1912 4.1 2.5 .2	2/5/73 14 NE 34 1180 2135 1.23 .57 .1
3/6/74 13 SW 39 1135 2135 13.5 2.7 .9	1/4/74 13 W 36 989 2134 5.5 3.5 1.0	3/13/74 --- 35 899 1934 8.1 6.9 3.6
2/8/74 2 W 32 1172 2153 .5 .5 .3	1/11/74 11 W 33 1018 2134 2.2 1.6 .1	
1/8/74 6 SW 33 1199 2134 1.9 .7 .1	3/6/74 13 SW 39 1135 2135 13.5 2.7 1.0	
3/21/74 15 WSW 38 1035 2153 36.0 13.4 .8	11/5/73 15 NW 51 1198 2135 3.0 .1 none	
9/10/73 11 W 55 1267 2335 3.9 .2 .1	1/9/74 8 WNW 32 1101 2134 2.2 1.9 1.0	
2/26/74 15 S 33 777 1738 5.1 2.0 .1	4/23/74 16 NW 49 1075 1913 4.3 .1 none	

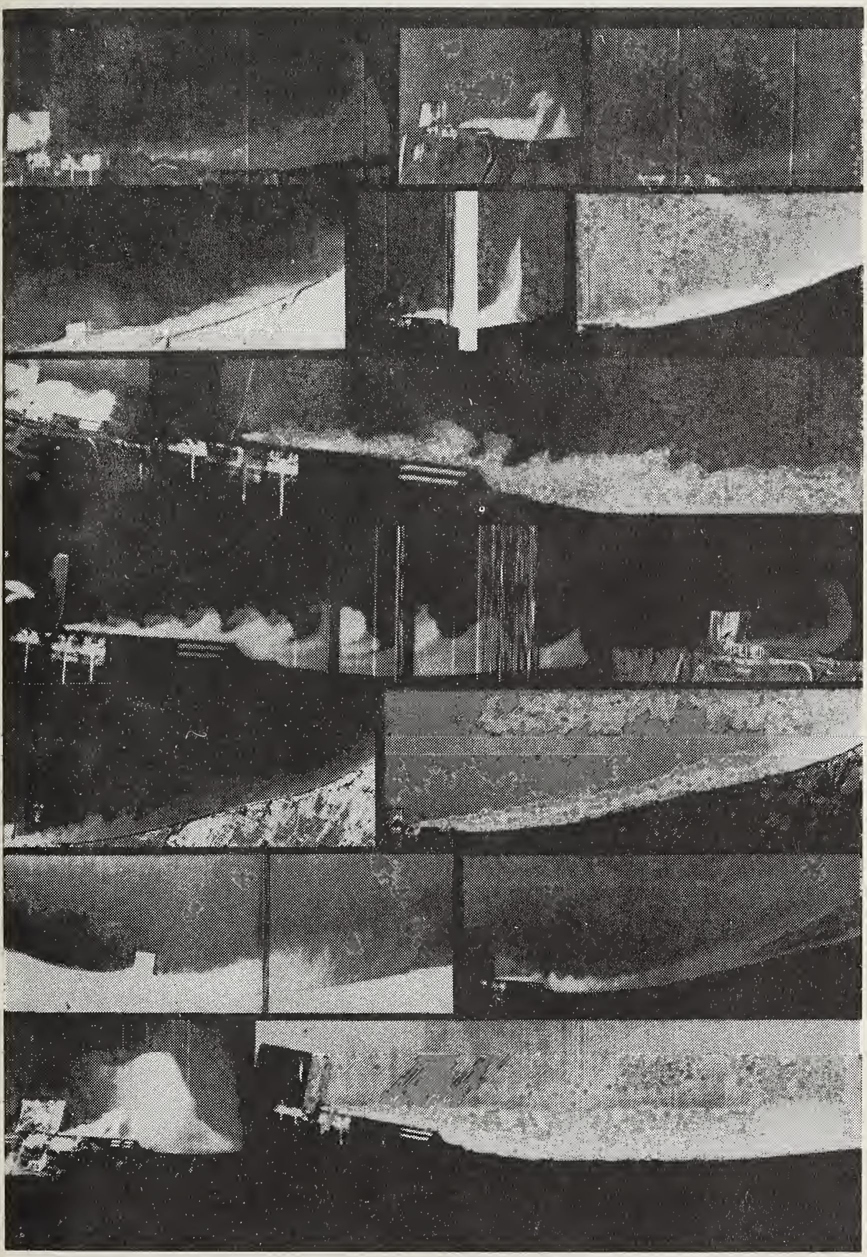


FIGURE 9. Thermal images for the Oak Creek power plant.

Routine Monitoring Routine thermal monitoring of thermal plumes is recommended. Public interest in all aspects of power generation has understandably increased with the dramatic increase in the number of power plants. Aerial remote sensing of thermal discharges is an inexpensive way to insure compliance with

7/11/73 8 NE 54 I: 19 120 II: 392 354 11.0 6.7 2.9	9/4/73 15 SSE 51 I: 45 120 II: 386 355 5.0 1.0 .2	10/5/73 10 SSE 58 I: 38 475 II: 387 475 5.4 1.7 .6	5/31/73 12 N 50 I: 42 120 II: 391 354 4.9 1.8 .6

5/30/73 10 NNE 50 I: 42 120 II. 372 354 3.7 1.1 .6	7/3/73 10 S 53 I: off II: 394 354 1.3 .3 .1	4/17/73 26 S42 I: 44 120 II: 394 354 9.5 3.9 .4

5/15/74 12 SSE 44 I: 9 II: 364] 364 13.6 1.7 .5	9/10/73 12 WSW 48 I: 23 120 II: 394 354	6/14/73 12 S 51 I: 44 120 II: 389 354 3.4 .3 .03

6/7/73 20 SW 49 I: 40 120 II: 382 355 2.0 .7 .1	6/15/73 15 SSE 48 I: 44 120 II: 391 227 6.8 2.3 .6	6/6/73 3 E 50 I: 41 120 II: 391 227 14.8 5.7 1.2	9/7/73 10 E --- I: 25 60 II: 390 354 -------------

7/10/73 10 NE 44 I 45 120 II: 388 354 5.4 2.8 .5	5/24/73 5 SE 52 I: 46 120 II: 43 100 5.3 2.3 .01	6/12/74 18 W.50 I: 0 II: 390] 304 1.7 .6 .2	7/3/74 20 S 53 I: 29 II: 335] 314 5.4 1.6 .6

5/11/73 15 WNW 50 I: 46 120 II: 57 100 .4 .1 .01	9/14/73 8 SSE 55 I: 45 120 II: 391 354 22.5 14.3 1.6

7/10/73 8 NNE 44 I: 27 120 II: 416 354 2.4 .3 .2	6/26/73 13 WSW 50 I: 24 60 II: 392 354 1.3 .7 .2	5/9/74 10 NE 47 I: 22 II: 279] 287 2.2 .7 .2	10/10/73 12 S 58 I: 29 II: 382] 414 4.4 1.2 .6

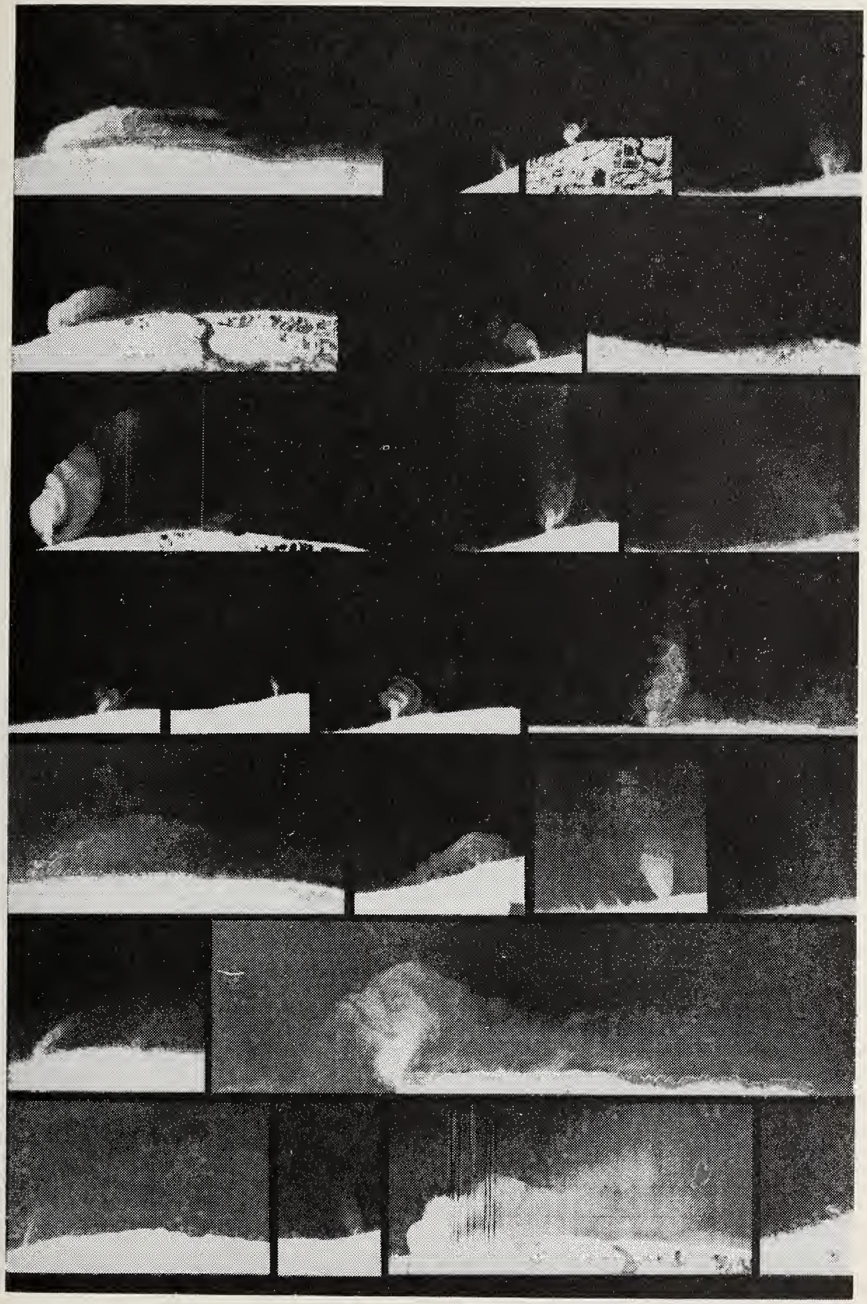


FIGURE 10. Thermal images for the Edgewater power plant.

regulations, and keep the public informed of the extent of thermal discharges into Lake Michigan. New power plants should be monitored frequently initially, to extend what has been reported herein. Routine monitoring would also be useful as a guide and a complement to other thermal plume sampling programs.

5/31/73 10 SW 51
I: 480 858
II: 450 858
13.2 2.1 .2

6/27/73 11 SSW 50
I: 500 858
II: 479 858
3.3 .5 .1

7/3/73 SW 51
I: 970 858
II: 970 858
4.0 .9 .2

6/12/74 16 W 50
I: 366 486
II: 490 871
2.9 1.0 .2

7/10/73 10 NNE 54
I: 500 858
II: 500 858
11.1 2.8 .3

7/17/74 16 S 55
I: 500 858
II: 500 858
5.2 .3 .1

9/7/73 9 SSE 48
I: 495 858
II: 500 858
16.9 3.3 .6

9/10/73 9 WSW 49
I: 459 858
II: 495 858
21.7 5.7 1.0

6/14/73 9 SSW 50
I: 500 858
II: 495 858
5.9 2.0 .3

6/15/73 12 SSW 47
I: 500 858
II: 480 858
18.2 .8 .1

5/11/73 12 NW 49
I: 365 858
II: 480 858
5.3 .7 .04

5/21/74 9 SSE 49
II: 495 884
4.6 .8 .2

6/7/73 14 SW 49
I: 487 858
II: 500 858
8.8 2.0 .2

6/26/73 calm 51
I: 970 858
II: 970 858
2.1 .5 .1

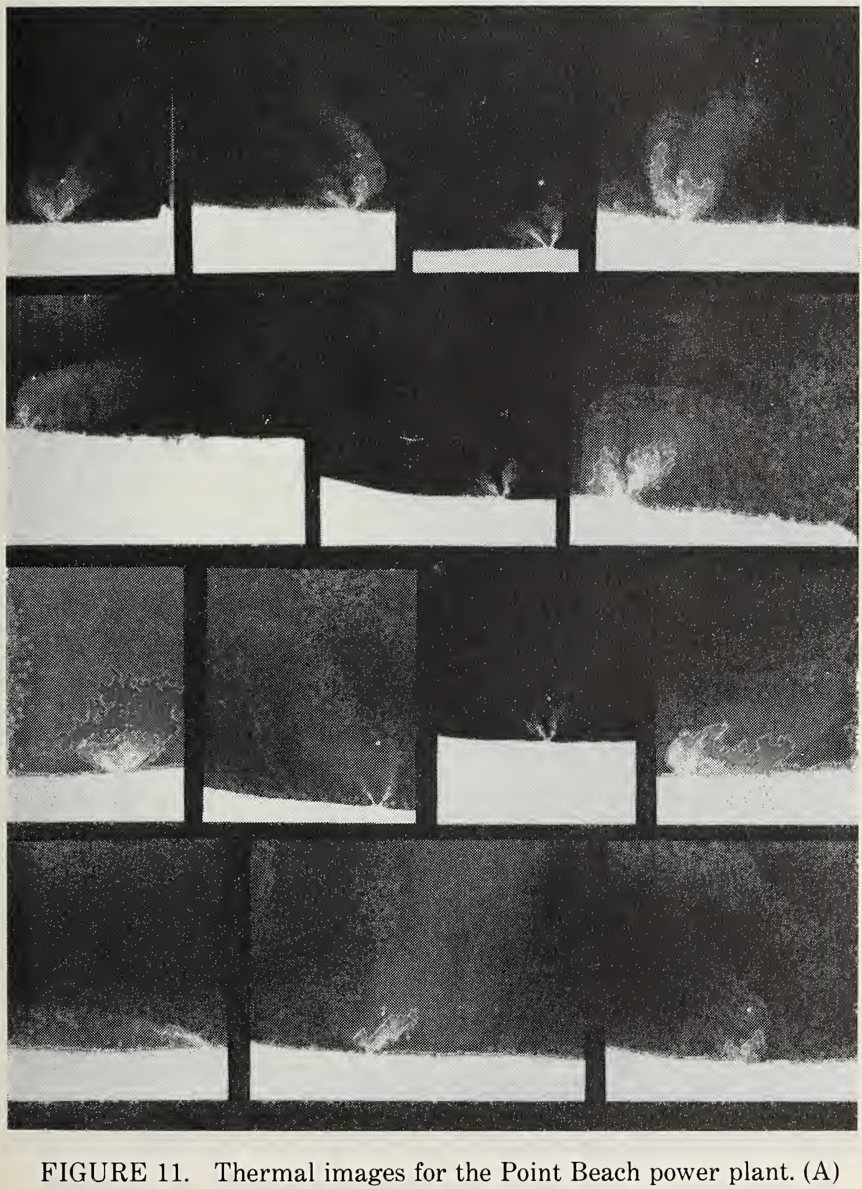
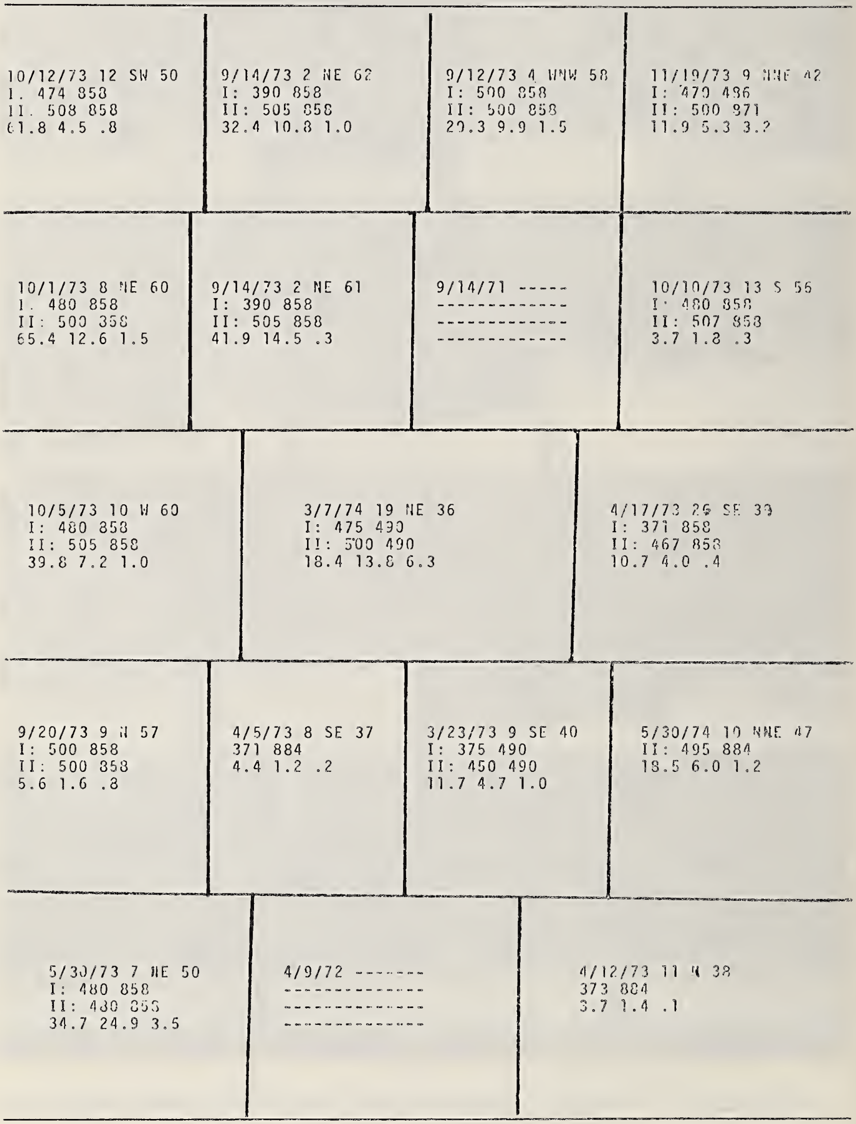


FIGURE 11. Thermal images for the Point Beach power plant. (A)

Round-the-Lake Monitoring If routine monitoring is deemed necessary, it would be foolish not to monitor an entire region, or at least all of Lake Michigan. Aerial remote sensing has proven to be quite cost-effective for monitoring the Wisconsin portion of Lake Michigan; the cost-effectiveness would certainly increase if all of Lake Michigan were included.



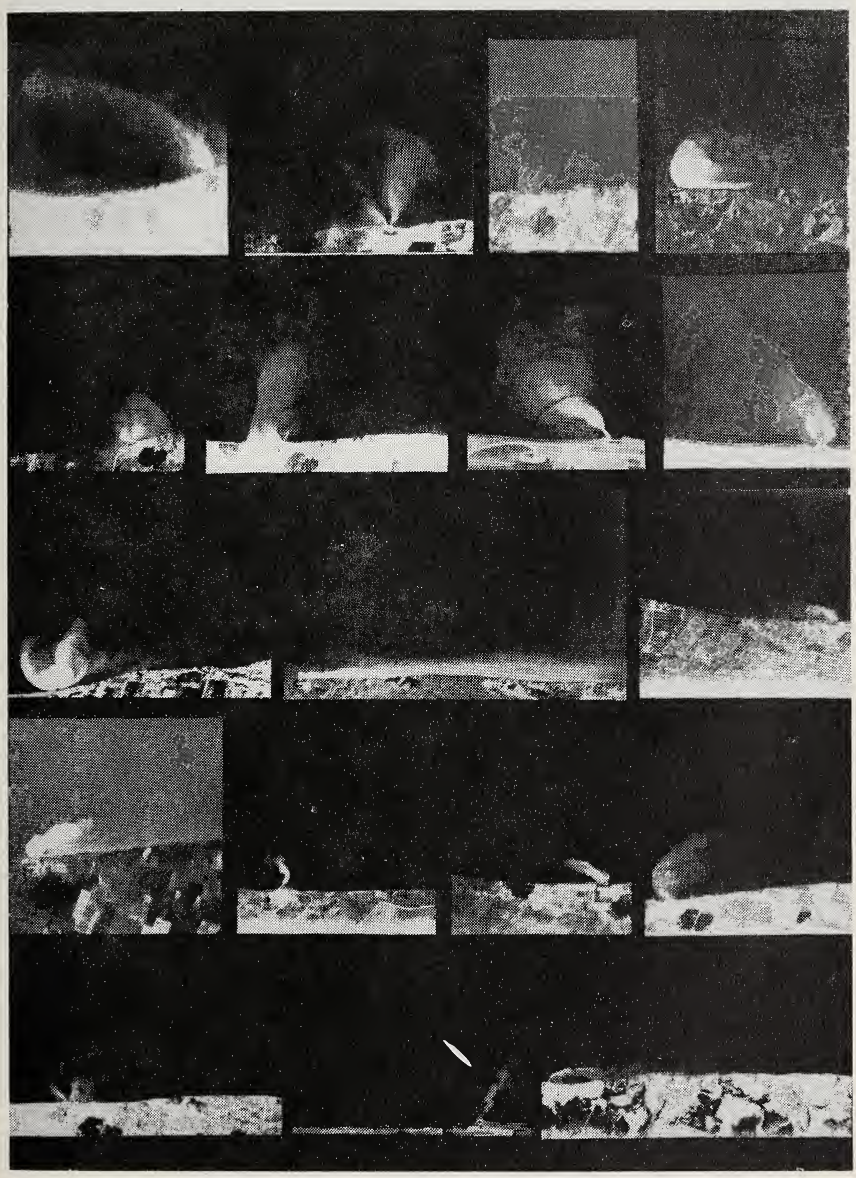


FIGURE 12. Thermal images for the Point Beach power plant. (B)

9/15/71 -------

4/11/72 ------

4/15/72 ---- --

7/11/73 --------

5/9/74 3 NNE --
II: 490 884

4/6/72 ------

4/11/72 ------

4/11/72 -----

4/12/72 -----

5/15/74 9 NW 44
II: 488 884
10.5 1.5 .3

Sept. 1971

4/9/72 -----

5/15/74 13 NW 43
II: 500 884
3.3 1.0 .1

4/12/72 -----

4/15/72 -----

4/23/74 NW 44
I: 0
II: 485 884
8.2 .6 .2

FIGURE 13. Thermal images for the Point Beach power plant. (C)

4/17/73 10 SSW 42
227 457
1.0 .2 .1

2/19/74 5 NW 34
247 428
.2 .1 .02

2/21/73 5 NW 33
283 400
.4 .1 .03

2/18/74 1 SW 32
233 371
.7 .1 .04

1/4/74 4 SW 33
322 364
.3 .3 .05

1/11/74 4 N 32
317 422
.5 .4 .2

3/27/73 7 SE 37
248 363
2.0 .8 .4

2/20/74 8 SW 32
220 371
.3 .04 .02

2/18/74 2 S 33
245 428
.4 .4 .2

4/11/73 5 SW 37
260 377
1.1 .1 .1

2/12/73 7 SE 33
222 518
.7 .1 .02

2/22/73 7 W 34
277 400
2.5 .6 .1

10/5/73 3 W 64
270 451
1.8 1.0 .1

10/12/73 10 SSW 68
249 451
.3 .1 .03

2/27/74 6 S 33
247 330
.4 .1 .05

4/5/73 8 SW 41
257 410
1.4 .7 .3

3/12/74 36
248 382
.01 0 0

2/26/74 3 S 35
239 359
.5 .1 .02

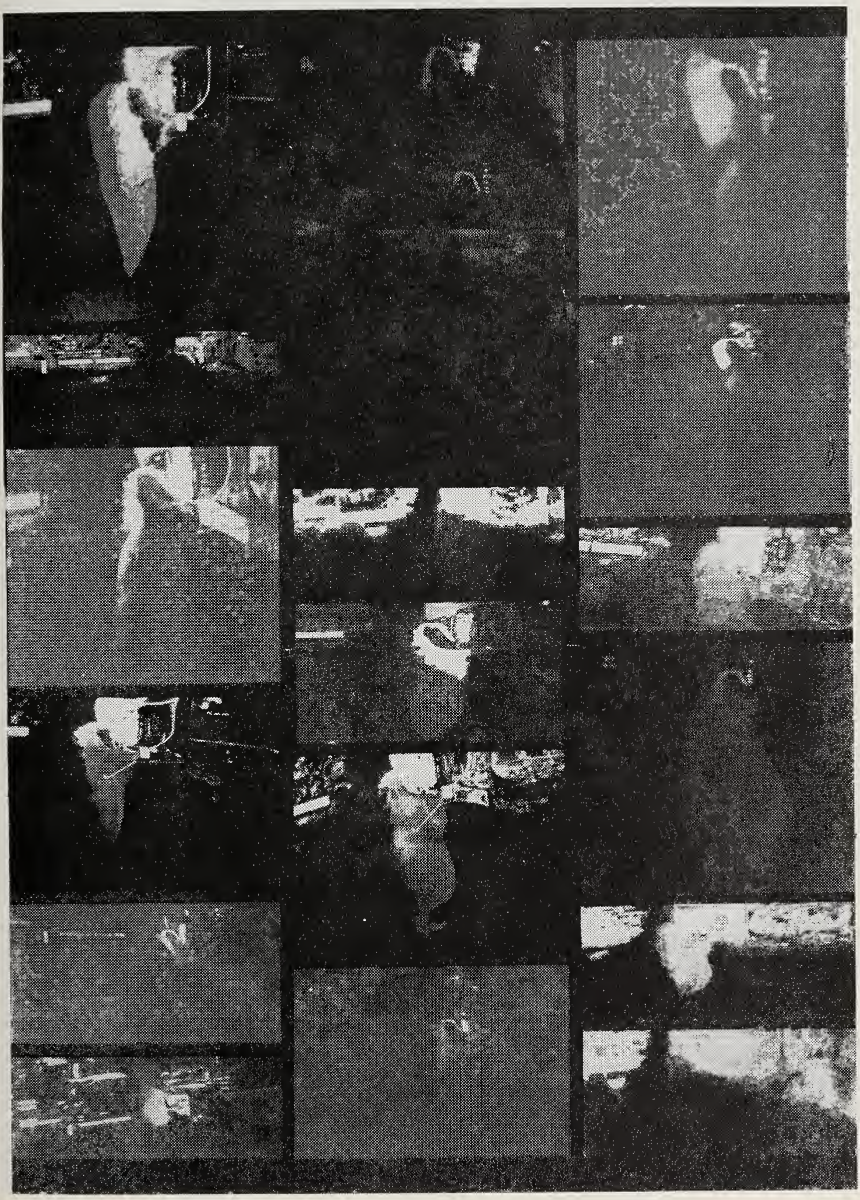


FIGURE 14. Thermal images for the Pulliam power plant. (A)

9/7/73 -- 70
290 603
.5 .1 .01

11/19/73 7 NE 42
331 385
4.6 1.3 .8

3/6/74 6 SW 36
246 382
3.4 .4 .2

4/23/74 9 N 44
360 593
.2 .1 .02

9/20/73 2 NE 58
282 451
.9 .5 .1

2/5/73 6 E 34
350 466
2.0 .2 .01

2/8/74 2 SW 33
275 415
.4 .2 .04

9/4/73 8 SSW 68
286 744
.5 .4 .2

9/14/73 5 SW --
322 744

3/7/74 9 NE 34
234 382
.3 .1 .03

9/12/73 4 NW 62
290 796
7.4 3.1 1.2

2/9/73 4 W --
356 466

6/12/74 --- 62
261 414

1/30/73 4 E 32
313 388
.7 .2 .02

3/13/74 2 E 36
245 382
.6 .04 .01

9/10/73 3 SW --
281 796

10/17/73 4 SW --
347 536

1/30/74 6 SE 33
359 471
1.6 .2 .02

7/10/73 3 NE 72
323 874
3.2 .8 .2

7/11/73 3 ESE 72
333 874
5.8 2.1 .1

FIGURE 15. Thermal images for the Pulliam power plant. (B)

6/15/73 4 SW 72
336 833
.8 .4 .02

3/23/73 7 SE 37
251 372
.4 .1 .03

6/14/73 3 SW --
328 833

5/30/74 --- 61
267 403
1.6 .4 .04

5/15/74 6 W 52
254 453
.4 .1 .02

5/31/73 5 SW 59
348 594
.6 .3 .1

5/21/74 --- 56
265 431
1.3 .5 .1

6/7/73 8 SW --
351 743
1.1 .5 .1

6/6/73 4 W 70
343 833
1.1 .6 .1

5/15/74 5 SW 50
244 453
.7 .4 .02

3/28/73 2 SE 34
258 363
1.3 .7 .3

5/11/73 11 W 54
347 652
.3 .2 .1

10/1/73 4 NE 66
283 373
.6 .2 .1

10/10/73 6 S 63
306 396
1.3 .7 .3

7/17/74 --- 76
284 848
.9 .1 .03

7/3/73 5 SSW 71
308 774
.8 .3 .03

9/14/73 4 SW 70
327 744
.3 .1 .02

5/30/73 7 S 52
341 594
.6 .3 .3

7/3/74 --- 72
360 932
.2 .1 .02

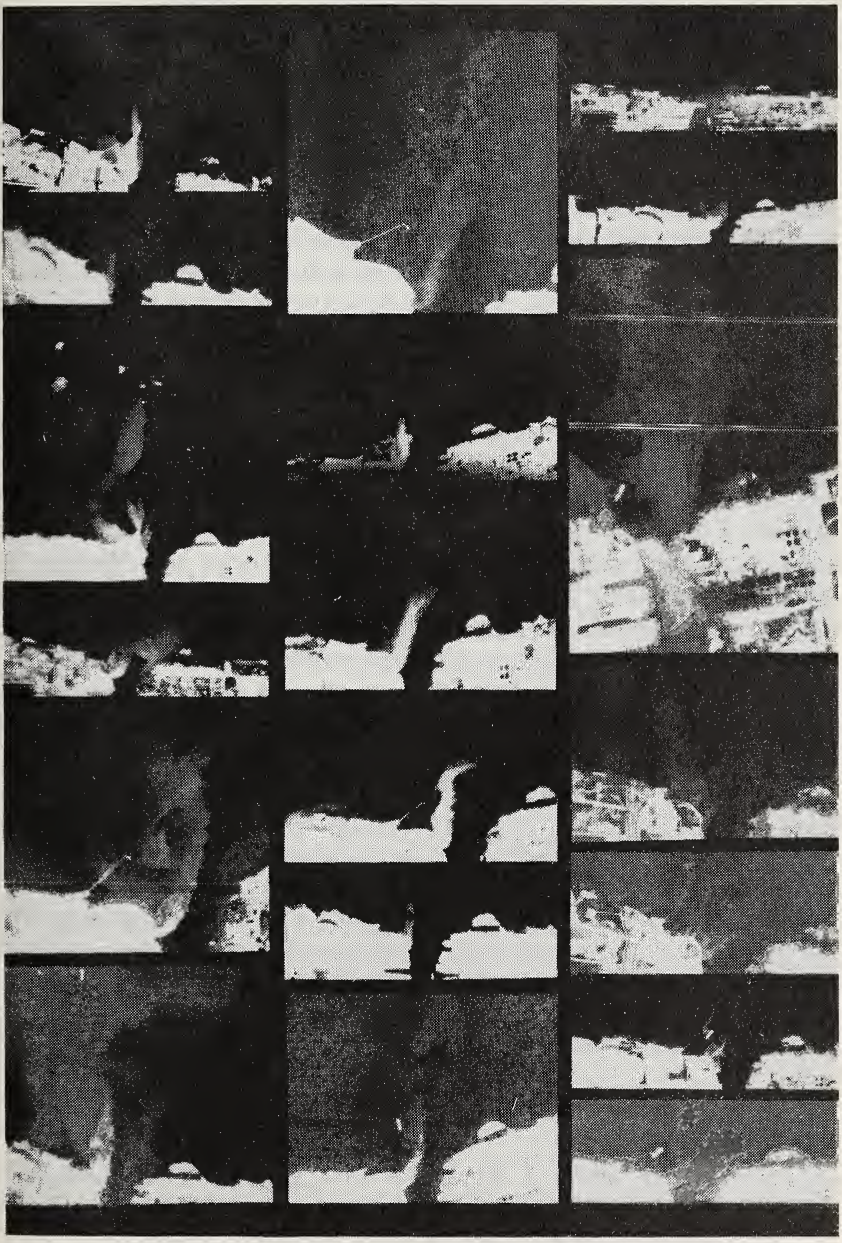


FIGURE 16. Thermal images for the Pulliam power plant. (C)

Thermal Standards The thermal standards for power-plant thermal plumes should be written operationally, as a compromise between "end-of-pipe" standards and biological-effect standards. That is, standards should be based on information that *can* be obtained with a reasonable effort. Standard remote-sensing monitoring procedures should be developed, which would include standardized, routine, ground-truth measuring techniques. The control of raw data through the entire processing procedure should also be standardized to insure that legal integrity is maintained. Every attempt should be made to avoid arbitariness by continuing intensive biological effect programs at a few representative plants, rather than studying all plants on relatively limited bases.

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CHANGES IN SUBMERGED MACROPHYTES IN GREEN LAKE, WISCONSIN, FROM 1921 TO 1971

Mary Jane Bumby
Green Lake, Wisconsin

ABSTRACT

In 1921, H. W. Rickett studied the macrophytes in this lake and his data are the basis for a 50 year comparison. The 1971 and 1921 data at the 30 selected stations showed that, overall, total biomass decreased. Five species increased in biomass while eight species decreased; four species of *Potamogeton* were not found in the 1971 quadrats, but all except one have been identified as still present elsewhere in the lake. *Myriophyllum spicatum, Vallisneria americana* and *Potamogeton crispus* have the largest increases, while *Chara* sp. had the largest decrease of more than 600 gm/m^2. The largest total biomass decrease occurred at the deepest area in the littoral zone 3 (3-10 m) with zone 2 (1-3 m) and zone 1 (0-1 m) also decreasing in that order. The sharp differences in biomass between the high and low stations selected from Rickett's report have diminished; all the previous high stations have declined in biomass and the low stations display no specific pattern of change. One high and one low station within the deepest zone located where effluents entered the lake, were devoid of vegetation in 1971. Over the 50 year span, the total percentage of dry weights of the comparable plant species showed an insignificant increase, but some individuals had significant variations.

No *Cladophora* problem existed in Green Lake during Rickett's observations, but, in 1971, the biomass of the filamentous algae, mainly *Cladophora* sp., formed a serious nuisance in the littoral zone and proved to be the most important autotroph by weight in zone 1 and third in both zones 2 and 3. Blue-green algae in the phytoplanktonic community in 1971 were *Microcystis aeruginosa, Anabaena flos-aquae, Aphanazomenon flos-aquae* and *Gloeotrichia echinulata.*

It appears that the littoral plant community in Green Lake has diminished in the past 50 years, especially in the deepest zone, although macrophytes of foreign origin, *Vallisneria americana* and filamentous algae are increasing in importance.

INTRODUCTION

Green Lake, located in Green Lake County (Lat. 42° 48′ N, Long. 89° 00′ W), has a narrowly oval outline oriented northeast to southwest with a length of 11.9 km and a maximum width of 3.2 km (Fig. 1). This lake, which is the deepest inland lake (72.7 m) in the

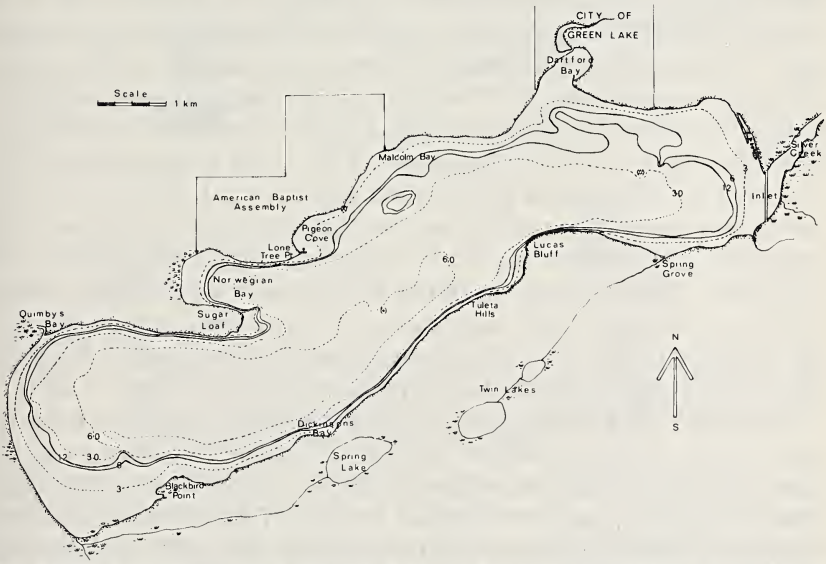

FIGURE 1. Hydrographic map of Green Lake adapted from Marsh and Chandler (1898) showing depth in meters and geographic features mentioned in text. Plankton samples were collected at Pier Station (X), Buoy Sation (#) and Deep Station (*). Some physical data were also obtained from the latter site (Bumby 1972).

state (Juday 1914), was formed by glacial action when the Green Bay lobe of the Wisconsin Stage of glaciation modified the preglacial valley formed earlier by stream erosion. The ice moved through this valley in the direction of the lake's long axis and deepened the basin which is underlain by easily worn Potsdam sandstone. Glacial drift closed the smaller tributary valleys and impounded the water into the present lake basin by depositing a moraine at the west end of the ancient valley. The water thereafter drained through a new outlet, the present day Puchyan River, which flows northeasterly to join the Fox River, finally draining into Lake Michigan.

Pietenpol (1918) noted that Green Lake is not "marsh stained". Silver Creek is the largest stream entering the lake; additional water comes from springs, either directly, or via five small streams on the SW and SE shores and one stream enters the head of Norwegian Bay, through land owned by the American Baptist Assembly (ABA). The hydrographic map of Green Lake (Fig. 1) shows the low areas which Rickett (1924) described as "extensive swamps and marshes" at the Silver Creek and other stream inlets. Other marshy areas are evident in the vicinity of Quimby's Bay and at the head of Norwegian Bay which Rickett described as a "muddy bog". The shoreline is diverse with low sandy beaches at the ends of the lake, wooded slopes of varying steepness, and perpendicular cliffs of Potsdam sandstone at Lucas Bluff, W of Lone Tree Point, S of Sugar Loaf and E of Dickenson's Bay. An unauthorized dam which raised the level of the lake 5 ft. (1.5 m) was built by the Victor Lawsons at one of the mills along the outlet; the date is unknown but probably was before the first hydrographic map (Marsh and Chandler, 1898) because the depth of the lake was reported by them as 72.2 m. Perhaps then, this change of water level, which affected the entire shoreline of the lake, occurred 23 years before Rickett's study of the macrophytes in the pristine water of Green Lake.

Presently, "Big Green", as it is often called, is, and has been for some years, heavily used for recreation during all seasons of the year. It is beautifully set within a densely wooded margin which is surrounded by a large watershed area of 27,618.8 ha (Marter and Cheetham 1971). This basin can be divided into 1,537.8 ha in roads and farmsteads, 991.1 ha in urban areas (two cities) and 1, 256.6 ha in public land; the remaining 86.3% (23,832.5 ha) is mostly in agricultural use. Because of its attractive setting, large size, depth and proximity to populated areas, there are many houses of all sizes along this lake's 43.9 km of shoreline. Fortunately, extensive parts of the shore have not been subdivided. The City of Green Lake is located on the NE edge of the lake near the outlet. The Wisconsin Department of Natural Resources is authorized to determine the maximum and minimum levels of the lake but the actual control of the level is in the hands of the City of Green Lake, since it owns the dam.

Sewer lines are located within the City of Green Lake (1,033 in 1970) but the lake is not affected because the partially treated sewage is discharged into the outlet. Plans are underway to improve this plant. In 1971, treated sewage effluents did enter the lake from the ABA treatment plant, which discharges into Norwegian Bay (Fig. 1) at station 13 (Fig. 2), and also from the City of Ripon (grown from 3,929 population in 1920 to 7,053 in 1970) through its

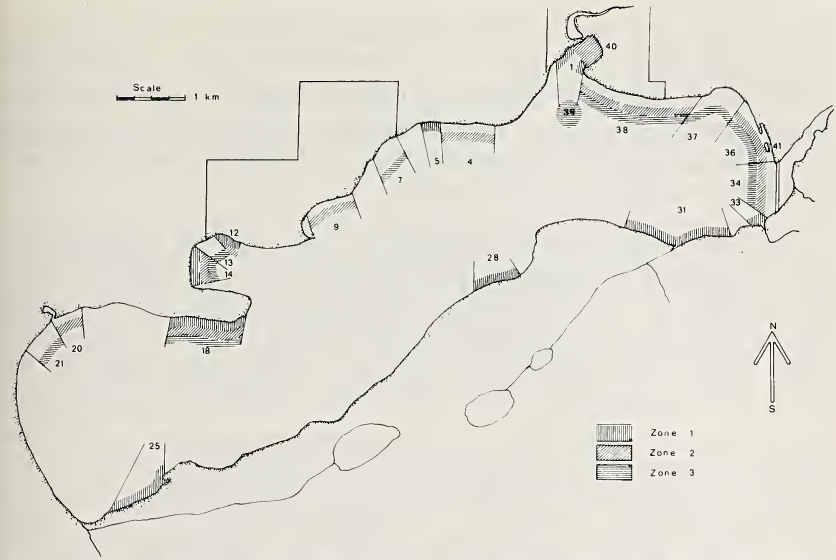

FIGURE 2. Outline map of Green Lake showing the location of the stations sampled in 1971. Depth zones at these stations are Zone 1 (0-1m), Zone 2 (1-3 m) and Zone 3 (3-10 m). Station numbers are those of Rickett (1924).

discharge into Silver Creek which enters near station 34 (Fig. 1 and 2). Septic systems are used in all other areas around the lake, regardless of steepness of slope, soil type, and height of land above the water table. Almost all of the previously described low-lying areas of the lake's shoreline have been affected by channels dredged for boat docks and by the dredge spoils used as land fill for real estate development. Perhaps because of these circumstances of population growth, large watershed area, sewage disposal methods and the change of the low-lying land from its natural state, many symptoms of deteriorating water quality have appeared in Green Lake in recent years. Colored oblique aerial photographs give evidence of some of these conditions (Bumby 1972). These photographs show opaque, discolored water entering the lake through the Silver Creek inlet which carries both Ripon's sewage effluent and runoff from a low-lying real estate development, and also at the opening of Quimby's Bay (which has been deepened and enlarged through dredging for real estate development). The obvious mixing of seston in the water in the littoral zone by heavy motorboat traffic is visible in another photo. But, the real evidence of increasing eutrophication of the lake is found in the plants including *Cladophora* sp. and other filamentous algae now growing abundantly attached to rocks and macrophytes to 1.5 m depth in spring and early summer; two introduced species, *Potamogeton crispus* and *Myriophyllum spicatum*, very prominent in the submerged community; the decreased biomass of submerged macrophytes; and the various blue-green algae floating on or near the surface of the water in summer.

In the six years since the summer of 1971 several changes have occurred. The *Potamogeton* species which were reported in 1921 but not collected in 1971, have been identified (except for one) along with previously unreported species in Green Lake. Concern for water quality has risen over the effect of the body wastes of the Canada geese which linger at Green Lake until late freeze-up date in mid-January. This problem has been aggravated by the new DNR policies enacted to make Horicon Marsh inhospitable to the migrating geese. But perhaps recent changes to liberalize hunting regulations will help. The three collective sewage systems in the watershed area have made improvements. The ABA put into operation a primary facility with an absorption pond for land disposal of effluent to avoid discharge into Norwegian Bay. The Green Lake City sewage system has been extended to some lakeshore residents and a hotel, and is now planning the necessary enlargement and modernization of its sewage plant. The City of Ripon has in almost full operation its new modern activated sludge, tertiary treatment system which will significantly change Silver Creek and its environs. Fifteen Ripon College students completed studies of the physical, chemical and biological parameters from June 1972 to August 1974 paid by the federal government and by the Green Lake Association. This latter organization of interested volunteers pursues many issues and problems concerning the lake. The Green Lake Sanitary District (established in 1964) is financing a study which will produce a feasibility report on control of the input of nutrients into the lake. The conversion of the sanitary district into a lake district is an important issue before the Green Lake County Board. Mechanical harvesting of nuisance weeds had been studied and considered too expensive but some owners have sprayed herbicides on the aquatic weeds and algae. This approach is not inexpensive either and may have more detrimental effects than now known, besides causing toxic reactions in unknowing swimmers who enter these areas too soon after spraying. The problems of the changes in water quality of Green Lake are profoundly interwoven with human activity.

METHODS

The sampling method used in this study was based as nearly as possible on Rickett's method so that data from the two studies could be validly compared. Rickett (1924) chose 41 stations of which 38 were determined by shore characteristics and the three others were marshy bays. At each station, aquatic plants were taken from three depth zones: zone 1 (0-1 m), zone 2 (1-3 m), and zone 3 (3-10 m or where plants cease to grow) and collections were taken in the shallow zone first. A square frame of thin, heavy metal, 50 x 50 x 7 cm, was used to delineate a 0.25 m^2 area of the bottom, and all large algae and macrophytes (including roots) within the frame were collected.

Actually, the pattern Rickett used for the collection of samples is not clear. He stated that multiple samples were taken at stations in zones 1 and 2, whereas, because the plants in zone 3 were more homogeneous where bottom type and slope were similar, one collection was often applied to several of these similar stations in that zone. The number of 0.25 m^2 samples collected averaged less than three per station for all depth zones. Whatever the pattern of sample collection used by Rickett, the weights were computed in g per m^2 for each species at the stations; see Tables 3, 4 and 5 of Rickett (1924). I used the totals of these 1921 wet weights in choosing the stations to be studied in 1971. No dates of collection of samples were furnished in the 1921 study.

For this 1971 study, ten of Rickett's 41 stations were selected in each zone (depth) to include the five highest and the five lowest in wet weight total values. Because of these criteria, it can be noted in Fig. 2 that the ten stations compared over the 50 years for zone 1 are not necessarily the same stations used for zones 2 or 3. The pattern for the collection of the samples consisted of the following: in both zones 1 and 2, samples were taken at three different anchorages randomly located within the limits of each station, whereas in zone 3, one sample was randomly collected at each station. Wet weights were tabulated, averaged (for zones 1 and 2) and then computed into g/m^2 for all species collected within each of the 10 stations at each of the three zones. Thus, data of 1971 and 1921 can be satisfactorily compared for the majority of the species; the problems involving the species will be revealed below.

The 1971 collections in zone 1 were completed July 7-9; all 30 samples were taken within 0.5-1.0 m depth, average 0.8 m. In zone 2, the 30 samples were collected between 1.4-2.6 m, average 2.1 m and were taken from July 16-30. The 10 samples in zone 3 were collected on August 7-8 in depths ranging from 3.7-5.2 m, average 4.4 m. Sometimes a clear line was observed at about 4.6 m beyond which little or nothing grew on the bottom; Rickett reported no plants after 8 m.

Labeled plastic bags separated each sample collected within a quadrat and kept the plants fresh. Collected material was examined and sorted the same day by placing the contents into a large, white enamel pan filled with water. As much of the filamentous algae as practicable was separated from the *Chara* sp. and other macrophytes. After sorting and identifying the species of macrophytes and filamentous algae (under 20 to 140x magnification), they were wrapped in absorbent, dry cloths to remove the excess water, then unwrapped and weighed with a Dial-O-Gram scale accurate to 0.1 g. The weighed samples were separately placed in labeled paper bags and dried at 70 C for 4-6 days. Rickett estimated dry weights from the wet weights with a factor for wet:dry for each species.

Data for biomass of the filamentous algae over the 50 year period are not comparable because in 1921 algal biomass was not determined for each quadrat. Rickett wrote of the lack of *Cladophora* sp. in Green Lake, contrasting this with the serious algal problems in Lake Mendota at that time. He reported that in Green Lake *Cladophora* sp. grew only as a fringe on a few of the rocks at the edge of the water or a few inches below the surface in some areas. Estimations of the biomass of the very few large patches of *Cladophora* sp. then growing in Green Lake in zone 1 were obtained with a different technique from the collection of plants in quadrats; the perimeter of a patch was estimated by Rickett after rowing a boat around it and, from the wet and dry weights directly obtained from the algae collected in one of these patches, the biomass of the other patches was approximated. Therefore, it was not possible to satisfactorily compare these different areas and weight measurements for *Cladophora* over this 50 year interval.

The total biomass collected in 1971 at each station and zone is presented in two ways in this report; the biomass is given both with and without the weights of the filamentous algae, mainly *Cladophora* sp. Without the algae, the values are the basis for comparison with Rickett's data, while the inclusion of the algae gives a clearer portrayal of the plant community in Green Lake during the growing season of 1971.

In 1971, the samples in zone 1 and 2 were taken by a diver using snorkel, face mask and flippers. A SCUBA diver collected the plants in zone 3, using a pressure sensor to determine the exact depth at which the samples were taken. A "diver with a helmet" was used by Rickett in the deepest zone.

Rickett wrote of the lumping of rare species with similar macrophyte species because his study was a quantitive one. Certainly, it is unfortunate that no voucher specimens from his study could be located because verification of their identifications would help answer several questions. Voucher specimens from the 1971 study are deposited in the University of Wisconsin-Milwaukee herbarium. The nomenclature for various plant species is that of Fassett (1960) as revised by Ogden (except for the species of *Myriophyllum* and *Ranunculus);* algae were identified according to Smith (1920), and the revised edition of Ward and Whipple (Edmondson 1963) was used for the zooplankton.

RESULTS

The biomass of the individual species of submerged macrophytes in 1921 and 1971 are discussed in sequence from the largest over-all increase in wet weight to the largest decrease, followed by comment on those plants which seemingly disappeared. References are made to minor aquatic plants, to attached filamentous algae (according to biomass), to plankton (according to presence), and to some physical data.

This report gives the macrophytes found in Green Lake in 1971 and also in 1921, the macrophytes reported only in 1921, and the macrophytes not found in 1971 but identified later from 1971 to 1974; 6 taxa of macrophytes are noted which either were not present in 1921 or were possibly missidentified at that time. The basic data for these comparisons of changes in biomass and species are tabulated in the thesis (Bumby 1972) in Appendices A, B and C and are summarized in its Tables 3, 4 and 5. Each species collected in 1971 is compared to the 1921 data according to their biomass (total g/30 m^2 for total zones or total g/10 m^2 for any one zone) numerically and in percentage (Bumby 1972), and here graphically (Figs. 3, 4, 5, and 6).

The biomass of the algae is often indicated in the above data for each macrophyte species at the zones as it is also for the changes in the selected stations in each zone (Figs. 7A, 7B, 8A, 8B, 9A, 9B).

BIOMASS CHANGES IN SUBMERGED MACROPHYTES

Increases

The following taxa increased in wet weight biomass over the 50 year period in the selected stations. Approximations of biomass compared are in total g/30 m^2 with or without the inclusion of the filamentous algal biomass. As the result of this study, the most abundant species and the one with the largest increase in biomass is *Myriophyllum spicatum* L. The species identified as *M. verticillatum* L. var. *pectinatum* Wallbr. by Rickett is no longer present in the lake in any of the stations checked in 1971 (where it had been abundant in 1921). Its place has been completely taken over by the Eurasian invader, *M. spicatum*, with more than one-third increase in biomass (Fig. 3). As mentioned before, no voucher specimens from the 1921 study have been located so the specimens concerned cannot be verified. Thus, it is possible that the species of the 1921 study may have been either incorrectly identified or may have changed from a minor species (the same or a different minor species) to a dominant one in the plant community today. In my thesis, I designated this taxon as *M. exalbescens* Fernald, but it was identified from voucher specimens as *M. spicatum* in November 1972 by F. M. Uhler of the Patuxent Wildlife Research Center, Laurel, Maryland.

Myriophyllum spicatum is the most important plant in Green Lake today and this is not unusual for a hard water lake of 163 to 183 ppm $CaCO_3$ (Hasler 1967). Over the 50 year period, total wet weight of the *Myriophyllum* taxon increased by 2,232 g. Its 1971 total wet weight of 8,265 g represented 46% (56% dry weight) of the total biomass in this comparative study (Bumby 1972). In 1921, Rickett reported *M. verticillatum* L. var. *pectinatum* Wallbr. present in Green Lake with a total wet weight of 6,033 g which was only 11.6% (10% dry weight) of the total biomass at the selected stations. Flowers and fruits were found on floating *Myriophyllum* on July 2, 1971 and, in September, more flowers and fruits were seen on both floating and rooted plants in a sheltered area. During the summer and fall of 1972 and 1973, no fertile plants were observed, but 1974 produced profuse growths of fertile plants.

The species showing the second largest increase in biomass is *Vallisneria americana* Michx. whose wet weight was 1,785 g in 1971 in contrast to 214 g in 1921. In 1971, this wet weight was about 10% of the total biomass whereas 50 years ago, it was only 0.4%.

Rickett listed *V. spiralis* L. as being present in Green Lake, but this seems to be an error in identification; Fassett (1960) comments that the latter species is European and the only species recorded in North America is *V. americana*. Also, only *V. americana* has been

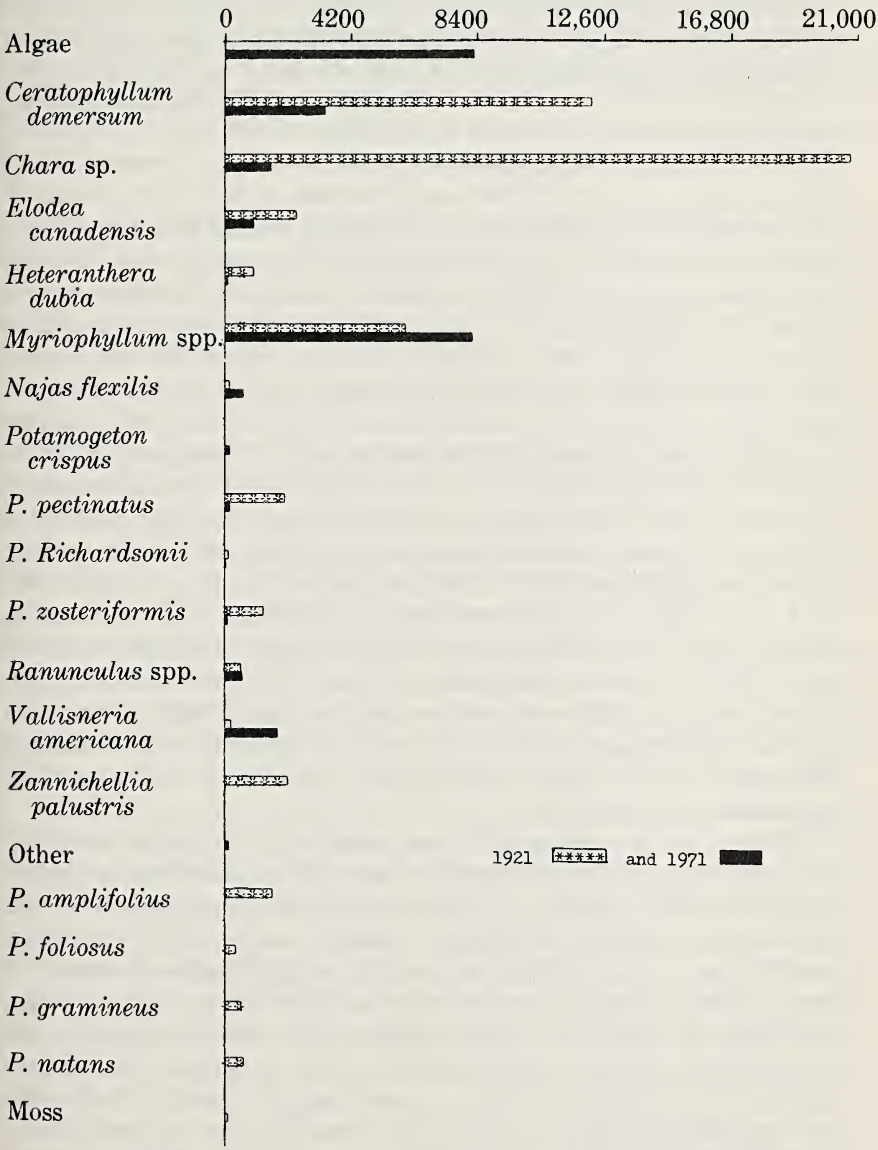

FIGURE 3. The total changes in wet weight biomass g/30m² of each species collected in the three zones in 1921 and 1971.

reported by Nichols and Mori (1971), Modlin (1970) and Belonger (1969) whereas Rickett (1922) reported that it had the greatest biomass in Lake Mendota in 1920.

Third in the series of those macrophytes showing increases is *Najas flexilis* (Willd.) Rostk. and Schmidt, one of the three taxa in Green Lake with true hydrophily. It increased in wet weight from 186 g (0.4% of total biomass) to 647 g in 1971 (3.6% of total biomass).

Ranking fourth in weight among taxa with increasing total biomass was an early summer macrophyte which was not reported in the 1921 study. *Potamogeton crispus* L. has a total wet weight of 180.4 g which was 1% of the total biomass in this study. Since it disintegrates in early summer, its weight is probably undervalued. The appearance of *P. crispus*, an important European invader, may be of particular significance in judging the quality of lake waters because it often appears in polluted water (Fassett 1960) and in waters which have been enriched with city wastes (McCombie and Wile 1971). On the other hand, Sculthorpe (1967) includes *P. crispus* with the "almost truly cosmopolitan" submerged hydrophytes which become easily established in the areas where native plants are not well adapted. Its turion is the most highly specialized of all the aquatic plants and these winter buds were often seen floating in Green Lake during this study and have become increasingly evident in the summers since 1971. Fertile plants were not noticed until 1974, when they were profuse. Since its introduction from Europe, it has spread to the West Coast (Ogden 1943), and Moyle (1945) reported this species in Minnesota about 1910; perhaps this plant was in the lake in 1921 and was lumped in with another *Potamogeton* species. Unfortunately, this taxon will probably become extremely important in the plant community because of its abundant vegetative reproduction.

Comparison of weights of *Ranunculus longirostris* Godron [= *R. circinatus* Sibth. (Fassett 1960)] with weights of the *Ranunculus* sp. reported in 1921, indicated the least gain in biomass, only 19 g. The 1921 *Ranunculus* sp. with 553 g wet weight, was 1.1% of the biomass; the 1971 species, with 572 g wet weight, was 3.2% of the biomass. On July 2, 1971, flowering specimens of the former species were identified in the floral key of Muenscher (1944). Rickett had reported the presence of *R. aquatilis* L. var. *capillaceus* D.C. (now called *R. trichophyllus* Chaix., according to Fassett, 1960). The species Rickett found was not collected in the present study. However, both of these species have been reported in water bodies in this area by Belonger (1969), Modlin (1970) and Nichols and Mori

(1971) who cite *R. longirostris*, while *R. trichophyllus*, reported by Rickett, was listed by Lind and Cottam (1969). Interestingly, Hotchkiss (1967) considers *R. aquatilis* and *R. longirostris* as the "same". As in the *Myriophyllum* situation, a complete replacement by another species of the same genus over the 50 year period may have occurred or there may have been an error in identification, which cannot be resolved because no herbarium specimens of the earlier collection are available.

Decreases

The following taxa showed declines in wet weight biomass at the 30 stations compared in 1921 and 1971. Often an increase in percentage of the total biomass in 1971 will be evident which reflects the decline in total biomass of that year, especially for those species in the lower range of decreases. See Fig. 3.

Potamogeton Richardsonii (Benn.) Rybd. changed from 119 g in 1921 to 53 g in 1971. This taxon had the least decline in wet weight biomass, although it constituted only 0.2% of the total biomass 50 years ago and 0.3% in 1971. This minor increase may reflect the different total biomass values in these studies.

Second in the group of species with decreases is *Heteranthera dubia* (Jacq.) MacM. which declined a total of 867 g and changed from 1.8% of the 1921 total biomass to 0.5% in 1971.

Potamogeton zosteriformis Fernald decreased 1,234 g in wet weight and changed from 2.5% of the total biomass in 1921 to only 0.4% in 1971. Perhaps indicative of its low status in eutrophic lakes is its relative frequency of 0.12% in University Bay (Lind and Cottam 1969) and 0.4% in Lake Wingra (Nichols and Mori 1971).

Elodea canadensis (Michx.) Planchon [= *Anacharis canadensis* (Michx.) Planchon] changed from 2,380 g wet weight in 1921 when it was 4.6% of the total biomass, to 952 g of wet weight and 5.3% of the total biomass at the present time. McCombie and Wile (1971) found that *Elodea* sp. was either absent or abundant, but always associated with abundant *Chara* sp., in the clearer impoundments with specific conductivities between 224 and 330 micromhos/cm^2 at 18 C. Because *Chara* sp. also declined in the 1971 study (see below), this study seems to support their observations of a relationship between these two taxa.

Potamogeton pectinatus L. diminished 1,858 g in wet weight since 1921. Its biomass changed from 4% of the total biomass in 1921 to 1% of the total biomass in 1971. The date of collection is important as this is a late-maturing plant (Belonger 1969). Fertile plants were common every year 1971-74 in Green Lake. Sculthorpe (1967) wrote that *P. pectinatus* may grow in very polluted areas and is among the "silt-loving species". This seems contradictory in this study, since silted and polluted conditions are a recent occurrence in this lake; perhaps this plant is responding to other physical or chemical environmental factors.

Zannichellia palustris L., one of the few macrophytes with true hydrophily, was identified by its seeds on frail, otherwise barren stems, collected in July and early August 1971. The biomass of this early-summer plant would have been greater, if its leaves had been present at the time of collections. During the time of the study, this plant showed a decrease of 2,072 g in wet weight with a change from 2,083 g in 1921 (4% of the total biomass) to 11.4 g (0.06% of the total biomass) in 1971. It was not reported by Modlin (1970), Belonger (1969), Nichols and Mori (1971), Livingston and Bentley (1964) or McCombie and Wile (1971). Lind and Cottam (1969) reported it in University Bay in Lake Mendota with a relative frequency of 0.03% and noted that it had not been reported previously in that area. It is a very small plant which matures in early June and could be easily overlooked if broken into small pieces.

Ceratophyllum demersum L., another common plant with submerged hydrophilous flowers, diminished 8,834 g in wet weight from 12,190 g (23% of the total biomass) in 1921 to 3,356 g (19% of the total biomass) in 1971.

Chara sp. showed the most dramatic decline from its peak biomass 19,194 g (40% wet and 54% dry of the total biomass) in 1921 to 1,553 g (9% wet and 13% dry of the total biomass) in 1971. In 1971, *Nitella* sp. was observed in Green Lake in very small quantities and was not separated from *Chara* sp. Rickett reported the abundance of *Chara* sp. in Green Lake; he found that it grew " . . . almost everywhere . . . sometimes mixed with other plants, often forming great masses in which no other form can get a foothold." He contrasted its abundance in Green Lake with its paucity in Lake Mendota which he had studied the summer before. The difference he attributed to Lake Mendota's muddier bottom and its warmer, more turbid water. Recent documentation of the abundance of *Chara* sp. has been reported by Modlin (1970) and Belonger (1969) and the tolerance of it for wide ranges of $CaCO_3$ (4.2-118 ppm) can be found in the work of Livingston and Bentley (1964). However, environmental situations exist where no *Chara* sp. can be found, as in Lake Wingra (Nichols and Mori 1971), and where it is the taxon with the lowest relative frequency of 0.01%, as in University Bay in Lake Mendota (Lind and Cottam 1969). Thus, *Chara* sp., although still present in Lake Mendota, is very limited (at least in University Bay). It has declined in Green Lake, according to this study, from about 50% to 10% of the total biomass over these 50 years and yet it is still very successful in other lakes mentioned above. Can there be chemical and/or physical parameters causing these two opposite trends? Perhaps the increased erosion of the rich farmland in the watershed area is changing Green Lake's bottom and its water clarity to be more like Lake Mendota's of 1920.

Aquatic Plants Reported in 1921 But Not Collected in 1971

Four species of *Potamogeton* which occurred in Green Lake in 1921 were not found in the 1971 quadrat samples: *P. amplifolius* Teckerm., *P. foliosus* Raf., *P. gramineus* L. and *P. natans* L. However, *P. natans* and *P. gramineus* were found in other areas of the lake during the 1971 study. *P. amplifolius* and *P. foliosus* were not collected in quadrats nor observed elsewhere in the lake in 1971. In Rickett's study, these four species collectively represented a small percentage (6.4%) of the total biomass. Further investigation during 1972 through 1974 led to the verification of the presence of *P. amplifolius*, *P. nodosus* Poir., and *P. friessi* Rupr. The narrow-leaved *Potamogeton* species (which resembles *P. foliosus)* was determined by R. R. Haynes. No flowers were observed in 1971, but, except for *P. natans,* fertile plants were found during succeeding summers.

In 1921, *P. amplifolius* was relatively abundant at 3% of the total biomass. Besides its apparent absence in 1971 in Green Lake, it also was not reported in Lake Wingra (Nichols and Mori 1971) or University Bay of Lake Mendota, although it had been a common species in 1922 (Lind and Cottam 1969). Documentation of its abundance in other areas are given by Modlin (1970) and Belonger (1969). In 19 impoundments in Ontario, this aquatic plant was found only in the least fertile impoundment with the lowest conductivity and with Secchi disc reading of 2.2 m (McCombie and Wile 1971). Presently in Green Lake, it does grow in beds between stations 28 and 25 (Fig. 2).

Although present in Green Lake in 1971, *P. gramineus* was not recorded in any of the quadrats; its special floating leaves and flowers were not observed in 1971 nor during the years since. This species comprised 1.1% of the total biomass in 1921.

P. natans made up 1.2% of the total biomass in 1921. Although seen in the lake in 1971, it was not collected in any of the quadrats. No flowers were seen in the years since, but its floating leaves have been observed.

P. foliosus had a wet weight of 363 g or 0.7% of the biomass in the collections of 1921. In 1971, this species was not found in the quadrats nor through casual sampling in the years since but a similar plant *(P. friessi)* was verified in 1972 and 1973.

Minor Aquatic Plants

Several aquatics such as a moss and species of *Lemna* were observed in 1971 but not in sufficient quantities for adequate comparisons (Table 3 of Bumby 1972).

In 1921, these plants comprised 0.4% of the total biomass. Rickett stated that a diver could sink up to his knees into beds of the moss *Drepanocladus* sp., quite abundant in zones 2 and 3. Only one of the selected stations sampled in 1971 had mosses in 1921; thus, these plants occur but in sparse distribution.

Lemna minor L. and *L. trisulca* L. were found in the lake, the latter only in very small numbers in Dartford Bay quadrats (station 40) where this tiny flowering plant was entangled with algae and macrophytes growing on the bottom.

Neither the aquatic moss nor *Lemna* sp. was present in sufficient numbers to be compared with Rickett's results or listed except as minute amounts or traces (X) in the figures and tables (Bumby 1972).

The Algae

Attached algae collected in Green Lake in 1921 and collected in 1971 were: *Cladophora* sp., *Nostoc* sp., *Rhizoclonium* sp., *Rivularia* sp., *Spirogyra* sp., *Tolypothrix* sp., *Ulothrix* sp., *Zygnema* sp. *Vaucheria tuberosa (?) was not collected in 1971.*

Although this study is mainly concerned with macrophytes, some observations of the algae were made in 1971 because they are significant in interpreting the changes in biomass in Green Lake. Massive nuisance blooms of *Cladophora* sp. have appeared in Green Lake in recent years; these growths often extend from the waterline down to a depth of 1.5 m in rocky areas. No *Cladophora* problem existed in 1921 and Rickett used a different technique for estimation of the algal biomass. Rickett noted that sometimes

Oedogonium sp. replaced *Cladophora* sp. in the muddier stations and *Spirogyra* sp. also grew on the plants and rocks.

In 1971, most of the algae were of the filamentous type and only a cursory microscope examination of each sample collected in a quadrat was made to identify the conspicuous genera. The weights of the algae which were collected in the quadrats in each zone are on record in Table 3 (Bumby 1972) and the weights at each station are in Appendices A, B and C (Bumby 1972); weights of non-filamentous algae (as *Rivularia* sp. and *Nostoc* sp.) are not included, unless found attached to the macrophytic plants in all zones, and not separated from these plants when they were weighed.

Algae listed above were attached either to the macrophytes or to the rocks under shallow water. In zone 1, 24 of the 60 samples contained filamentous algae; in zone 2, 33 of the 60 samples; while in zone 3, only 2 out of 10 samples (actually 2 in 8, as two samples were devoid of plants) contained weighable quantities of filamentous algae. Their occurrence in zone 1 (from the highest to the lowest frequency) are *Cladophora* sp., *Rhizoclonium* sp., and *Spirogyra* sp., whereas in zone 2, *Cladophora* sp. was most abundant followed by *Rhizoclonium* sp., *Zygnema* sp., *Rivularia* sp. and *Tolypothrix* sp. In zone 3, *Rhizoclonium* sp. and *Rivularia* sp. were present but sparse.

In recent years, a massive floating bloom of *Spirogyra* sp. has been an unsightly covering of the lake along the shore but only on calm days in the very early spring. *Vaucheria tuberosa (?)* was listed at one station in 1921, but was not observed in the present study. The attached filamentous algae were extremely important among the autotrophs in Green Lake in 1971 and will be discussed further with the macrophytic biomass changes within the zones and stations.

CHANGES IN THE PERCENTAGE OF WATER TO DRY CONTENT FOR EACH SPECIES

The dry weight comparison for each species found in 1921 and 1971 are listed in Table 1 as percentages of wet weights. Eight of the 12 macrophytes with comparable data were almost at the same level of water content in both studies. For that reason I have used wet weights in most of these comparisons but dry weights are shown in the graphs (Figs. 7, 8 and 9) and data are in the thesis (Bumby 1972). Comparing dry weights of the taxa eliminates the weight variability accumulated because of the differences in both water adhering to the outside of freshly sampled plants (due to the

TABLE 1. PERCENTAGE DRY WEIGHT IN EACH SPECIES FOR ALL ZONES IN 1921 AND 1971

Species Found in 1921 & 1971	% Dry Wt. 1921	% Dry Wt. 1971
Algae		18.22
Ceratophyllum demersum	7.02	8.50
Chara sp.	15.08	20.12
Elodea canadensis	4.4	13.07
Heteranthera dubia	10.56	9.28
Myriophyllum spicatum		16.44
M. verticillatum var. *pectinatum*	9.63	
Najas flexilis	9.93	10.05
Potamogeton crispus		7.97
P. pectinatus	12.21	12.50
P. Richardsonii	14.64	19.35
P. zosteriformis	12.41	14.10
Ranunculus longirostris		13.35
R. aquatilis var. *Capillaceus*	11.69	
Vallisneria americana	7.71	6.49
Zannichellia palustris	6.96	7.10
Other		14.35
P. amplifolius	11.9	
P. foliosus	10.55	
P. gramineus	11.5	
P. natans	11.43	
Moss	19.49	
Lemna Sp.		5.71
With Algae:		15.06 ± 4.65 S. D.
Without Algae	11.19	13.58 ± 4.52 S. D.

differences in leaf forms, etc.) and in the water content within the structurally different cells of the plants (Sculthorpe 1967).

Every species in each sample collected in 1971 was weighed both wet and dry. In contrast, Rickett dried about 12 samples of a species, averaged the dry weights as a percentage of the wet weights and then used these averages for estimating dry weights of these samples. The macrophytes in 1921 had an average dry weight percentage of 11.2; the 1971 average dry weight was 13.6% ± 4.52% S.D. The minor differences in the 1971 and 1921 dry weights may be due to an increase in epiphytic algae and other organisms clinging to the macrophytes, to an increase in the settling out of particulate matter from the water, to an increase in the accuracy of the equipment and to the differences in the technique for determining dry weights in the two studies. The latter does not permit a comparison of the significance of the changes in dry weights because there is no way of estimating the within-sample variance of Rickett's data.

Although no great change in the total percentage of dry weight of the aquatic plants in Green Lake occurred over this 50 year period, some significant variations appeared among the individual species. *Elodea canadensis* indicates a three fold increase over the 1921 percentage dry weight; however, its 1921 percentage of 4.4 seems unusually low. What may be two *Myriophyllum* species (as identified in 1921 vs. 1971) have a substantial difference almost twice what was reported in the earlier survey and *Chara* sp. showed a 25% increase in 1971 weight data. Macrophytes with almost the same dry content in both studies are as follows: *C. demersum, H. dubia, N. flexilis, P. pectinatus, P. zosteriformis, Ranunculus* spp., *V. americana* and *Z. palustris.*

BIOMASS CHANGES IN THE ZONES

Previously, I discussed changes of the individual taxa in total biomass (Fig. 3); next the changes in the individual macrophyte species collected in each zone in 1921 and 1971 as wet weights in grams are shown graphically in Figs. 4, 5 and 6. These are based on the numerical total wet weights (g/10 m^2) which are listed for each zone in Table 3 (Bumby 1972).

In zone 1 (Fig. 4), a shift of dominance occurred from *Chara* sp. and *Ceratophyllum demersum* to *Chara* sp. and *V. americana.* Altogether, 14 species were found in zone 1 in 1921 with wet weights ranging from 2,520 to 44 g, whereas 13 species were present in 1971 with wet weight ranging only 614 to 3.3 g. The total biomass of macrophytes of this shallow zone in 1971 was only about one-third that in 1921. The filamentous algae were the most important autotrophs in this zone in 1971.

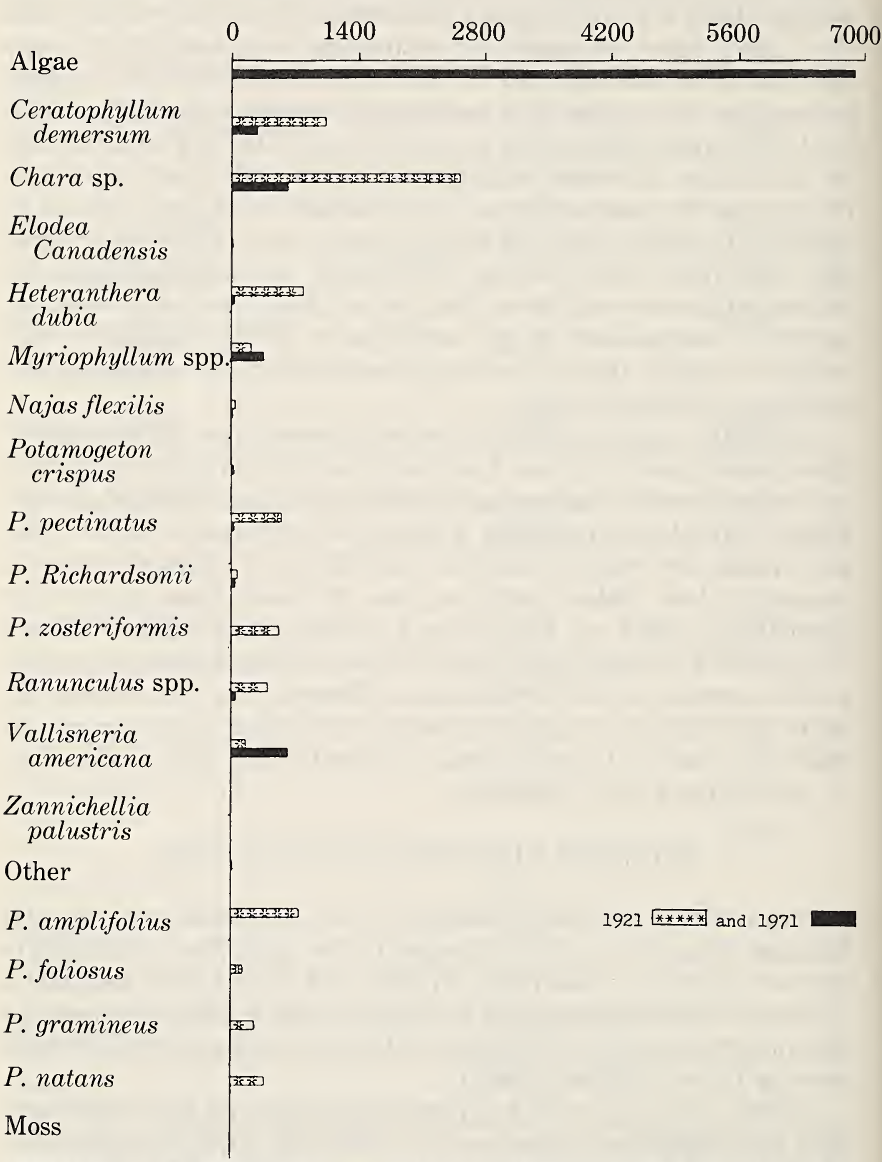

FIGURE 4. Total biomass in grams wet weight collected at zone 1 in 1921 and 1971

The 17 species found in 1921 in zone 2 (Fig. 5), varied in wet weights from 12,974 to 7.0 g whereas the 15 species present in 1971 varied from 4,543.2 g to a trace (X). This involved an obvious shift

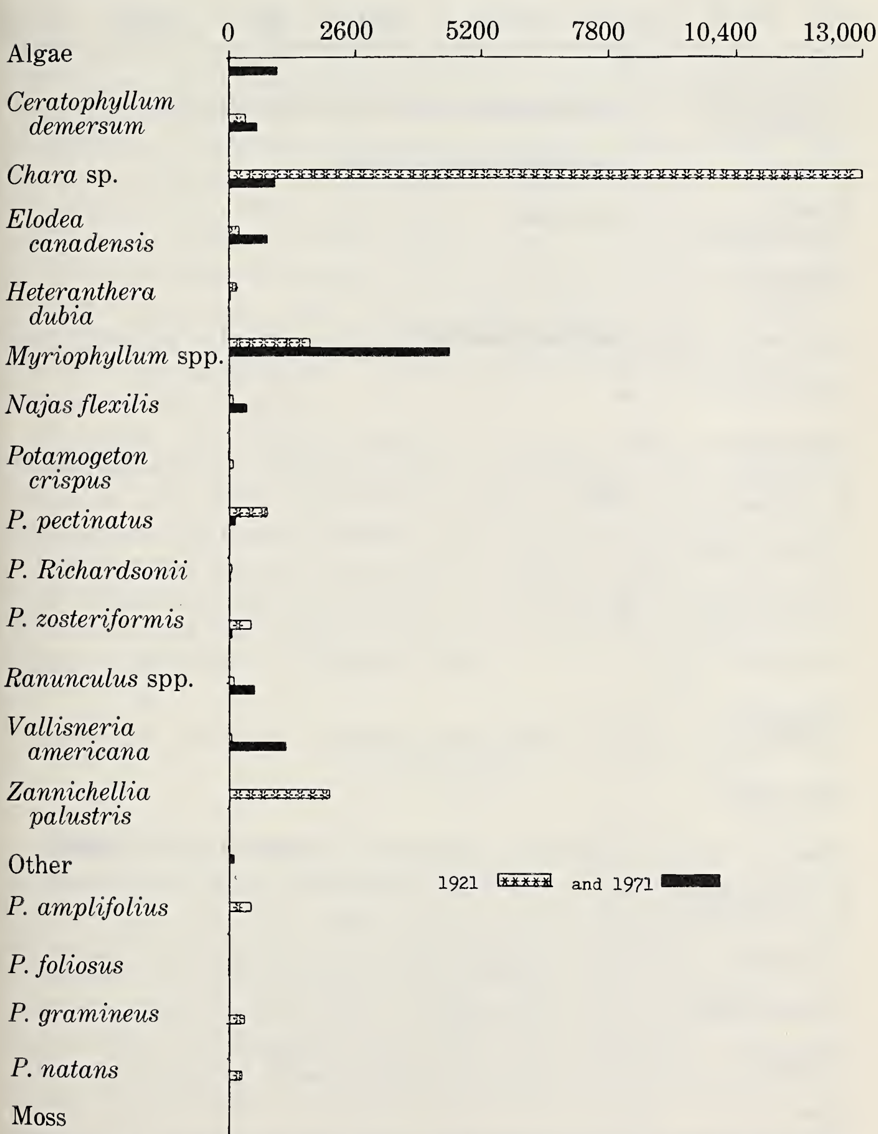

FIGURE 5. Total biomass in grams wet weight collected at zone 2 in 1921 and 1971

from *Chara* sp. to *Myriophyllum* and *Vallisneria* dominance at zone 2 during the 50 year period.

Of the 13 taxa found in zone 3 (Fig. 6) 50 years ago, the wet weights ranged down from 10,815 g. Although 11 of the 13 species

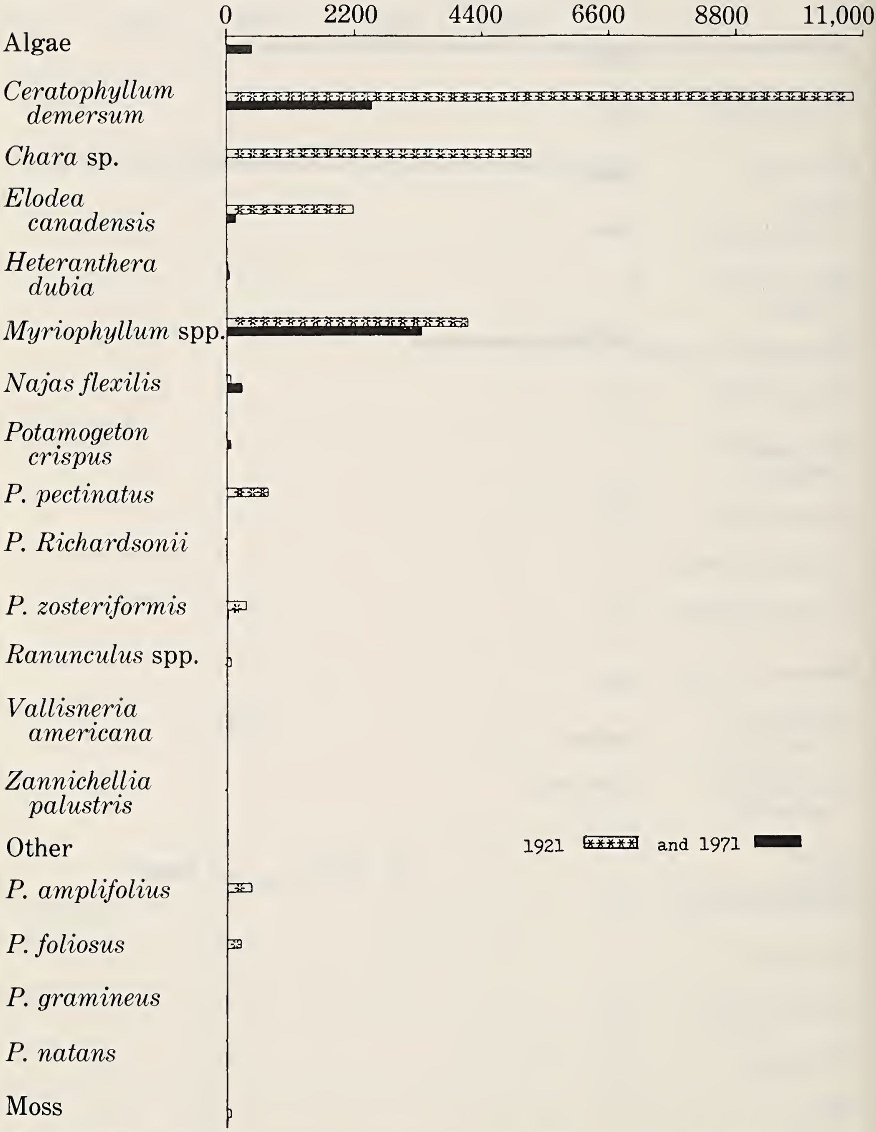

FIGURE 6. Total biomass in grams wet weight collected at zone 3 in 1921 and 1971

were present in 1971, their 3,370 g wet weights showed a reduction of about two-thirds in zone 3 and a shift of dominance from *Ceratophyllum demersum* and *Chara* sp. to *M. spicatum* and *C. demersum.*

The change in the diversity of the macrophytes is not clear because of the four *Potamogeton* species not found in the quadrats in 1971; it cannot be stated, then, that they moved to another zone or that they disappeared from the lake. These include *Potamogeton amplifolius, P. foliosus, P. gramineus* and *P. natans* which were present in all zones in 1921 except for *P. natans* (not reported in zone 3 by Rickett). In 1971, *Zannichellia palustris, Elodea canadensis* and *P. crispus* seem to be newcomers in zone 1; *P. crispus* and a trace of *Lemna trisulca* were observed in zone 2, and in zone 3, *P. crispus* was the only new plant which grew here if the changes in identification of both the *Myriophyllum* genus and the *Ranunculus* genus are agreeable and *P. crispus* was not lumped in with another similar species in 1921.

The total wet weight biomass in zones 1 and 3 diminished percentagewise in almost the same relationship (-73% and -74%), while in zone 2 it decreased the least (-53%). When attached filamentous algae were included, there is a gain in biomass in zone 1 (+16%) but still loss for both zones 2 (-48%) and zone 3 (-72%). The zone 3 figure reflects the relatively low total of algae in the deepest zone, while the zone 1 figure reflects the higher total weights of the algae there (Table 7 of Bumby 1972).

CHANGES IN TOTAL BIOMASS AMONG THE SELECTED STATIONS

Figures 7A, 8A, and 9A represent graphically the wet and dry weights of the submerged macrophytes present in 1921 and 1971 at each station within the separate zones. The station numbers are arranged according to the decreasing values of the total wet weights in g/10 m^2 of the plants tabulated by Rickett in 1921. Figures 7B, 8B and 9B include the wet and dry weights of the attached filamentous algae which were recorded in the 1971 study along with the weight of the macrophytes. These graphs are based on the data in Bumby (1972) Appendices A, B and C. The recent and past situations at these stations are quantitatively presented for the macrophytes and for the biomass of the algae in 1971 (by weight) which can be seen when any station in B is compared with the same station in A.

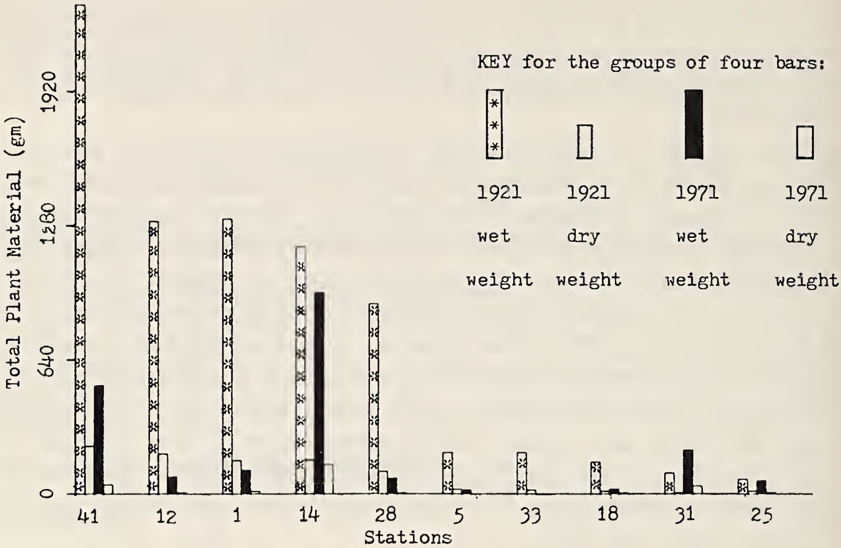

FIGURE 7A. Total macrophytic biomass in grams wet and dry weights collected at the ten stations in zone 1 in 1921 and 1971

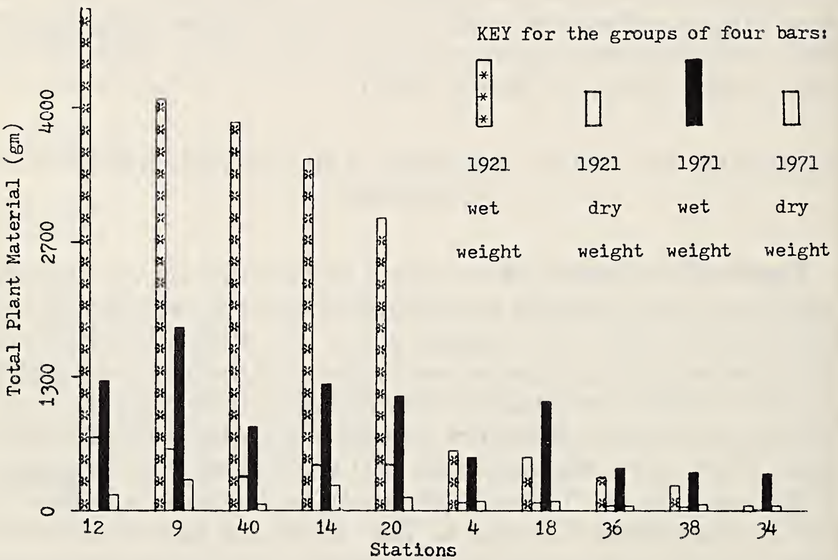

FIGURE 8A. Total macrophytic biomass in grams wet and dry weight collected at the ten stations in zone 2 in 1921 and 1971

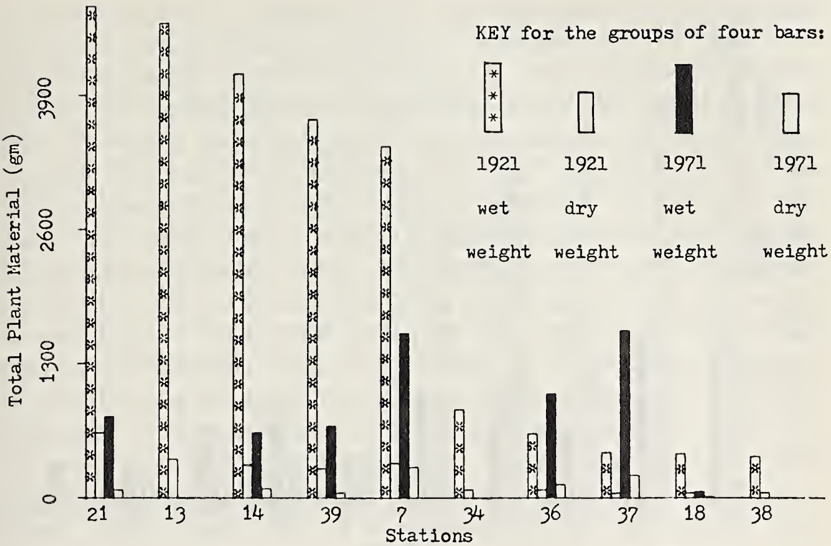

FIGURE 9A. Total macrophytic biomass in grams wet and dry weights collected at the ten stations in zone 3 in 1921 and 1971

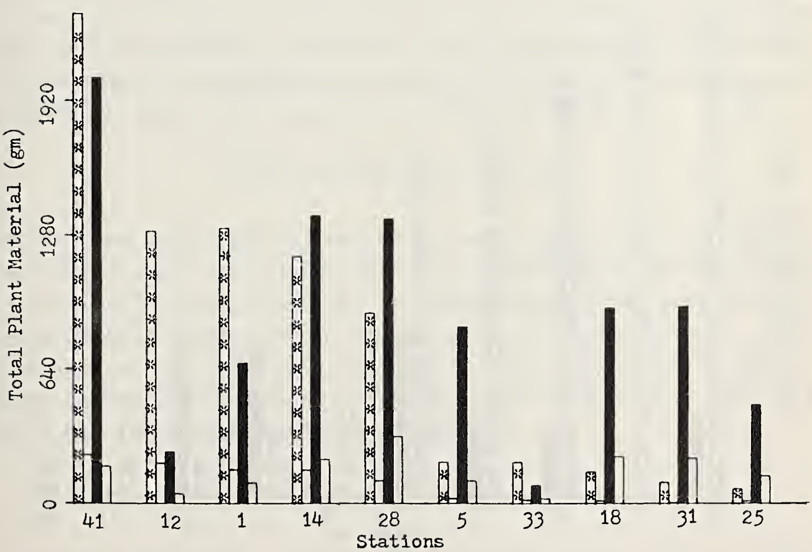

FIGURE 7B. Zone 1 with algae included in 1971 quantities

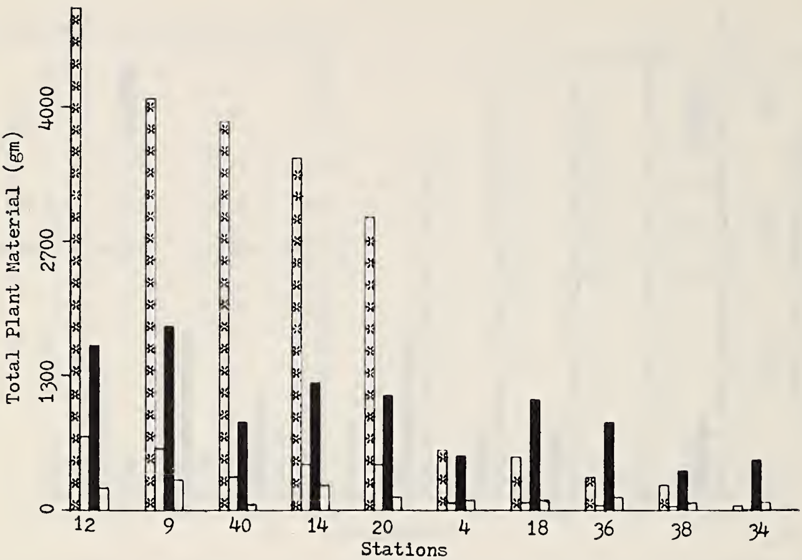

FIGURE 8B. Zone 2 with algae included in 1971 quantities

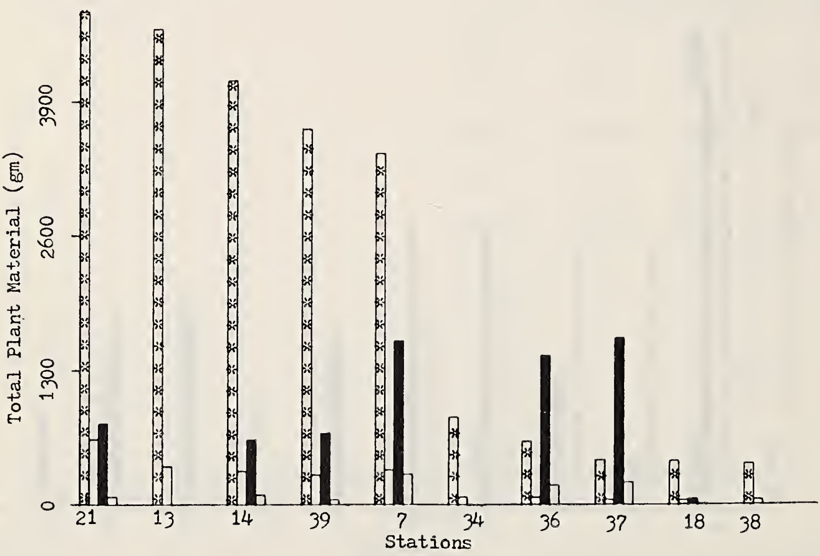

FIGURE 9B. Zone 3 with algae included in 1971 quantities

From these data, it appears that a comparison of the wet weight biomass at the low weight stations at three zones in 1971 and 1921 showed no specific pattern of change; i.e., some stations increased and some decreased. However, the high weight stations at all three zones showed a definite pattern of decrease in the wet weight biomass. The numerical decreases in total macrophyte biomass occurred at all 1921 high weight stations at every depth in the order: zone 1 least, zone 2 next, and zone 3 largest total decrease. At zone 3, stations 34 and 13 were devoid of vegetation and station 38 only had 3.2 g; the first two are located at areas where sewage effluent enters the lake (Fig. 2). This trend continues even when the weight of the attached filamentous algae is included in the biomass. Thus, it appears that the missing nutrients accompanying the reduction in macrophytic biomass have not been entirely incorporated into the attached filamentous algae growing in the littoral zone. This suggests that most of the nutrients may be accounted for in other biota, and the abundance of the phytoplankton (especially blue-green algae) observed in the summer of 1971 seems to corroborate this possibility. Although this work is chiefly on submerged macrophytes, some obervations were made on the plankton in ten water samples collected from three stations different from those used for the macrophytes (see Fig. 1). Many blue-green algae were found on or near the surface waters of the lake in 1971 including *Microcystis aeruginosa, Anabaena flos-aquae, Aphanizonemon flos-aquae* and *Gloeotrichia echinulata;* these were present in 50% to 70% of the samples. Diversified populations of diatoms, green algae and zooplankton were also present, too. (Bumby 1972).

THE PHYSICAL DATA

Secchi disc readings of Green Lake water taken in this 1971 study and by Lueschow *et al.* (1970) place this water body within the range of eutrophic Great Lakes such as Ontatio and Erie, according to Beeton (1965). However, there seems to be no change in light transmission, since Juday's 1942 study. The clinograde dissolved oxygen curve is well above the minimum levels for life in 1971 and also in the 1966 study by Hasler (1967).

DISCUSSION

Biological evidence, such as the decrease in the biomass of the macrophytes which this study shows, is more indicative of changes in the quality of the water in Green Lake than are the physical data collected in 1971. The 1971 stations devoid of vegetation at zone 3 (stations 34 and 13) and one with only 3.2 g (station 38) could reflect effect of sewage; this situation may be more prevalent in other areas of the lake not included in this study. (Fig. 2). The macrophyte change, the increase in the seston and the assumed but undocumented increase in phytoplankton are probably more indicative of change in light intensity in the littoral area than shown by the light penetration data, obtained only at Deep Station (Fig. 1). Macrophytes are greatly affected by the intensity and quality of light which are determined by turbidity, the color and ". . . the absorptive effect of the water itself" (Reid 1961).

The overall lower biomass, found in 1971 as compared with 1921, could be due in part to the shift in species composition. The magnitude of the decrease of the eight species which declined was simply much greater than the increase of the five species which increased in total biomass (Table 3 of Bumby 1972). The 1921 average percentage of dry weight was not an important difference to cause the lower biomass in this study (Table 1). Other studies have shown little change in the frequency of plants through a summer (Swindale and Curtis 1957), but the weights of the different species of plants can vary during a summer; viz., *Zannichellia palustris* and *Potamogeton crispus* mature early in the summer, while *Vallisneria americana* matures late in the summer. However, the similarity of collection times and techniques between Rickett's and the present study should rule out this problem. Belonger (1969) cited Dane's report of 1959 which showed that over a three year period, there was a definite change in aquatic plant distribution in New York ponds: thus, ". . . Appreciable changes can occur over relatively short periods." Consequently, the fact of analyzing only one summer for the approximations for both the 1921 and 1971 studies cannot be ignored.

Volker and Smith (1965) listed several of these factors pertinent to Green Lake in their study of a decrease in number and frequency of species of aquatic flora in Lake East Okoboji over a 46 year period. Increased human activity in and around its shores altered several factors believed to be responsible for the change. Factors which may be responsible for reduced vegetation are as follows: first, the increased nutrients in the lakes from agricultural fertilizers and increased sewage effluent from the increased population in the area; and, second, the increased siltation and turbidity due to real estate development in low areas, inlet waters and motorboat activity. Sculthorpe (1967) quoted Southgate (1957) that low concentrations of anionic detergents in most treated sewage effluents of that period, can be deleterious to some hydrophytes. Edmondson (1968, p. 165) points out that ". . . even drainage from fertilized fields is less rich than sewage effluent. . ." and that ". . . moderately hard-water lakes are probably more sensitive to sewage enrichment than soft-water lakes, all other things being equal."

The other school of thought is presented by Lind and Cottam (1969) who hypothesize that, because of human activity and natural aging, lakes become rich in nutrients with consequent tremendous increases in algae and macrophytes. This latter view does not explain the 1971 decline in Green Lake macrophytes in all zones and especially in the deepest zone. When the filamentous algae are included, an increase in biomass is evident in the shallow zone as measured in early summer; later, as the water warms, these autotrophs disappear. Perhaps the nutrients no longer in the macrophytes moved into the phytoplankton of the lake in 1971; more quantitative investigations in this area would be helpful.

The decrease in the aquatic macrophytes in Green Lake could be followed by blooms of phytoplankton, according to Mulligan (1969) who cited the 1903 report of Kofoid that algae blooms did not occur in a lake with large growths of benthic plants. Mulligan also wrote of Pond's (1905) observation that floating aquatic macroflora and phytoplankton competed for the same nutrients. Thus, the decrease in biomass of *Chara* sp. and *Ceratophyllum demersum* (both without root systems) could reflect increase in the phytoplankton with their competitive advantage of higher nutrient loading rates. However, other plants with root systems have diminished also, according to this study, so other factors are undoubtedly involved. The decline of *Chara* sp. in Green Lake may have a very significant effect on the lake because Schuette and Adler (1929) pointed out that this alga, which made up about half of the macrophytes found in Rickett's entire study, can cause deposition of almost 1000 metric tons of $CaCO_3$.

In early studies, Marsh (1898) noted there was never any large amount of "vegetable matter" in Green Lake. An *Anabaena* sp. usually appeared over the entire lake in July and August for a short time but was never enough to form a "scum" except in 1896, when an *Anabaena* sp. appeared in late June and lasted into August. Marsh also noted that diatoms were always abundant. Juday (1942) computed that the estimated standing crop of plankton in Green

Lake was 2944 kg/ha wet weight, which was one-third larger than in Lake Mendota. Green Lake is much deeper and the clarity of the summer water permitted the zone of photosynthesis to reach a depth of about 15 m.

From the present study, it appears that additional seston in the water of the littoral zone (originating from the inlet water, sheet runoff from rich farm land and from real estate development in low areas, motorboat activity and probably additional phytoplankton) has changed the penetration of light so that macrophytes, especially in the deepest littoral zone, have been significantly reduced. A change in the dominance of *Chara* sp. may be particularly significant to the total biomass results in 1971. Also, aggressive weedy species of foreign origin, e.g., *Potamogeton crispus* and *Myriophyllum spicatum* which are successful in polluted water, have moved into the aquatic community.

Perhaps Green Lake, so different from Lake Mendota in 1921 (Rickett 1924), is approaching the Mendota status of 50 years ago with *Chara* sp. less important, *Vallisneria americana* increasing in abundance, *Cladophora* sp. becoming dominant in the shallow zone among the autotrophs, and the seston in the water becoming a more important factor.

ACKNOWLEDGMENT

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PHOTOSYNTHESIS OF THE SUBMERGENT MACROPHYTE *CERATOPHYLLUM DEMERSUM* IN LAKE WINGRA

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ABSTRACT

Apparent photosynthesis of *Ceratophyllum demersum* was measured in fall 1975 by a ^{14}C technique for a preliminary evaluation of its productivity. Productivity decline with depth was correlated with diminishing irradiance; laboratory studies indicate, however, that the decline in productivity was also controlled by increasing tissue age and reduction in leaf/stem ratio. The saturated photosynthetic rate of 2.3 mg $C \cdot g^{-1}$ (dry weight) $\cdot hr^{-1}$ for *C. demersum* was attained at 650-700 μE $m^{-2} \cdot sec^{-1}$ at a water temperature of 21 C.

INTRODUCTION

A number of studies (Wetzel, 1975) show that primary productivity of macrophytes can be an important parameter in aquatic ecosystems. Most lakes are small and shallow (Wetzel and Allen, 1972) with a well-defined littoral zone colonized by aquatic plants which effect fixation, utilization and transformation of energy. Macrophytic communities are often more productive than phytoplankton (Westlake, 1965). Submersed macrophytes may provide the greatest single input to the benthic carbon budget (Rich *et al.*, 1971).

Lake Wingra is a small, eutrophic, alkaline lake within the city limits of Madison, Wisconsin. *Ceratophyllum demersum*, in Lake Wingra, grows in scattered patches anchored in the soft sediment within the *Myriophyllum spicatum* community which dominates the littoral zone (Nichols and Mori, 1971). Although of secondary importance to *M. spicatum* in Lake Wingra, *C. demersum* dominates the submersed aquatic vegetation in several southern Wisconsin impoundments.

I conducted experiments under laboratory conditions and "in situ" using a carbon-14 technique to obtain measurements of photosynthetic rates of shoot sections and to examine factors influencing differences in these rates. Meyer (1939) studied the daily cycle of apparent photosynthesis of *C. demersum* and found a correlation with the daily curve for solar radiation. Effects of turbidity and depth on photosynthesis have been investigated by Meyer and Heritage (1941), while Carr (1969a) has given more attention to light intensity, light quality and water flow. She found that production of *C. demersum* increased with current of the water up to 0.54 $cm \cdot sec^{-1}$. Carbon source, pH, temperature and effect of nitrogen supply on photosynthesis of *C. demersum* also influence photosynthesis (Carr, 1969b; Goulder, 1970; Goulder and Boatman, 1971). Depth distribution of photosythetic tissue, and light adaptation affect the total photosynthetic productivity in *Myriophyllum spicatum* (Adams *et al.*, 1974). I have considered the photosynthetic response to light and depth distribution of biomass with the other important factors controlled. These data for Lake Wingra allow a preliminary comparison between *C. demersum* and the littoral dominant *M. spicatum* characterized by Adams and co-workers (Adams *et al.*, 1974).

MATERIALS AND METHODS

Field studies

Photosynthesis of *Ceratophyllum demersum* within the *Myriophyllum spicatum* community.

a. *Natural Photosynthesis Profile.* Shoots grown in 2 m water depth were collected the morning of September 11, 1975, cut into 15-30 cm sections of 0.25-0.82 g dry weight, and incubated in 510 ml glass bottles at their natural depth. Bottles were filled with lake water to which 2 ml of $^{14}C\text{-}NaHCO_3$ (specific activity of 1.5 $\mu Ci \cdot ml^{-1}$) were added. Period of incubation was 1 hr. Two dark bottles were also employed. At the end of each incubation the plants were briefly rinsed in 0.1 N HC1 to remove any ^{14}C-monocarbonates precipitated on the leaf surfaces during the experiment. Then they were quickly frozen in liquid nitrogen to stop photosynthesis.

The plant samples were returned to the laboratory, lyophilyzed, dried for two days, and weighed. Leaves and stems of each section were isolated and analyzed separately. The dried samples were ground to powder and 10 mg subsamples were wrapped in ashless filter paper (Whatman #40) and combusted in oxygen in a chamber described by Adams *et al.* (1974). Evolved $^{14}C\text{-}CO_2$ was trapped in 5 ml of ethanolamine, an aliquot (0.2 ml) of which was pipetted into a modified Bray's solution (Bray, 1960) and counted in a Packard Tri-Carb scintillation counter. Water samples were titrated to determine total alkalinity, as mg.$CaCO_3$ 1^{-1} (Am. Public Health Assoc., 1965). From the alkalinity, pH and temperature, total carbon was calculated from the table of conversion coefficients of Saunders, *et al.* (1962). Photosynthetic rates were expressed as mg C per g dry weight of plant per hour and were calculated from the ^{14}C data with an isotope correction factor of 1.06, with correction for dark fixation of carbon.

Net irradiance during the experiment was measured with a recording pyranometer (Belfort) and the photosynthetically active radiation (PhAR) with a Lambda Quantum-sensor LI-170; the results are expressed as langleys·min^{-1} (= cal·cm^{-2}·min^{-1}) and μE m^{-2}·sec^{-1}, respectively.

b. Terminal portions (20 cm) from shoots collected near the bottom (water depth of 1.60 m) were used. Following the same ^{14}C procedure, the growing tips were incubated on the afternoon of October 3, 1975 at four depths within the water column (subsurface, 0.5, 1.0 and 1.60 m). Plant material varied between 0.3-0.6 g dry weight. This experiment was designed to isolate the effects of light and temperature on photosynthesis, holding other factors relatively constant.

Laboratory studies

a. Photosynthesis profile of *Ceratophyllum demersum* exposed to constant light and at a water temperature of 25C.

C. demersum was collected on August 25, 1975. Whole plants were placed in a 4.5 l Plexiglas cylinder chamber and incubated for 1 hr. in lake water previously filtered through a glass fiber filter paper (Whatman GFC) to which 20 ml (30 μCi) of ^{14}C-$NaHCO_3$ were added. *C. demersum* was exposed at saturating light intensity from a Lucalox lamp; a current flow of 2 l ·min^{-1} ensured adequate mixing of ^{14}C solution and uniform temperature within the chamber. After the exposure periods, the entire plants were removed and cut into 10 cm sections. Carbon-14 distribution in different plant sections was determined by the same procedure described previously.

b. Photosynthesis-light intensity curve of growing tips.

Apical portions of shoots of *C. demersum* were collected on September 18, 1975. For each of seven different light intensities, three replicates were incubated the next morning in filtered lake water; again, measurements were made in 1 hr. periods. Two ml (3.0 μ Ci) of ^{14}C-$NaHCO_3$ were added to each 510 ml glass bottle. Dark bottles were also incubated in the course of this experiment. Temperature was controlled at 21 ± 1 C (temperature of lake water at that time) by placing bottles in a water bath. Temperature, and initial and final pH, were recorded every time.

RESULTS AND DISCUSSION

The natural photosynthesis profile of *Ceratophyllum demersum* "rooted" in 2 m of water, is shown in Fig. 1. Temperature and PhAR at incubation depth, percent of total plant photosynthesis and percent of total plant weight are shown for each stem section. Average surface irradiance during the incubation period was 0.28 $ly \cdot min^{-1}$. Temperature decreased negligibly from the surface to the bottom (20.3-19.7). The first stem section (growing tips) had a photosynthetic rate of 3.40 mg $C \cdot g$ dry $wt^{-1} \cdot hr^{-1}$ expressed on total weight basis, well above the value of 1.06 mg $C \cdot g^{-1} \cdot hr^{-1}$ for *C. demersum* from Conneaut Lake (Western Pennsylvania) on 2 September presented by Wetzel (1965). The rate declined quickly to zero with increasing depth in association with rapidly attenuated light and gradually increasing stem/leaf ratio and tissue age. The most productive sections are the first two, with 84% of total productivity. This result is due, apart from the influence of light and stem/leaf ratio, to the greater biomass concentration which is found within 30 cm of the surface (33% of total plant weight) (Fig. 1). Dark carbon fixation is 0.21 mg $C \cdot g$ dry $wt^{-1} \cdot hr^{-1}$ and seems to have a significant effect on apparent photosynthesis, unlike in *Myriophyllum spicatum* (Adams *et al.*, 1974). In comparison with the August 14, 1972 photosynthesis of *M. spicatum* in Lake Wingra (Adams *et al.*, 1974), *C. demersum* plants show a much more rapid reduction of ^{14}C-uptake from growing tips to the bottom.

I have separately analyzed the leaves and stems of the same plant presented in Fig. 1, first to assess stem contribution to total photosynthetic productivity and, second, to evaluate variation due to changes in quantities of photosynthetic tissue with depth. Figure 2 indicates that, if translocation of ^{14}C-labeled photosynthate did not

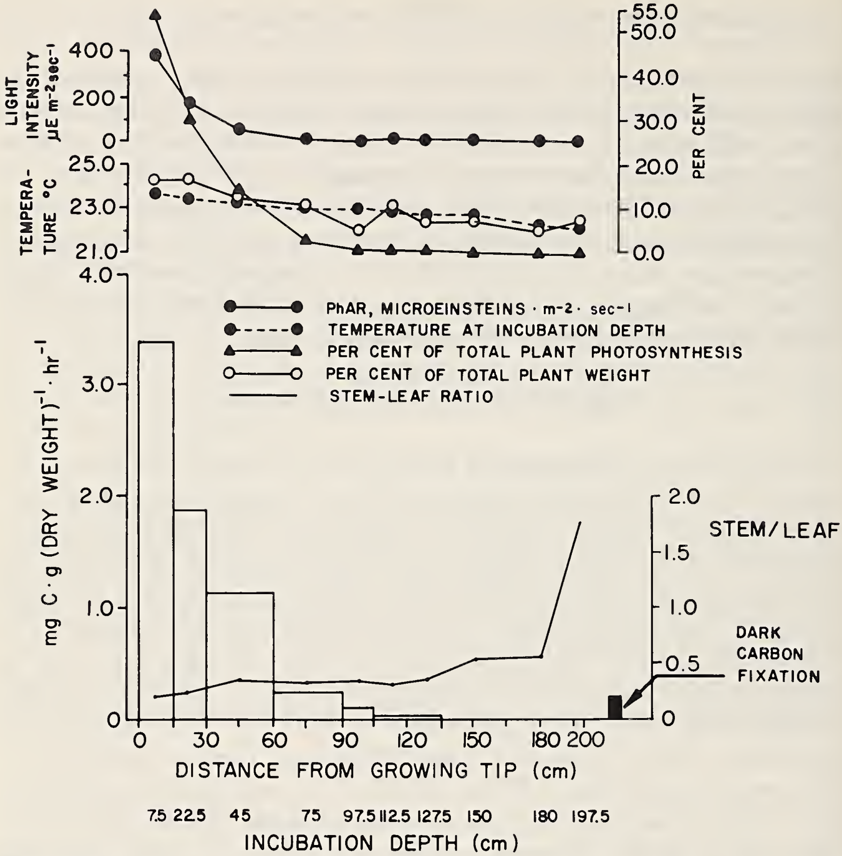

FIGURE 1. Apparent photosynthesis of 15-30 cm shoot sections of *Ceratophyllum demersum* incubated at natural depths within the *Myriophyllum spicatum* community on September 11, 1975.

occur, stem tissue is photosynthetically much less active than leaf tissue. The marked decline in apparent photosynthesis along the *C. demersum* shoot was not offset by conversion to a leaf weight basis, in contrast with data for *M. spicatum* (Adams *et al.*, 1974).

The photosynthesis profile of *C. demersum* under laboratory conditions is shown in Fig. 3 with the photosynthetic rates, light intensity, percent of total plant photosynthesis and percent of total weight. Again, the greatest photosynthetic rate occurs at the top (3.26 mg C·g dry $wt^{-1}\cdot hr^{-1}$), but in this case there was an apparent plateau of photosynthetic rates near the surface (56% of the total photosynthetic productivity occurred in the first two segments), followed by a pronounced decline in the last three stem sections. With the light, temperature, current flow and water chemistry effectively constant, the different photosynthetic rates are probably due to the tissue age and stem/leaf ratio differences.

Figure 4 points out the effect of the variable natural light regime on photosynthesis. Since only growing tips were used, tissue age and stem/leaf ratio were relatively constant, as was temperature. With a mean surface irradiance of 0.30 ly·min^{-1}, C uptake declined markedly from 1.40 mg C·g dry wt^{-1}·hr^{-1} at the surface to less than 0.2 mg C·g dry wt^{-1}·hr^{-1} at 1.60 m.

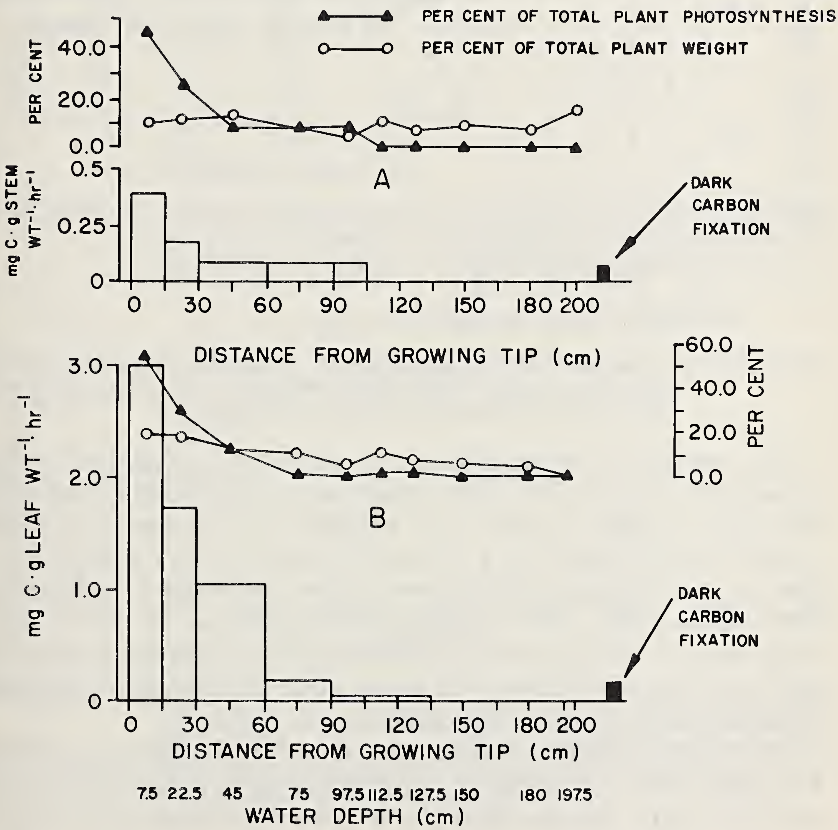

FIGURE 2. Carbon uptake of 15-30 cm sections of *Ceratophyllum demersum* incubated at natural depths within the *Myriophyllum spicatum* community. A. Stems; B. Leaves. 11 September 1975.

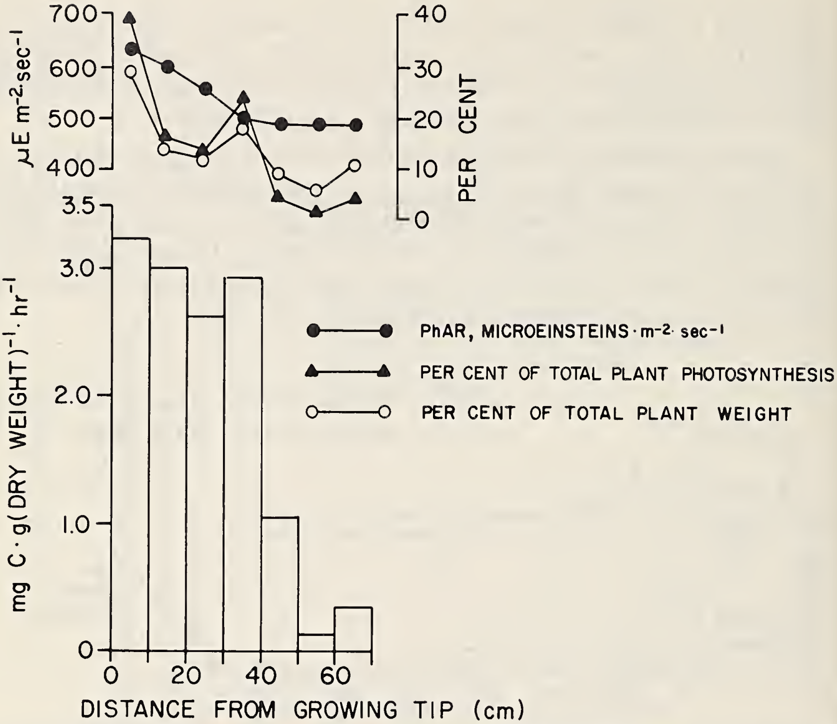

FIGURE 3. Vertical distribution of carbon-14 fixation of *Ceratophyllum demersum* under laboratory conditions. Water temperature 25 C, pH 8.8; alkalinity 124 mg $CaCO_3 \cdot 1^{-1}$.

The control of photosynthesis by light was quantified in the laboratory (Fig. 5). The light saturated photosynthetic rate of *C. demersum* apical shoots at 650-700 μ E.m^{-2}·sec-1 (≅ 0.5 cal·cm^{-2}·min^{-1}) and 21 ± 1 C was 2.30 mg C·g^{-1} (dry weight)·hr^{-1}. Spence and Chrystal (1970) found a low saturation irradiance of 0.02 cal·cm^{-2}·min^{-1} for *Potamogeton obtusifolius;* W. Stone (personal communication) found saturated photosynthetic rate of 8.9 mg C·g^{-1} (dry weight)·hr^{-1} at about 1000 μE·m^{-2}·sec^{-1} for Lake Wingra *M. spicatum* in September.

Talling (1957) introduced a parameter Ik, the irradiance at which a straight line representing the initial slope of the light curve intersects a line representing the saturated photosynthetic rate; Ik is considered a measure of light-temperature adaptation and the onset of light saturation (Vollenweider, 1974). Calculating the initial slope of the *C. demersum* light curve by regression (r = 0.95) gives an Ik of 250 μE·m^{-2}·sec^{-1}. *M. spicatum* in September has an

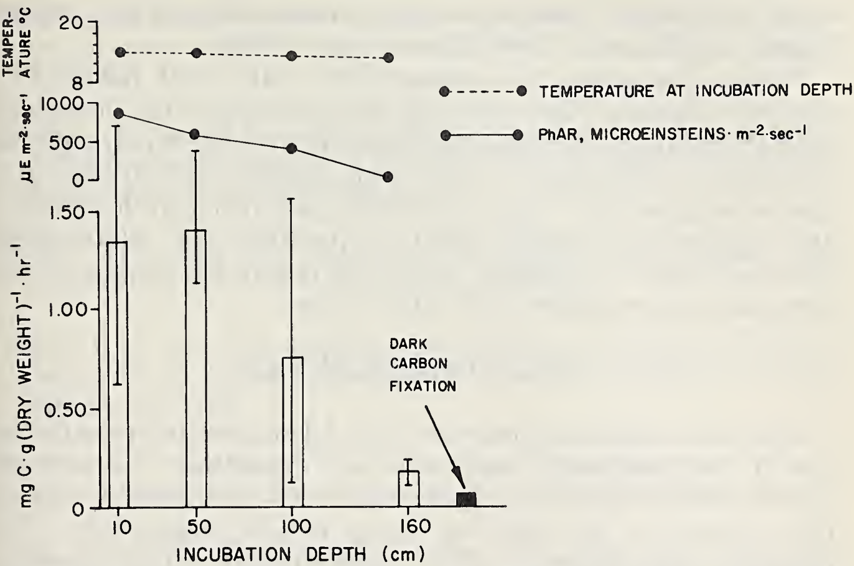

FIGURE 4. Apparent photosynthesis of growing tips of *Ceratophyllum demersum* incubated at four different depths within the community on October 3, 1975. Vertical bars are ranges.

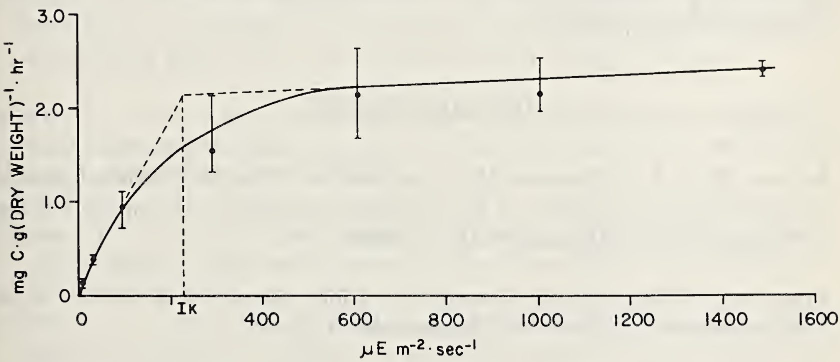

FIGURE 5. Apparent photosynthesis light curve of growing tips of *Ceratophyllum demersum* (3 replicates) on September 19, 1975. Circles are mean values; vertical bars are ranges. Water temperature 21 C; alkalinity 144 mg $CaCO_3$ ·l^{-1}; pH 8.7. Concerning Ik, see the text.

Ik of about 800 μE·m^{-2}·sec^{-1} (W. Stone, personal communications). This indicates that *C. demersum* may be considered a "shade" species as suggested by Carr (1969b). The full significance of this shade adaptation is little studied, although others have recognized "sun" and "shade" adapted aquatic macrophytes (Carr, 1969b; Spence and Chrystal, 1970; Spence *et al.*, 1973).

Factors controlling the photosynthetic rates with depth of *C. demersum* include light, tissue age and stem/leaf ratio. Compared with *M. spicatum*, the dominant species in the Lake Wingra littoral macrophyte community, *C. demersum* may be characterized as a species adapted to low light intensity. Experiments in other seasons and further information about competition and relationships between these two species would be useful for studies of the dynamics and evolution of the littoral zone.

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THE EFFECTS OF MADISON METROPOLITAN WASTEWATER EFFLUENT ON WATER QUALITY IN BADFISH CREEK, YAHARA AND ROCK RIVERS

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INTRODUCTION

In December, 1959, the Madison Metropolitan Sewerage District (MMSD), acting pursuant to the directions of the Legislature in Section 144.05 (1) of the Wisconsin Statutes, initiated diversion of their wastewater effluents from the Yahara River between Lakes Monona and Waubesa, to the Badfish Creek, which empties into the Yahara and Rock Rivers below Lake Kegonsa. This diversion was accomplished by the construction of a $3.5 million pipeline and diversion ditch from the Nine Springs Sewage Treatment Plant to Badfish Creek. The purpose of diversion was to improve water quality in Lakes Waubesa and Kegonsa by reducing the amounts of aquatic plant nutrients discharged to these lakes. Additional information on the diversion is discussed in Mackenthun *et al.* (1960), Wisniewski (1961), Wisconsin Department of Natural Resources (undated) and Teletzke (1953). It is generally agreed that this diversion did improve water quality in the two lower lakes (Lawton, 1961; Sonzogni and Lee, 1974). However, while the diversion of the Madison effluents lowered the nutrient levels within these lakes, the concentrations present after diversion were still sufficient to produce excessive growths of algae. These nutrients are primarily derived from urban and rural runoff, groundwater and the atmosphere (Sonzogni and Lee, 1975).

One of the frequently asked questions about this diversion was its effect on the Badfish Creek and Yahara and Rock Rivers. Beginning in 1953, stations on the Badfish Creek, Yahara and Rock Rivers have been sampled on a weekly to bi-weekly basis and analyzed for biochemical oxygen demand (BOD), dissolved oxygen (DO), suspended solids, nonvolatile solids, soluble and total phosphate, ammonia, nitrite, nitrate, organic nitrogen and coliforms at approximately 20 locations by the Madison Metropolitan Sewerage District. This paper presents a review of the chemical data and discusses the water quality in the Badfish Creek, Rock and Yahara Rivers based on the MMSD data.

DATA REDUCTION

Because of the large amounts of data available (over 50,000 data points), overall means and standard deviations were computed for each of the parameters measured at each of the sampling stations. The overall mean concentration should give a reliable estimate of the trends of water quality at each of the stations for the study period, generally from 1953 through 1970. The standard deviation for the data at any one station for any particular parameter gives a measure of the variability of the data from the mean. The data for the annual means with the various chemical parameters is presented in a report by Lee and Veith (1971). The sampling stations used by the MMSD are presented in Table 1 and Fig. 1.

The weekly to bi-weekly data on the concentrations of various chemical contaminants in the receiving waters for the Madison Nine Springs Sewage Treatment Plant effluent (MMSD-STP) provide a good index to water quality at that location in the receiving streams. The data, however, do not provide quantitative information on the relative significance of various sources of these contaminants. In order to make quanitative estimates of this type, discharge measurements of each of the tributary sources must be available. In general, discharge information was not available with the result that this paper has to discuss the effects of the Madison

TABLE 1. SAMPLING STATIONS: BADFISH CREEK, YAHARA AND ROCK RIVERS

Station	Stream	Location
NS		Nine Springs Sewage Treatment Plant effluent
A		Aerator No. 1 (End of Diversion Pipeline)
B	Diversion Ditch	Berman Bridge on E-W road Sec. 31 Dunn Tn.
1	Badfish Creek - N. Branch	N-S road between Sec. 4 and 5 Rutland Tn.
3	Badfish Creek - S. Branch	County Trunk A culvert Sec. 16 Rutland Tn.
4	Combined Badfish Creek	County Trunk A bridge Sec. 15 Rutland Tn.
8	Combined Badfish Creek	St. Hy. 59 bridge Sec. 4 — Porter Tn.
9	Yahara River	St. Hy. 59 bridge Sec. 10 — Porter Tn.
10	Yahara River	Stebbinsville Dam — in pond
14A	Yahara River	Fulton Power House Tailrace
15	Rock River	Below Indianford Dam at Power Plant
16	Rock River	St. Hy. 14 bridge N of Janesville

Sampling stations indicated are the same as those used by the Madison Metropolitan Sewerage District.

FIGURE 1. SAMPLING LOCATIONS ON THE BADFISH CREEK, YAHARA AND ROCK RIVERS.

Nine Springs Sewage Plant effluent on the receiving waters in a qualitative to semi-quantitive manner.

Quality of the Nine Springs Sewage Treatment Plant Effluent

The Madison Nine Springs Sewage Treatment Plant (STP) of the Madison Metropolitan Sewerage District is a primary and secondary treatment facility. It is designed to remove suspended solids and oxygen demand in the form of BOD (biochemical oxygen demand). The plant consists of primary sedimentation tanks followed by either trickling filters or activated sludge aeration tanks with approximately 72 percent of the flow passing through the activated sludge treatment process. Both the activated sludge and trickling filter process water go to secondary settling tanks, the effluent of which is chlorinated and pumped via the 1959 diversion pipeline and ditch to the Badfish Creek. The solids removed in the primary and secondary sedimentation tanks from the trickling filter part of the plant, and the waste activated sludge obtained from the secondary sedimentation tanks of the activated sludge part of the plant, are combined and digested at elevated temperatures. The digesters are fixed-cover, completely mixed systems. The digested sludge is pumped to sludge-holding tanks and then to sludge lagoons located adjacent to the STP. In 1962-63, during the time that the plant was expanded to handle an additional wasteload, the digester supernatant was pumped with the sludge to the lagoon.

TABLE 2. MADISON NINE SPRINGS SEWAGE TREATMENT PLANT AVERAGE FLOWS, EFFLUENT BOD AND SUSPENTED SOLIDS*

Year	Flow (MGD)**	Average BOD-5 day (mg/1)	Average Suspended Solids (mg/1)
1952	16.7	20	16
1953	16.2	16	15
1954	17.1	17	21
1955	17.7	16	23
1956	17.5	16	23
1957	17.6	21	27
1958	17.7	21	27
1959	20.8	34	49
1960	22.5	30	39
1961	21.7	34	40
1962	22.0	45	51
1963	22.8	47	52
1964	23.0	18	23
1965	24.5	19	24
1966	26.0	21	24
1967	27.2	18	17
1968	29.3	22	24
1969	31.3	20	21
1970	30.7	21	27

*Data based on information provided in the annual reports of the Metropolitan Sewerage Commission.
**Million gallons per day.

Prior to that it was returned to the sedimentation tank. Since the summer of 1970 some of the liquid present in the sludge lagoons was pumped back to the primary tanks.

From an overall point of view the MMSD-STP is doing an excellent job in removing suspended solids and BOD (see Table 2). Normally, plants of this type have a residual BOD in the order of 20 mg/l after treatment. During the period from 1964 to 1970, the MMSD-STP achieved an effluent BOD of approximately 20 mg/l. In 1961 through 1963, when the plant was under construction for expansion,the BOD in the effluent became approximately twice this value, indicating relatively poor treatment compared to what could be achieved, and what was previously achieved.

The total suspended solids in the MMSD-STP effluent since the plant has been reconstructed has averaged about 20 to 25 mg/l, which indicates a good removal of solid material. As in the case of BOD, there were high values of suspended solids found only during 1961-1963 construction period.

These results are in accord with the report from the Wisconsin Department of Natural Resources (Wis. DNR, 1971) in which they stated that in a 19-month period, from February 1969 through August, 1970, the average effluent BOD from the plant was 20.1 mg/l, and the average suspended solid concentration 23.0 mg/l They concluded that the present treatment efficiency was good.

It should be noted that in the period since the 1959 diversion, the flow in the MMSD-STP has increased from about 20 million gallons per day (mgd) to approximately 31 mgd. Also, it should be noted that in 1962-63, at the time of plant expansion, the flows were approximately 22 mgd. Therefore, since the last expansion, the flows have increased approximately 9 mgd and the plant has still maintained a high treatment efficiency with good removal of BOD and suspended solids.

Effect of Treated Effluent on the Badfish Creek

The prediversion data were generally taken at Stations 1, 3, 4, 8, 9, and 10 for the period 1953-58 for BOD_5 , nonvolatile suspended solids, nitrate, nitrite, and ammonia. In general, 237 samples were taken from these stations for these parameters. Prediversion sampling of Station 8 did not start until 1956, in which time 110 samples were taken. Total phosphorus, soluble phosphate and organic nitrogen prediversion samples were collected from Stations 1, 3, 4, 8, 9, 10, 14A, 15, 16 and 17. The post diversion samples were taken from all stations listed in Table 1 from 1959-1970 during which time approximately 395 samples were taken from each station.

In the period 1953 to the present, the MMSD has sampled at weekly, and later at bi-weekly intervals at three locations in the Badfish Creek. In addition, some samples have been taken from the wastewater in the diversion ditch before the water enters the Badfish Creek North Branch. Also, routine sampling has been conducted on the South Branch of the Badfish Creek. Station 1 represents the composition of the North Branch of the Badfish Creek at a point below where the MMSD-STP effluent enters this creek (see Fig. 1). At this point, the Badfish Creek contains the sewage treatment plant effluent from the Village of Oregon, storm water drainage from Oregon, the effluent from the MMSD-STP effluent and any drainage arising from agricultural lands. It is estimated that approximately 50 to 80 percent of the flow at this station is derived from the MMSD-STP effluent. The Village of Oregon expanded its wastewater treatment facility in 1969. It is expected that this plant should achieve BOD and suspended solid removals such that its effluent should have approximately the same characteristics as that of the MMSD-STP. This would not have been true prior to the reconstruction of this plant. However, when mixed in the Badfish Creek, because of the relatively large discharges of MMSD effluent, it is estimated that MMSD-STP contributes about 99 percent of the wasteload (Wis. DNR, 1971) to the Badfish Creek at Station 1.

BOD and Dissolved Oxygen

Prior to the introduction of the MMSD-STP effluent to the Badfish Creek, the BOD_5 in the Creek at Station 1 ranged from 4 to 7 mg/l (see Table 3). After diversion it has increased to approximately 20 mg/l, with a maximum in 1962 and 1963 of 27 and 31 mg/l, respectively for the annual average BOD_5. Since the expansion of the plant in 1963, the annual average of BOD_5 at Station 1 has been in the order of 12 to 17 mg/l. A comparison between the STP effluent and this station's data shows that there is a reduction in the BOD_5 from the effluent at the STP to Station 1. This reduction is probably due to dilution from the Badfish Creek water and due to removal of BOD through sedimentation and biochemical processes in the diversionary pipe and ditch.

TABLE 3

OVERALL MEAN CONCENTRATIONS OF SELECTED CONTAMINANTS IN THE MMSD EFFLUENT, DIVERSION DITCH, BADFISH CREEK AND YAHARA RIVER

Parameters	Station																			
	STP	3		1		3		4		8		9		10		14A		15		16
	Post Div	Post Div	Pre Div	Post Div	Pre Div	Post Div	Pre Div	Post Div	Pre Div	Post Div	Pre Div	Post Div	Pre Div	Post Div	Pre Div	Post Div	Pre Div	Post Div	Pre Div	Post Div
BOD_5 (mg/1)	28	23	6	19	2	21	3	17	3	19	6	11	6	7	6	9	7	7	6	8
Nonvolatile suspended solids (mg/1)	4	7	9	18	28	18	31	18	43	36	19	25	9	12	18	21	24	34	20	20
Total Phosphorus (mg P/1)	—	4	0.5	3	0.04	0.06	0.1	2.0	0.09	2.0	0.4	0.9	0.4	0.1	0.3	0.6	0.1	0.1	0.1	0.2
Soluble Phosphate (mg P/1)	—	3	0.4	2	0.02	0.03	0.09	2	0.04	2	0.3	0.6	0.3	0.08	0.2	0.3	0.04	0.06	0.07	0.1
Nitrate (mg N/1)	2	0.8	2	0.9	3	3	3	1	3	2	0.5	1	0.2	.02	0.4	1	0.2	0.5	0.2	0.6
Nitrite (mg N/1)	0.3	0.3	0.2	0.3	0.02	0.03	0.04	0.3	0.04	0.4	0.03	0.2	0.03	0.03	0.04	0.2	J.02	0.2	0.02	0.07
Ammonium (mg N/1)	15	12	1	12	0.2	0.2	0.3	9	0.5	7	0.2	3	0.4	0.3	0.3	2	0.1	0.3	0.2	0.3
Organic Nitrogen	3	1	3	0.5	0.6	0.8	1	0.7	2	2	2	2	2	2	2	2	2	2	2	2

*Post div = Post wastewater diversion
**Pre div = Pre wastewater diversion

The suspended solids data for Station 1 show that (Table 3), in general, they are approximately the same as the MMSD-STP effluent, although occasionally some relatively high values are found which are probably derived from storm water drainage from the Village of Oregon and agricultural lands.

The best way to examine the effect of the STP effluent BOD on water quality at Station 1 on the Badfish is to examine the dissolved oxygen levels at this station. In the case of dissolved oxygen, annual means should not be used for comparison purposes, since it is the critically low DO values which are of importance to aquatic organisms. Examination of the data (see Lee and Veith, 1971) for Station 1 shows that at several times during each year the dissolved oxygen (DO) levels at this station are less than 3 mg/l, and frequently are less than 1 mg/l, especially during the summer and fall of 1970. Normally, a DO of 5mg/l or more is desirable (US EPA, 1976), with 3 to 4 mg/l being the minimum for maintenance of some of the desirable forms of fish. It is concluded that the dissolved oxygen concentrations at Station 1 are sufficiently low to have a significant adverse effect on aquatic life at this location.

In order to ascertain whether it is the MMSD-STP effluent or some other conditions which are causing this low DO at Station 1, examination of the data from Stations A and B should be made. Station A is located at the effluent from the cascade aerator at the point where the effluent enters the diversion ditch from the pipeline. Station B is approximately one half mile from this point on the diversion ditch. In general, in recent years the effluent from the cascade aerator has run between 4 to 8 mg/l of dissolved oxygen. By Station B occasionally zero DO values have been reported, with frequent values less than 3 mg/l. Generally, whenever low values are reported at Station B, even lower values are reported at Station 1. Further study will be necessary to ascertain the relative flow times and the expected rates of BOD exertion in the diversion ditch between the cascade aerator and Station 1. However, from a cursory examination of the data, it can be expected that there would be a significant reduction in the amount of dissolved oxygen in this ditch due to residual BOD present in the MMSD-STP effluent.

Prior to the 1959 diversion, data collected by the Committee on Water Pollution, State of Wisconsin (Mackenthun *et al.*,1960 and Wisniewski, 1961), and the Madison Metropolitan Sewerage District show that low dissolved oxygen values were found at Station 1. At times, essentially zero dissolved oxygen was found at this station. It is possible that the low dissolved oxygen values found at Station 1 prior to diversion were due to the discharge of wastewaters from the Village of Oregon to the Badfish Creek. Since the 1959 diversion, this pattern has not changed to any significant extent. The primary difference in the data before and after diversion is with respect to Stations 4 and 8. Both the Committee on Water Pollution and the MMSD data show that no critically low dissolved oxygen values were found at the lower two stations in the Badfish Creek prior to diversion. However, after diversion occasionally low dissolved oxygen values were found.

Examination of the DO and BOD_5 data for Station 4, which is located about four miles downstream on the Badfish Creek below Station 1, shows that occasionally critically low DO concentrations are encountered at this station, which can be attributable to the MMSD-STP effluent. The South Branch of the Badfish Creek joins the North Branch between Stations 1 and 4. Examination of the data for DO and BOD_5 for station 3 on the South Branch of the Badfish, shows that it does not contribute to the low DO values which are observed at Station 4. If anything, it would tend to raise the DO values at Station 4 slightly above what would be encountered without the dilution water brought in from South Branch.

The critically low DO values shown in the MMSD data for Stations 1 and 4 are supported by the Department of Natural Resources 1971 Report in which they state on page 32 (Wis. DNR, 1971) that in this reach of the stream the organisms found are indicative of high levels of pollution just below the outfall, while at Station 4, the stream is considered to be in a semi-polluted condition.

The next station that was routinely sampled by the MMSD on the Badfish Creek was Station 8, which is located just above the confluence of the Badfish Creek with the Yahara River. Station 8 is approximately 12 miles below Station 4. Between these two stations several small tributaries enter the Creek. In addition, it can be expected that during periods of rainfall appreciable amounts of pollutional materials derived from agricultural lands, such as crop land, small feed-lot operations, and drainage of marshes, would contribute to the wasteload of the stream. Of particular importance would be the drainage from wetlands. Lee, Bentley and Amundson (1975) found the drainage from wetlands in south-central Wisconsin to have adverse effects on water quality in the receiving stream. Frequently, this drainage contained low dissolved oxygen, high nitrogen and phosphorus.

Examination of the DO data for Station 8 shows that occasionally DO levels of less than 4 mg/l are encountered at this station. In general, the BOD values found at Station 8 are equal to or greater than those found at Station 4, thereby indicating that, since appreciable BOD removal would be expected in the stream between these two stations, significant BOD addition occurs in this stream, due to several sources. First, because of the large amounts of plant nutrients present in the stream, a prolific growth of aquatic plants is found. These plants tend to contribute to the BOD of the stream; however, examination of the winter data, when the growth of aquatic plants would be minimal, does not show that this is a significant source of BOD for the stream.

Another factor to consider is the possible effect of nitrification on the BOD of the stream. It is conceivable that little or no nitrification has occurred by Stations 1 and 4, while by Station 8, significant nitrification is in progress. This nitrification would possibly show up in the normal BOD_5 test at Station 8 and not be present at Stations 1 and 4. There is some support for this suggestion, based on the changes in the ammonia and the nitrate concentrations from Stations 4 and 8 for the Badfish Creek (see Table 3).

In general, there is an increase in suspended solids in the Badfish Creek from Stations 1 to 4 and 4 to 8 (Table 3). This increase indicates either the amounts of algae present in the creek or the large amounts of materials contributed from rural runoff. Since the organic nitrogen content of the stream remains essentially constant throughout its length, it is possible to tentatively rule out increases in algae as a cause of the increases of the solids. It is more likely, based on the data available, that this is due to an increase in the amounts of erosional material brought into the stream from the farmlands.

An additional point that should be made with regard to the effects of the MMSD-STP effluent on Badfish Creek is that this effluent will likely increase the amounts of aquatic plants, particularly attached filamentous algae, in the creek. These aquatics become sufficiently thick at times that they have caused the MMSD to purchase a weed cutter for harvesting weeds from the diversion ditch. Probably the most significant problem caused by the luxuriant growth of aquatic plants in Badfish Creek is the effect of these plants on the DO in the stream. It is reasonable to expect that the Badfish Creek would show a large diurnal DO fluctuation with a maximum DO in late afternoon and a minimum in the morning just before sunrise. This marked change in DO would be related to the photosynthesis and respiration of the aquatic plants and the respiration of the bacteria in the stream utilizing the organic matter in the water. Data showing the magnitude of the diurnal fluctuations in DO were unavailable except for a limited study by the graduate students in Sanitary Engineering at the University of Wisconsin-Madison (Sanitary Engineering, 1969). Based on the fact that the MMSD data were all collected during the day at a time when DO would be expected to be higher than in the early morning, it is reasonable to expect that the minimum DO values would likely be lower due to this diurnal DO fluctuation. In some streams of this type a several mg/l diurnal DO fluctuation is encountered, so that even a 5 mg/l DO in midday might have a just-before-sunrise minimum DO of 3 mg/l or less. Additional study would be necessary in order to ascertain the significance of the diurnal DO fluctuations arising from the luxuriant aquatic plant growth on the DO concentration of Badfish Creek.

Another problem which is caused by the discharge of the MMSD-STP effluent to the Badfish Creek is the large amounts of ammonia ($NH_3 + NH_4^+$) that are contributed. Ammonia has been shown to be acutely toxic to fish at concentrations of a few mg/l or less in 96 hours at the pH range in the Badfish Creek (US EPA, 1976). The US EPA has established 0.2 mg/l as unionized ammonia as a safe level for chronic exposure of fish at pH 8 and 20 C. This concentration is equivalent to a total ammonia ($NH_3 + NH_4^+$) of approximately 0.5 mg/l as N. Measurements of pH by the MMSD showed the averages ranged from approximately 7.5 to 8.5 in the MMSD-STP effluent and in waters of Badfish Creek, Yahara and Rock Rivers. The STP effluent has between 12 and 20 mg/l of ammonia nitrogen ($NH_3 + NH_4^+$). At Station 1 the 12-year average, since diversion, is 10.6 mg/l of ammonia nitrogen, while at Station 8 this average is 6.7 mg/l N. There can be little doubt, based on the data available, that the primary source of ammonia is the MMSD-STP and that this ammonia would be expected to show toxicity to fish in the Badfish Creek throughout its length. Further, as noted above, ammonia concentrations of this level would exert a significant oxygen demand on the Badfish Creek.

Effect of the Madison Metropolitan Sewerage District Effluent on the Yahara River

In order to examine the effects of the discharge of the MMSD effluent on the Yahara River, Stations 8, 9 and 10 have been sampled since 1956 on a weekly, and more recently on a bi-weekly basis, with Stations 9 and 10 being sampled since 1953. Station 8 is located on the Badfish Creek approximately 1.5 miles above the point where this stream enters the Yahara River. Station 10 is located on the Yahara at the Stebbinsville Dam above the point where the Badfish enters the Yahara. Station 9 is located at the State Highway 59 bridge where this highway crosses the Yahara River below the confluence of the Yahara River and Badfish Creek.

Examination of the BOD_5 data for Stations 8, 9 10 (Table 3) shows that the annual mean concentrations at Station 8 are always higher than that at Station 10. The resultant BOD_5 at Station 9 is between the two values reported at Stations 8 and 10. In general the minimum DO at Station 9 is in the order of 5 mg/l; however, since this is a daytime value, it is possible that it could drop to what would be considered critical levels for some aquatic organisms, including fish, in the vicinity of aquatic plants in the river. There is some indication from the data available that some of the low values in DO that are found at Station 9 on the Yahara River are due in part to the BOD contributed from the Badfish Creek. However, as pointed out above, there appear to be other sources of BOD in Badfish Creek besides the Madison Metropolitan Sewerage District. With the data available at this time it is impossible to determine whether the MMSD-STP discharge is contributing significant amounts of BOD which causes the near-critical measured values for DO in the Yahara River.

Examination of suspended solids data for Stations 8, 9 and 10 shows that, in general, Station 8 on the Badfish has higher suspended solids values than Stations 9 or 10. Therefore, the Badfish is contributing suspended solids to the Yahara River. However, since Station 9 shows considerably higher suspended solids normally than Stations 1 and 4 on the Badfish, it must be concluded that the suspended solids present in the MMSD-STP effluent are not contributing significantly to the suspended solids present in the Yahara River.

The ammonia data for Stations 8, 9 and 10 shows that the Badfish Creek is contributing to excessive concentrations of ammonia in the Yahara River. These concentrations are sufficiently great to cause fish toxicity problems in this river near the confluence of the Badfish and the Yahara. It appears that the excessive concentrations of ammonia in the Yahara River at Station 9 are due to a major extent to the discharge of large amounts of ammonia from the MMSD-STP.

Examination of the nitrogen and phosphorus data for the Yahara River, Badfish Creek and the confluence of the two at Station 9 shows that the MMSD-STP effluent is contributing to the large amounts of nitrogen and phosphorus present in the Yahara River at Station 9. Excessive concentrations of nitrogen and phosphorus in the Yahara River would be considerably less than that for the Badfish Creek, since the Badfish Creek is a rapidly moving stream with essentially no impoundments or standing water. However, the Yahara River has numerous impoundments, many of which are constructed for power production. These impoundments create relatively low velocity water and lake-like conditions. Typically it has been found that inorganic nitrogen in excess of about 0.3 mg/l N,and soluble orthophosphate in excess of 0.01 mg/l P (0.03 mg/l $PO_4^{\equiv}$) (Sawyer, (1947) can cause excessive growths of algae and other aquatic plants in lakes. The Yahara River, before the Badfish enters it, has concentrations of nitrogen and phosphorus in excess of these values. The addition of the waters from the Badfish greatly increases the amount of nitrogen and phosphorus in the Yahara and will likely increase the problems of excessive growths of algae in various impoundments of the Yahara River.

Examination of the data for the two stations on the Yahara River below the point where the Badfish enters, shows that there is a slight reduction in BOD, soluble phosphate and ammonia as the water flows from Station 9 to 14A. Station 14A is located at Fulton, Wisconsin, on the Yahara River. There is an increase in nitrate which is probably attributable to nitrification of the ammonia and inflow of groundwater. Suspended solids data appears to be highly variable with no discernible pattern evident from the data available.

From an overall point of view there is an improvement in water quality in the Yahara River from Station 9 to 14A. In general, the DO values for Station 14A are above the critical value. It is possible that they might drop below critical values of 3 to 4 mg/l during early morning.

Effect of the Madison Effluent on the Rock River

Four sampling stations were established in order to ascertain the effect of the MMSD-STP effluent on the Rock River. Station 14A is located on the Yahara River at Fulton, above where the Yahara enters the Rock; Station 15 is at Indianford Dam on the Rock River, and Station 16 is at State Highway 14 bridge just north of

Janesville. The MMSD also sampled Station 17, located in the center of Janesville, but these data are not included because influenced by inputs from the city of Janesville. Examination of the DO data for these three stations shows that adequate DO is present at all stations throughout the year to maintain desirable aquatic life in the stream.

From examination of the 5-day BOD data, it is doubtful that the MMSD-STP effluent has any effect on the BOD levels found in the Rock River. The ammonia data show that the Yahara River is contributing increased concentrations of ammonia to the Rock River, as evidenced by an increase in the concentrations of this compound at Station 16 compared to 15; however, in general, the concentrations of ammonia at Station 16 are less than the critical concentrations for excessive growths of algae and for toxicity to aquatic organisms. On the other hand, comparison of the nitrate values for Stations 14A, 15 and 16 shows that the Yahara generally has higher levels of nitrate nitrogen than does the Rock River. Mixing the two increases the nitrate to levels that would produce excessive growths of algae. If the nitrate and ammonia are added together in order to calculate the inorganic nitrogen, it is found that in excess of a mg/l of inorganic nitrogen is present in the Rock River below the confluence of the Yahara and the Rock, and that this value is derived to some extent from the discharge of MMSD-STP effluent into the Badfish Creek. It will be necessary to do additional study in order to ascertain the amount of the inorganic nitrogen present in the Rock River at Janesville that can be attributed to the discharge from MMSD-STP.

The same type of pattern obtains for soluble phosphorus, where MMSD-STP effluent is contributing to excessive concentrations of soluble orthophosphate in the Rock River above Janesville. The inorganic nitrogen and soluble orthophosphate would be expected to contribute to the excessive growths of algae in the Rock River.

The suspended solids data do not show any discernible trends attributable to the discharge of MMSD-STP effluent to the Badfish Creek. It is doubtful that the discharge has any effect on the suspended solids which are found in the Rock River.

From an overall point of view; the only readily discernible effects of Madison discharge of wastewater effluents to the Badfish Creek on water quality in the Rock River above Janesville is an increase in the inorganic nitrogen and soluble orthophosphate above the levels that are said to cause excessive growth of algae in lakes and impoundments. Schraufnagel (1971) has estimated that approximately 90 percent of the phosphorus present in the Yahara River just before it enters the Rock River is derived from sewage plant discharges from DeForest, Windsor, Arlington, Waunakee, Cottage Grove, Oregon and Madison. Because of the relative size of these communities, by far the major part of the phosphorus is derived from Madison. He also estimates that approximately 60 percent of the phosphorus present in the Rock River immediately below confluence with the Yahara, is derived from municipal wastewater sources. Based on these estimates the MMSD-STP effluent contributes between 30 to 40 percent of the phosphorus present in the Rock River just above Janesville.

DISCUSSION

The purpose of the December, 1959 diversion of the Madison wastewater effluent from the Yahara River above Lake Waubesa to the Badfish Creek, which enters the Yahara River below Lake Kegonsa, was to reduce the amounts of aquatic plant nutrients, nitrogen and phosphorus compounds, that enter these small lakes. Generally, lakes do not have significant water quality problems in the surface waters due to low DO; however, lakes frequently tend to grow excessive amounts of algae more readily than do streams. There is little doubt that the diversion of the MMSD-STP effluent did result in improved water quality in Lakes Waubesa and Kegonsa, as evidenced by less excessive growth of obnoxious algae. There has, at the same time, been a deterioration in water quality in the upper parts of the Badfish Creek, which can be directly attributed to the discharge of effluent to this creek. The diversion of the nitrogen and phosphorus from Lakes Waubesa and Kegonsa to the Badfish has most probably created serious water quality problems in the Badfish and Yahara River at the point where the Badfish enters the Yahara, due to the high concentrations of ammonia which could lead to toxicity to fish and to excessive growths of algae in the Badfish Creek.

A comparison of the data (Table 3) available on the concentrations of nitrogen and phosphorus present at Station 9 on the Yahara River below the point where the Badfish empties into it prior to the diversion and after the diversion, shows that the amounts of inorganic nitrogen and soluble orthophosphate found in the river at this point have increased. As would be expected, Lakes Waubesa and Kegonsa would tend to act as nutrient traps by accumulating in the lake sediments some of the nitrogen and phosphorus that used to be discharged to these lakes. After diversion, there is an approximate doubling in the amount of phosphorus present in the Yahara River below the Badfish. There is essentially little opportunity on an annual basis for this phosphorus to be removed in the Badfish Creek.

The same pattern is found for the Rock River in that the diversion of the effluent around Lakes Waubesa and Kegonsa increased the concentrations of inorganic nitrogen and phosphorus present in the Rock River below the point where the Yahara River enters. It should be mentioned, though, that some of the increase in phosphorus found today in the Rock River just above Janesville would be attributable to the overall increase of phosphorus in the MMSD-STP effluent since 1959, i.e. almost a doubling in the amounts of soluble orthophosphate from 1959 to 1968. In the same period the total phosphorus present has remained essentially the same. It is interesting to note that this increase in soluble orthophosphate has occurred even though the 1962-63 expansion of the plant eliminated the return of digester supernatant to the primary sedimentation tanks. It was likely that even if the effluent had continued to be discharged through Lakes Waubesa and Kegonsa, the overall concentrations of soluble orthphosphate in the Rock River above Janesville would have increased somewhat due to the increases in concentrations in the MMSD-STP effluent during this same period of time.

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BACK TO THE LAND!
RURAL FINNISH SETTLEMENT IN WISCONSIN

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> The only language the stumps understand . . .
> is. . . Finnish.[1]

Although the Finns left an indelible imprint upon certain areas of Wisconsin, they never numbered among the state's largest foreign-born groups. Between 1900 and 1920, for example, Wisconsin's Finnish-born population grew from some 2,000 to 6,750 inhabitants, but more than fifteen other non-native contingents had larger representations during both census years.[2] The relatively small number of Finns in Wisconsin is even more evident when the figures are compared to those for Michigan and Minnesota, the two states which provided a bifurcated focus for the largest number of Finnish immigrants to this country. During 1920, Michigan and Minnesota each had a population of about 30,000 Finnish-born persons; and together the two states accounted for approximately forty percent of the United States' total Finnish community.

How, then, did the Finns develop and nurture a distinctive identity within Wisconsin? There were undoubtedly several reasons but a few factors were of paramount importance. One was that the majority of these Finns settled in relatively few areas of the state and thereby maintained a tightly-contained geographic identity and cohesiveness. Secondly, unlike most participants in the major migration waves between 1880 and World War I (the so-called "new immigration"), the Wisconsin Finns settled predominantly in rural rather than urban centers. Hence, it was somewhat easier for them to maintain a distinctive identity and culture. Thirdly, certain Finnish institutions, serving a regional or national audience, have been headquartered in Superior, Wisconsin. Of particular note is the Central Cooperative Exchange,[3] a Finnish-sponsored economic venture which was initiated during 1917. Before it merged with Midland Cooperatives, Inc., of Minneapolis in 1963, the wholesaling facility had an affiliated network of 244 local outlets spread throughout the Upper Midwest and did some $21 million worth of business during its peak year of operation.[4] Another important institution in Superior has been the Finnish language press. Its best known journalistic efforts have been the *Työväen Osuustoimin-*

talehti (Workers' Cooperative Journal), which is the primary news organ of the Finnish-American cooperative movement, published between 1930 and 1965; and the *Työmies (Workingman)*, which moved from Hancock, Michigan to Superior during 1914. Even today, the latter newspaper and its associated activities continue to provide a portion of North America's Finnish-readers with a politically left-of-center news outlet.

To many observers of the Wisconsin landscape, the most evident and interesting Finnish imprint lies in the various vernacular architectural elements built by this immigrant group. Ranging from the *sauna* and *riihi*[5] to log houses and barns, the craftsmanship and functional integrity of these structures have found an appreciative audience among folk architecture aficionados. The Finnish farm complex at Old World Wisconsin, located at Eagle, is an effort to display and preserve a major portion of this ethnic and cultural legacy. In addition, an 1898 Finnish log structure in the Brantwood area (the Matt Johnson or Knox house) recently was nominated for inclusion on the National Register of Historic Places.

Although Wisconsin's Finnish communities were relatively small, their activities reflect those of the overall Finnish population in America. The Wisconsin Finns helped to load Great Lakes ore carriers on the docks of Ashland and Superior; entered the treacherous waters of Lake Superior at Herbster and Bark Point to search for lake trout; ventured into deep underground mines at Hurley, Iron Belt and Montreal; felled trees and skidded logs in the forest surrounding Brule and Brantwood; tended assembly lines in factories at Milwaukee, Kenosha and Racine; and most importantly, cleared and farmed the land in various areas of Wisconsin's cutover region.

Since the basic story of Finnish settlement and institutional development in Wisconsin has been related by Kolehmainen (1944) and Kolehmainen and Hill (1951), this article will look more explicitly at the migration of Finns to the state and the agricultural enclaves they formed. A brief overall sketch of Finnish settlement activities will be given, but the major portion of the discussion will focus upon two rural communities in Wisconsin: Oulu (pronounced Oh-loo) and Owen-Withee. Separated by about 175 miles and settled during different periods, the two enclaves illustrate some of the geographic and temporal differences which characterized Wisconsin's Finnish settlement picture. The primary sources for this analysis include church records; the original manuscripts from the

Federal and Wisconsin State Censuses; U.S. Federal Land Office records; Finnish-American newspapers; and personal interviews conducted by the author.

FINNISH-AMERICANS AND RURAL SETTLEMENT

With the exception of a small number of Swedish-speaking Finns, primary Finnish settlement did not commence until the mid-1880s. As such, the major movement of Finns into the state occurred some twenty years after the initial bridgehead in America had been established in the Copper Country of Northern Michigan during 1864 (Holmio, 1967). These first Finns, recruited to work as miners in Michigan, eventually were followed by thousands of others. For many Finns, Michigan's mining communities served only as temporary way stations in their search for an always elusive American *El Dorado*. Many migrated to the rich iron ore fields of northeastern Minnesota; some sought work in the copper, coal and gold mines of the western United States; and others pursued a variety of activities which ranged from logging and railroad construction to the establishment of private businesses. Some emigrés returned to Finland, or made the trans-Atlantic crossing several times. Of greatest significance, however, were the agricultural activities initiated by Finns in several areas of the Upper Midwest. During the latter half of the 1860s, a few small Finnish agricultural enclaves were established on the prairies of Minnesota (Kaups, 1966); but by the 1880s little prime agricultural land remained for the vast majority of later Finnish immigrants. Because of this, thousands of Finns acquired small acreages in the Lake Superior cutover region[6] and began the massive task of clearing the land of stumps and boulders, draining and planting fields, constructing farmsteads and developing a network of Finnish oriented communities and cultural, social and economic institutions.

Possessing an undeniable land hunger, many Finns who retreated to the land during the nineteenth century were inspired by the teaching of Lars Laestadius, a Swedish religious revivalist who found many adherents in rural areas of western and northern Finland—the primary area for early emigrants to America. Espousing a life of piety and simplicity, the Laestadians (Apostolic Lutherans) believed that the maintenance of traditional ethnic values in a new country could be best accomplished by developing rural communitarian enclaves (Kaups, 1975). By the turn of the century, however, larger numbers of Finns began to emigrate from less conservative areas of their homeland (Kero, 1973, 1974); an appreciable number of these Finns had been politicized by an oppressive Russian czarist government in Finland.[7] Imbued with a strong belief in socialism, many quickly formed political and social organizations in America and began to call for higher wages and better working conditions, most notably in the mining areas of Michigan and Minnesota. By serving as leaders and participants in several strikes, but especially the infamous conflicts on Minnesota's Mesabi Range in 1906 and 1916 and Michigan's Copper Country during 1913, a number of Finns were blacklisted by the mining and steel corporations. Unable to secure work, many of them, as well as other Finns who were affected by the strikes, lockouts and shutdowns, moved to the woods and began to carve out a precarious existence on forty to eighty acre parcels of land (Ollila, 1975).

Whether conservative or radical, none of the Finns could escape the dangerous and often oppressive conditions they faced in the mines and several other employment pursuits. Finnish language newspapers solemnly announced the figures: a total of 63 Finns dead in a mine disaster at Scofield, Utah during 1900; almost 100 killed while mining coal at Hannah, Wyoming in 1903; 146 deaths in the mines of Houghton County, Michigan between 1900 and 1903; *ad infinitum* (Kolehmainen and Hill, 1951; Yli-Jokipii, 1971). Although not quite as dangerous, conditions in logging camps were far from idyllic. One woodsman working in northern Wisconsin reported that at his place of employment the food was poor, the land wet and the camp accessible only after a long trek through the woods (Kolehmainen, 1946). Other lumberjacks died from pneumonia or injuries when they did not receive adequate medical attention in the camps. In a rather widely reported story of 1907, four Finnish lumberjacks were jailed for fifteen days in northeastern Minnesota when a camp operator claimed they had left his place of employment before discharging a debt. The Finns stated that their departure had been hastened because they were given dull and rusty tools (an insult to a Finn!), had not been able to secure adequate food and had been forced to sleep three to a bed. They were jailed when the camp operator claimed they still owed him 77 cents apiece for transportation to the camp.[8] Small wonder then, that thousands of Finns in America heeded the call: "Back to the land!—'mother Earth will provide for all of us' " (Kolehmainen, 1946).

FINNISH SETTLEMENT IN WISCONSIN

Although major Finnish settlement activities in Wisconsin did not commence until the mid-1880s, some Finnish-born persons entered the state at a considerably earlier date. Most of these earliest pioneers, though born in Finland, either were of direct Swedish stock or spoke Swedish as their mother tongue (i.e., Swede-Finns). Undoubtedly the most important individual in this group was Gustaf Unonius, a minister and author who was born in Helsinki, Finland during 1810. Unonius later emigrated to America and in 1841 founded Wisconsin's first Swedish settlement at Pine Lake (*Nya Upsala*). Located in Waukesha County, the colony never prospered and by 1850 only a few settlers remained of the dozen or so families who had heeded Unonius' original call in 1841 (Nelson, 1943). During the 1870s and 1880s a small group of Swede-Finns settled in the vicinity of Bailey's Harbor; however, this contingent, whose numbers never exceeded fifteen to seventeen members, quickly intermingled and intermarried with Door County's Irish, German and Scandinavian population. Somewhat later in the nineteenth century, a larger group of Swede-Finns established farms in Wood County's Sigel Township; and the nucleus for a fairly large urban settlement was established in Ashland during the same period. Although the Swede-Finns in America identified more closely with Swedes than with Finns, Silfversten (1931; cited by Nelson, 1943) aptly noted the dilemma they faced: "They have their native country in common with the Finns, their language in common with the Swedes and their national history in common with both."

When considering Wisconsin's Finnish-speaking population, Aine (1938) and Kolehmainen and Hill (1951) have noted that the first permanent settlement was established in Douglas County during 1885. According to U.S. Federal Land Office records, a few Finns acquired homesteads during the summer of that year in what are now Amnicon and Lakeside Townships (the Wentworth-Poplar area). Since there were no roads into the area, provisions and livestock were brought from Duluth and Superior in small boats; after landing along the Lake Superior shoreline, the cattle, goods and personal belongings were transported inland by the settlers.[9] Once this initial node had been established, more extensive settlement took place as the land seekers moved steadily eastward through Douglas County and into Bayfield County (Fig. 1). By 1886

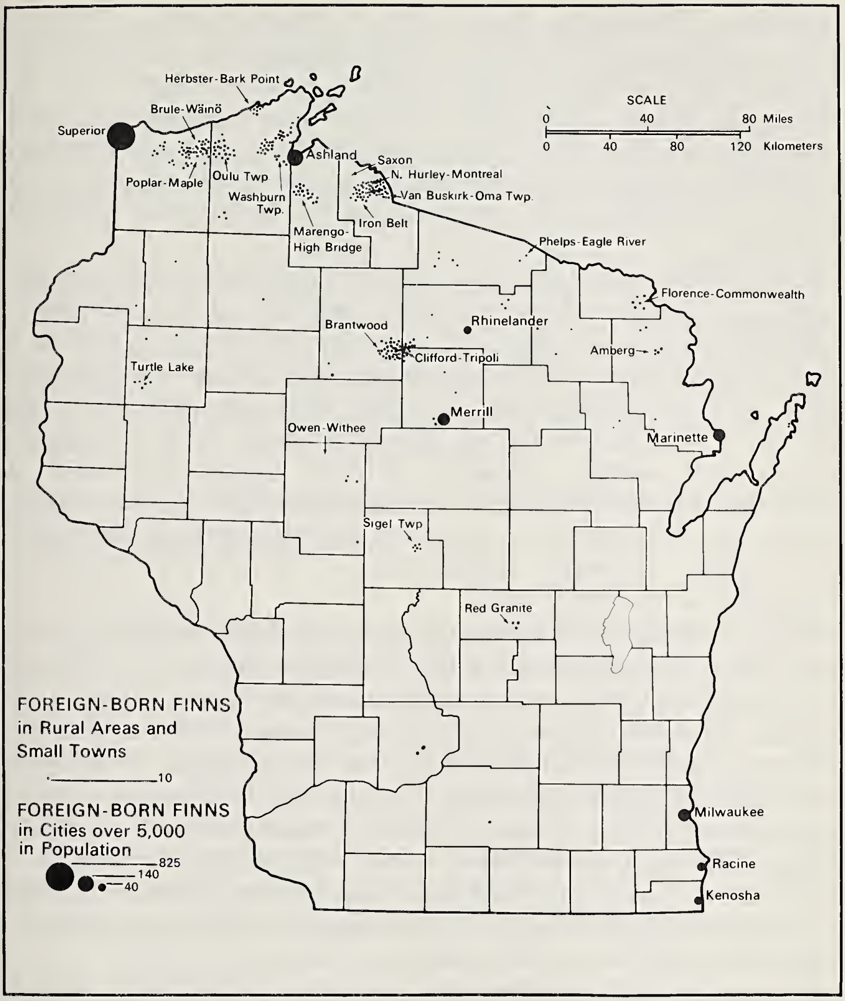

FIGURE 1. Distribution of Foreign-Born Finns during 1905, and Major Finnish Settlements in Wisconsin. With the exception of Saxon and Owen-Withee, the basis for all major Finnish settlements in Wisconsin had been established by 1905. Source: Wisconsin State Census, 1905

Finns had settled in the Maple area, and during the following year another group began to establish farms in the vicinity of Brule-Wäinö. The settlement wave reached Bayfield County in 1888, with the major Finnish concentrations emerging in what eventually would become Oulu Township. During the late 1880s Finns also established themselves in the City of Superior and in various communities along Iron County's Gogebic Range (Hurley, Montreal and Iron Belt). While a large number of the Iron County Finns worked as miners, they often acquired small acreages of land proximate to the mines and engaged in part-time farming. Eventually, larger farms were established just south of Hurley in a relatively extensive area centering upon Van Buskirk and Oma Township.

In the 1890's, other Finns began to purchase land in some Ashland County townships which had been forfeited by the Wisconsin Central Railroad.[10] Situated between Marengo and High Bridge, a large number of the Finns who moved to this area in subsequent years were attracted from both the Michigan and Wisconsin sections of the Gogebic Range. The latter years of the nineteenth century saw another important Finnish colony established at Brantwood and Clifford-Tripoli. With new settlers and land agents touting the virtues of the area, the settlement quickly became one of the fastest growing communities in Finnish-America (Kolehmainen and Hill, 1951).

With the exception of Saxon and Owen-Withee, by 1905 a nucleus had been established for all major Finnish settlements in Wisconsin. In addition to the communities mentioned above, Finns were situated in rural areas around Turtle Lake (Barron County); Florence and Commonwealth (Florence County); Washburn Township, Herbster and Bark Point (Bayfield County); Phelps-Eagle River (Vilas County); and Amberg (Marinette County). During 1902 some Finns began to work in the granite quarries of Red Granite, and in the 1890s and early 1900s a limited migration was underway to the cities of Ashland, Kenosha, Marinette, Merrill, Milwaukee, Racine and Rhinelander.

Once permanent settlements had been established, various institutions were developed by the Finns. Among the first to emerge were the churches, with three Lutheran variants (Suomi Synod, National Lutheran and Apostolic Lutheran) represented in many communities. A rather unique organization which soon developed in several of the older Finnish communities was the temperance society. Often, though not always aligned with church interests, most societies built halls where members could engage in social activities as well as pledge their opposition to demon rum.

When a greater number of politically active Finns moved to the state during the early twentieth century, socialist halls and locals were established in most of Wisconsin's Finnish-American communities. Many of these locals were rather short-lived, but at least twenty-three were initiated between 1905 and 1914 (Kolehmainen and Hill, 1951). A Finnish-sponsored institution with greater longevity, however, has been the consumers' cooperative. In addition to the cooperative wholesale facility located in Superior, some eighteen local cooperative stores and retail outlets were developed by the Finns in Wisconsin prior to World War II. Two stores organized in the Brantwood-Clifford area at the turn of the century even were among the very first consumers' cooperatives developed by Finns in the United States (Alanen, 1975). Although their numbers have dwindled and the original concepts and ideals have changed, the most evident legacy of Finnish institutional activity is provided by the churches and cooperative stores which still can be found in northern Wisconsin.

OULU AND OWEN-WITHEE: A COMPARISON OF TWO FINNISH COMMUNITIES

Oulu Background

As mentioned previously, Finnish settlement in the immediate Oulu area commenced during 1888. Some thirty settlers had claimed homesteads by the turn of the century, but the majority had to purchase their small acreages from private agencies or individuals (Kolehmainen and Hill, 1951). By 1915 the rapid development of Oulu Township[11] had been noted by outside, non-Finnish speaking observers; a highly laudatory article published in the *Wisconson Agriculturist*, for example, observed that Finnish immigrants had cleared the land in a few short years and that Oulu Township already could boast of nine schools, three churches, a socialist hall and a cooperative creamery and store. Stating that the Finnish farmer had a sickening fear of debt and a passion for cleanliness, dairy cows and dynamite (to blast stumps), the writer went on to exclaim:

> We must admit their adaptability to pioneer conditions. They are superior in intelligence, physical strength, patience and persistence. They are self contained and somewhat apart from the rest, but they are the makers of history as it will be written of this new empire.[12]

While the Oulu Township portion of the "new empire" supported close to 1,100 residents by 1920, a steady population decline occurred thereafter (by 1940 there were 910 residents, and by 1970 only 505 persons.) Oulu Township, as such, reflects the agricultural evolution of the entire cutover region. Envisioned as a new frontier for rural settlement at the turn of the century, the cutover was the target for recruitment by private companies and public agencies; special efforts were made to attract European immigrants who, unlike native Americans, ". . . would devote all their time to farming" (Helgeson,1962). Although the Finns persisted in their efforts to a greater extent than other groups, and indeed were still seeking land in the 1920s, many of the newly established farms were abandoned during agricultural recessions; other settlers ceased their efforts once it was recognized that at least twelve to thirteen years of steady effort were required to develop anything even approaching a productive farm (Hartman and Black, 1931).[13] Differences between the bounteous potential of the region as envisioned by the promoter, and reality as encountered by the settler often were quite striking. One account written during 1893, for example, claimed that farm life in the north woods of Wisconsin might not be entirely pleasurable, but neither was it all drudgery. The observer went on to state that by cutting down a few trees, dynamiting the stumps and dropping some seed potatoes into the pits, an "enormous return" would be assured.[14] By way of contrast, the actual back-breaking and slow task of carving out an existence in the cutover region was tellingly stated by an early Finnish settler in the vicinity of Oulu:

> With the snow still in the ground, in the spring, the whole family worked to clear the brush. We cleared out stones and blasted stumps. With the stones and stumps, we built the fence. The second year, we had three acres of potatoes to show the world. Everyone worked as hard as anyone can work (Doby, 1960).

Owen-Withee Background

The movement of Finns into the Owen-Withee area began around 1910, or more than twenty years after the Oulu Township development. Because of this rather late date, these Finns were not able to secure homesteads; however, the sale of land to immigrants in this section of northern Clark County comprises one of the more interesting segments of Wisconsin's Finnish-American settlement history.

After the John S. Owen Lumber Company had harvested most of the marketable timber in the Owen-Withee area, the company's holdings were put up for sale. National advertising campaigns were initiated, and the Owens sought to promote agricultural endeavors on their cutover land by ". . . selling on easy terms to those who gave promise of permanence."[15] One person, however, was responsible for bringing the largest number of Finns to Owen-Withee: land agent John A. Pelto. Bilingual agents such as Pelto often were hired by land holding companies, be they railroads, timber operations or speculators, to assist in the disposal of property. Undoubtedly finding it easier and more profitable to sell land to their foreign-born counterparts than to clear and farm the soil themselves, the agents used their powers of persuasion and hyperbole to entice settlers. Pelto, acting as an agent for the Owen Company, placed large advertisements in Finnish-American newspapers and journals which exclaimed: "Become a farmer in a place where there are possibilities—Owen, Wisconsin. . ." (Fig. 2). The ads praised the

FIGURE 2. Tulkaa Farmareiksi—"Become a Farmer" Ads such as this, praising the attributes and agricultural potential of the Owen-Withee area in Wisconsin, appeared in many Finnish language newspapers during the second decade of the twentieth century. Source: *Pelto ja Koti* (Superior, Wis.), March 1, 1917

area's level terrain and the ease with which land could be cleared and planted; the five railroad connections which made the community something more than just a "backwoods" location; the eighteen cheese factories located within a distance of twelve miles; the pickle factory, creameries, good roads and schools; and the expanding Finnish community itself. All of this, Pelto pointed out, was available for prices which began at fifteen dollars an acre.

Many Finns could not resist such mellifluous phrases and by 1920 Clark County contained a Finnish-born population of about 280 residents. Situated along the southern rim of the cutover area, the agricultural attributes of the "Clover Belt" did indeed prove to be significantly better than in Finnish settlement areas farther to the north. Despite such agricultural advantages, the arduous task of removing stumps and clearing fields still awaited the first settlers. One articulate second generation Finnish-American, for example, recalled that when her father was clearing land, he sometimes would stop work, wipe his brow, shake his fist in the air and shout: *Tämäkö on Pellon Jussin Amerika!* ("So this is John Pelto's America!"). Nevertheless, once land clearing had been accomplished and full-scale farming established, the Owen-Withee settlement emerged as the most prosperous of Wisconsin's larger Finnish communities. Although curses and vitriolic comments often were directed at land agents, in the Owen-Withee area John Pelto apparently had ". . . endeared himself in the hearts of his countrymen" (Kolehmainen and Hill, 1951).

Finnish Backgrounds of Oulu and Owen-Withee Residents

Recent studies by other investigators have sought to determine whether certain foreign-born groups (primarily Swedes) that settled in the Midwest formed culturally homogeneous enclaves (Ostegren, 1973; Rice, 1973). The studies have shown that at least in some cases, immigrants from relatively contained areas of Sweden did develop identifiable settlements in America; this, in turn, indicates that such immigrants undoubtedly shared a particular cultural uniqueness and heritage. Large-scale Swedish emigration to America, of course, began at an earlier date than did major Finnish migration; hence, many Swedes (and other early immigrant groups) were able to settle directly in America on inexpensive and often fertile land. Very few Finns could partake of these opportunities. Not only did the later arrival date mean that

Finnish agricultural endeavors were limited primarily to the nation's cutover region, but a large number of Finns from all areas of their homeland first intermixed in mining and other areas of the United States. Thus, the direct transfer of people from individual Finnish communes to specific American areas was very uncommon.

In spite of these conditions, it still was possible that some Finns formed relatively homogeneous enclaves in America—even after they had lived in this country for some time. Such occurrences would have been more likely during the nineteenth century when some homesteads still were available and when a number of immigrants from specific Finnish areas could have selected contiguous or proximate areas of land. Since few homesteads with any agricultural potential were available after 1900, it could be hypothesized that Finnish-American settlements formed after this date would represent a much broader geographic cross-section of the Finnish population spectrum.[16]

To explore these hypotheses in a preliminary manner, the Finnish birthfields for a sample of Oulu and Owen-Withee residents were investigated. Samples from both communities have been used, since there is no complete record of all Finns who moved to or resided in the two communities. Most information was derived from church records, especially those of the Suomi Synod, the American transplant of the Finnish State Church. Although the quantity and accuracy of information varied from congregation to congregation, the records of American Suomi Synod churches were relatively analogous to the meticulous church files maintained in Finland. The records used in this study generally included the date and place of birth, baptism, confirmation and marriage; date of arrival in America and the local community; and former place of residence in America. However, rather few of the professionally trained National Lutheran's clergy and certainly very few of the Apostolic Lutheran's lay ministry were thoroughly acquainted with the record keeping systems; hence, much less information could be derived for members of these two church bodies. In addition, it must be pointed out that many Finnish immigrants, especially during the post-1900 era when there was an array of political and other groups from which to choose, did not join any church (Kero, 1975).

Given these limitations, it was necessary to seek information other than ecclesiastical. Some secondary documents (e.g., Ilmonen, 1926) did provide data, but the most useful additional information was supplied by second generation Finnish-Americans living in

Oulu and Owen-Withee. By combining the information from these various sources, it was possible to develop complete or partial background data on 106 adult Finns in Oulu and 113 in Owen-Withee. The years covered by the samples were between 1889-1929 for Oulu and from 1911-1928 for Owen-Withee.

A large proportion of Oulu Township's population left their homeland during relatively early stages of Finnish emigration; hence, the greatest number of the township's Finnish-born residents came from the two provinces which sent the largest number of emigrants to America: Vaasa and Oulu.[17] Two birthfields are indicated: one, a rather widely dispersed area (radius=62 km), centering on Lapua, Kauhava and several adjacent communes in the Province of Vaasa, and the other, a much more concentrated pattern (radius=35 km), focusing on the communes of Lohtaja, Kalajoki and Alavieska in the Province of Oulu (Fig. 3). Thirty-four percent of the immigrants considered in the Oulu Township sample came from the former birthfield, and twenty-eight percent from the latter. It must be noted, however, that the birthfield in Vaasa Province served as the point of departure for twelve percent of all Finnish emigrés to America; whereas that in Oulu Province was under one percent.[18] Although the largest number of residents in the Oulu Township sample came from these two general areas of Finland, undoubtedly those born in the three communes of Oulu Province formed the township's most homogeneous group.

For the place of birth for Finns in the Owen-Withee sample, the geographic dispersion is much greater (Fig. 4). The majority were born in the western area of the country, but this pattern also reflects the overall Finnish emigration picture. Some Owen-Withee residents, however, hailed from other areas of Finland, indicating, of course, that some emigrated at a later date than did their Oulu Township counterparts. As hypothesized before, it seems unlikely that Finnish-American enclaves formed after 1900 had any major linkages with specific communal areas in Finland.

Migration within America to Oulu and Owen-Withee

Regardless of the rural area they eventually selected in the United States, virtually all Finns had to work at other occupations in the New World before they could secure the means to purchase land.[19] As stated previously, factors such as dangerous employment and labor unrest and conflict in the mining areas contributed to this

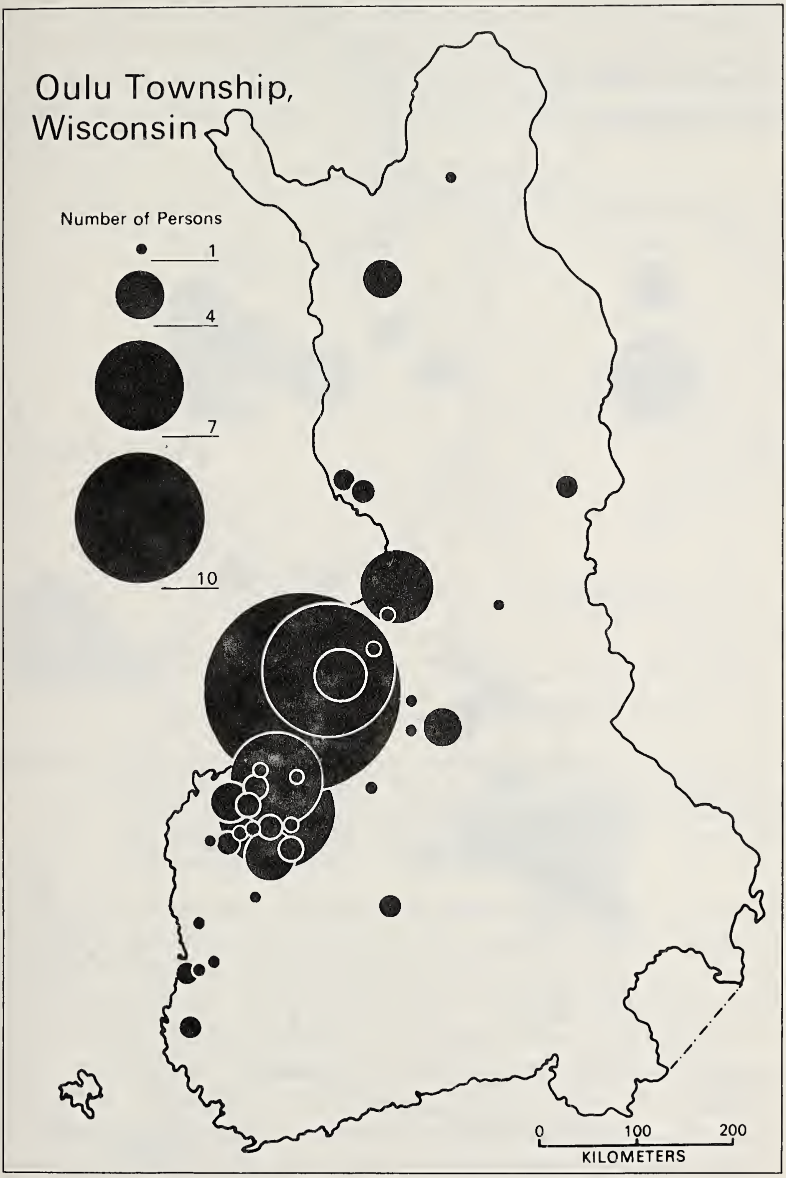

FIGURE 3. Place of Birth in Finland for Oulu Township Immigrants. The largest number of immigrants came from a grouping of communes in the two adjacent Finnish provinces of Oulu and Vaasa. Sources: Church Records, Ilmonen (1926), *Historical Sketches of the Town of Oulu,* and Personal Interviews

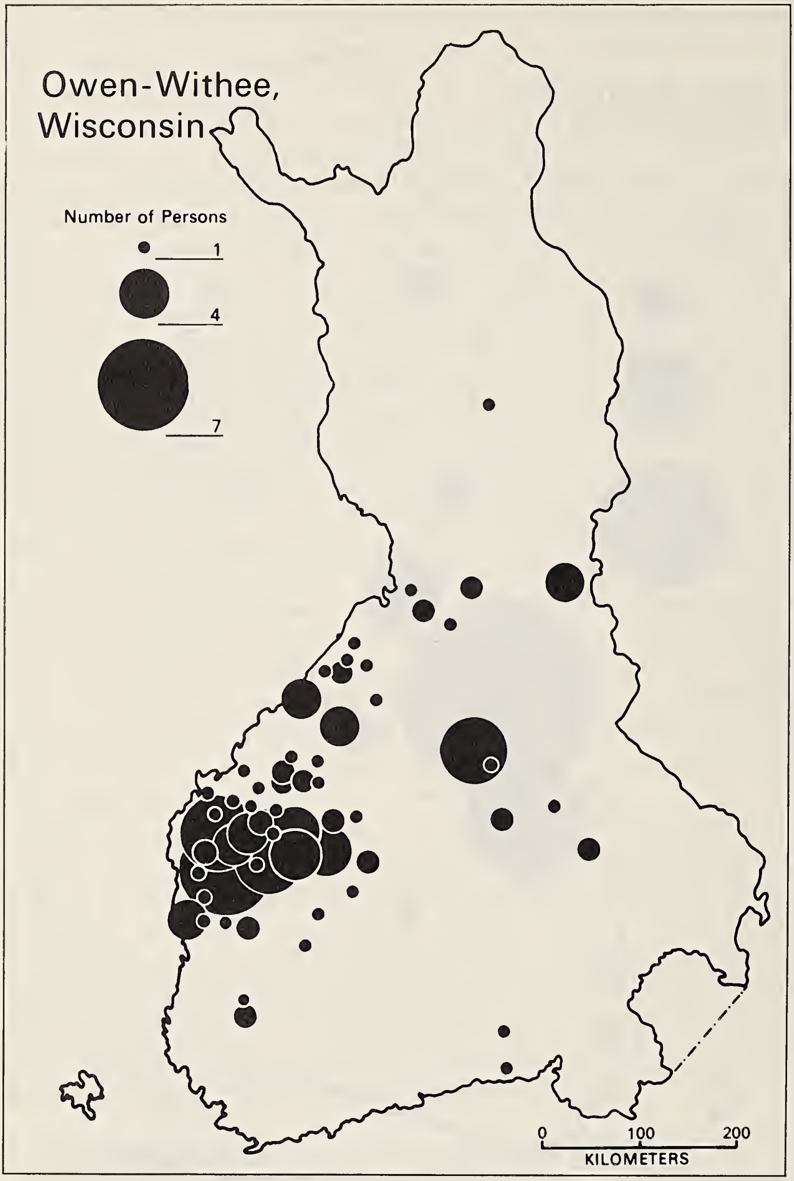

FIGURE 4. Place of Birth in Finland for Owen-Withee Immigrants. Settled at a later date than Oulu Township, the immigrants who established themselves in the Owen-Withee area came from a relatively wide area of Finland. Sources: Church Records, Ilmonen (1926), and Personal Interviews

back-to-the-land phenomenon. Although the movements considered in this study are based upon population samples only, the migration of Finns to Oulu and Owen-Withee does depict two representative threads in a much larger Finnish-American settlement fabric (Figs. 5, 6, 7).

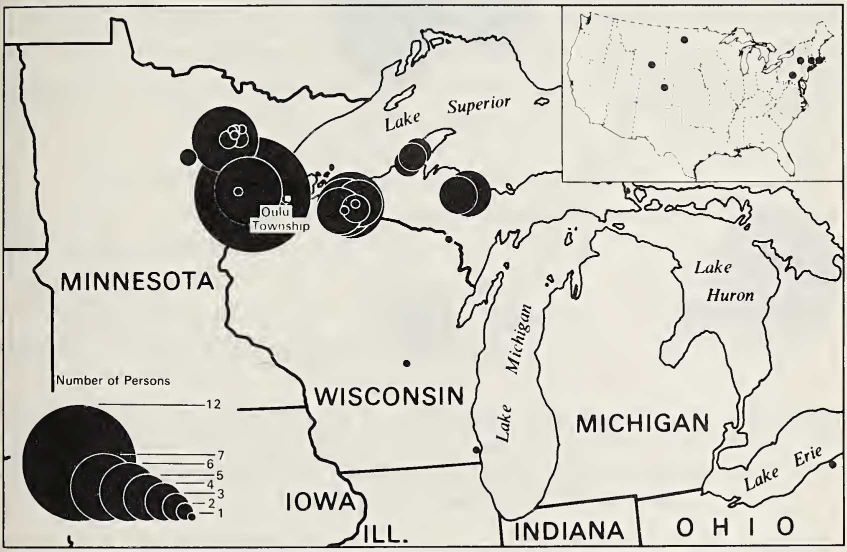

FIGURE 5. Prior American Residence of Finnish-Born Residents in Oulu Township, 1889-1929. The largest number of Finns who moved to Oulu Township came from the Gogebic Iron Range of Wisconsin and Michigan and from Northeastern Minnesota. Sources: See Fig. 3.

As could be expected, the greatest number of Finns who moved to Oulu and Owen-Withee came from the mining districts of the Lake Superior area. The magnitude and timing of the moves, however, varied significantly. During the early years of settlement in Oulu Township the largest number migrated from the Gogebic Iron Range, with lesser numbers coming from Michigan's Copper County and Marquette Iron Range. At the turn of the century, migration from the iron mining districts of Michigan continues, but was supplemented by an approximately equivalent number of arrivals from Minnesota. Many of the Minnesotans came from the Mesabi Iron Range, although several individuals migrated from the large Finnish colony centered in Duluth. During this entire period, a small but steady stream of land seekers also emanated from Superior; and a few from New England, Pennsylvania, Ohio, some

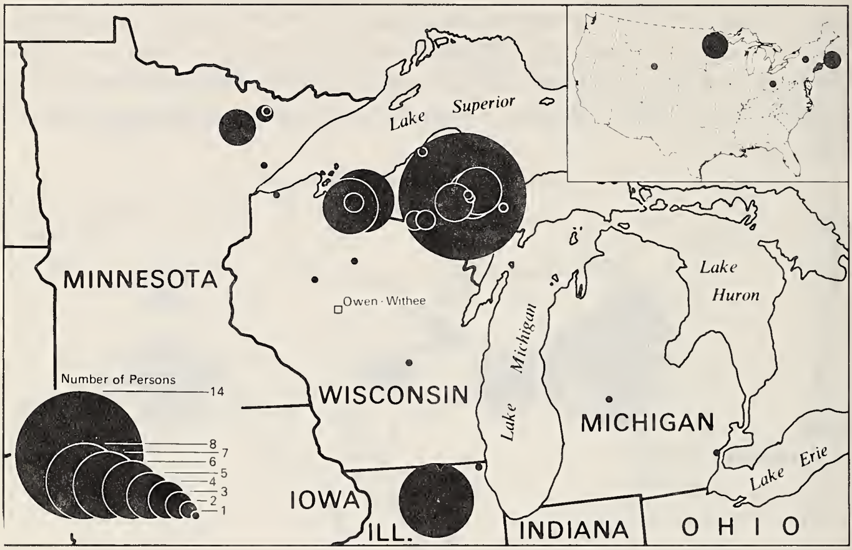

FIGURE 6. Prior American Residence of Finnish-Born Residents in the Owen-Withee Area, 1911-1928. Before moving to the Owen-Withee area, many Finns lived in Northern Michigan and DeKalb, Illinois. Sources: See Fig. 4

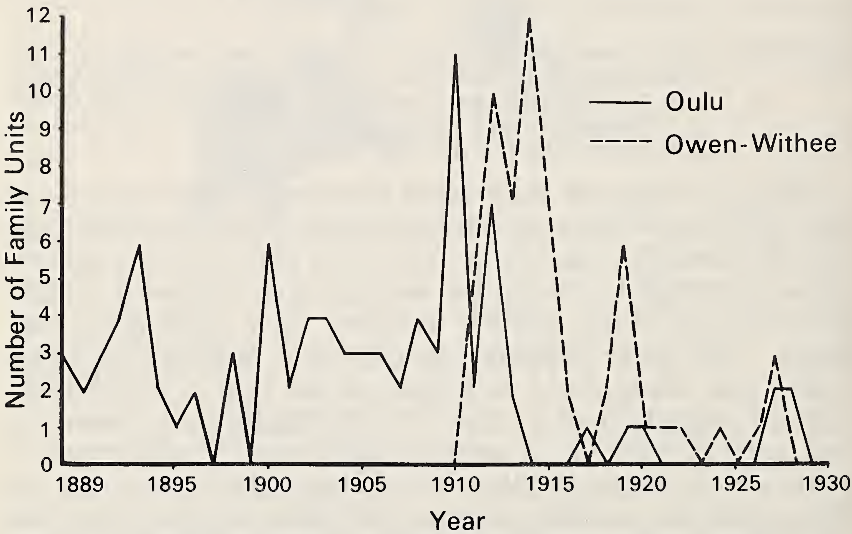

FIGURE 7. Number of Finnish Family Units Migrating Annually to Oulu Township and the Owen-Withee area, 1889-1929. Sources: See Figs. 3 and 4.

of the western states and a few Wisconsin communities. Overall there was a rather constant stream of Finns moving from Michigan to Oulu Township between 1889 and 1914. Migration from Minnesota, however, peaked during the years following the 1906 Mesabi Strike; of the twenty Minnesota Finns counted in the sample, more than one half arrived during the 1906-1910 interim.

When considering the previous American residence of Finns who moved to Owen-Withee, it is clear that the vast majority came from northern Michigan. Most of these individuals settled in the area during the 1911-1919 interim, the period of greatest sales promotion by the Owen Lumber Company and land agent John Pelto. As with Oulu Township, a significant amount of migration originated in the Gogebic Range with the greatest number coming from Wakefield, and from the Marquette Range city of Ishpeming. When compared to Oulu Township, the number of Finns arriving from Minnesota was much smaller. Although some migrated from Sparta, Ely and a few other Minnesota settlements, the availability of cutover lands in their home state undoubtedly lessened land hunger for Wisconsin property. One community outside the normal purview of Finnish-America, however, did contribute substantially to the Owen-Withee total: DeKalb, Illinois. Unlike urban Finns in Milwaukee, Kenosha and Racine who never were enticed to leave their relatively high paying industrial jobs for rural areas, a rather large proportion of DeKalb's Finnish-American community heeded John Pelto's clarion call: "Become a farmer. . ."

The timing of migration to Owen-Withee requires final mention. Migration activities peaked during 1914, the year of Pelto's most extensive promotional efforts; however, this also was the year following the Michigan Copper Country Strike. While it might have been expected that many jobless Finns in the Copper Country would migrate to Owen-Withee, relatively few individuals considered in this study chose this course of action.[20] Instead, it was Finns from the Marquette Range who most vigorously sought land in the Owen-Withee area. It is still possible, nevertheless, that the migration decisions of several Marquette Range inhabitants were influenced by the conflict and carnage which occurred throughout the Copper Country during 1913 and 1914.

CONCLUSION

Whether analyzed as an individual experience or as a collective phenomenon, the migration process generally involves a complex web of social, economic, political and/or psychological variables. The migration regimen for many Finns who moved to the Upper Midwest consisted of two major phases. The first involved the journey from Finland to America, followed immediately by a period of employment in one or more communities or areas.[21] The second phase occurred when the Finns left the mines, lumber camps and urban areas to pursue life as farmers, primarily in the cutover region. Whether this move was undertaken voluntarily or under duress, the settlement and institutional activities of these individuals constituted a distinguishing feature of the Finnish experience in America.

Given the amount of information available, it appears that the origins of a significant number of Oulu Township's settlers can be traced to two general areas or birthfields in Finland. Since the birthfield located in the Province of Vaasa was a major area for many Finnish emigrants, other Finnish-American settlements also claim significant numbers of residents coming from this area of the homeland. However, the other birthfield, focusing upon three communes in the Province of Oulu, sent a larger proportion of its emigrés to Oulu Township than might have been anticipated. The source area pattern for the Owen-Withee community, on the other hand, was much more dispersed and reflected the broader geographic base which characterized general Finnish migration during the early twentieth century.

Before too much is made of the seemingly homogeneous group that settled in Oulu Township, further work should be undertaken in other early Finnish-American settlements. It is possible that the transfer of cultural traits (e.g., architecture, cuisine, dialects, etc.) might be studied more effectively if the specific communal or home area of the immigrants is known and considered. Nevertheless, many distinguishing cultural traits and nuances undoubtedly blended together or were modified in some way once Finns came in contact with large numbers of other Finnish natives, other immigrant groups and Americans. As has been pointed out by several observers (e.g., Jaatinen, 1972), most rural Finnish communities in America were distinguished by their overall cultural cohesion and homogeneity. Seeking ". . .to create permanency amidst an impermanent environment" (Kaups, 1975), many Finns, regardless of their place of origin in Finland or political persuasion in America, participated collectively in the development of rural communities within a new and sometimes hostile land.

NOTATIONS

1. This quote, describing conditions in Northern Michigan, has been attributed to J. H. Jasberg, an effervescent Finnish land agent who was active throughout the Lake Superior area (Wargelin, 1924).
2. These figures, and those for Michigan and Minnesota, have been derived from the Federal Censuses for 1900 and 1920. Any numerical ranking of the total foreign-born population by country of birth or ethnic background has to be undertaken with a great deal of caution. During 1900, for example, Poles were listed by their place of birth: Austria, Germany, Russia or unknown. Canadians, on the other hand, were divided into French and English speaking groups. Although often thought to be an ethnically homogeneous group, the Finns were distinguished on the basis of their native or mother tongue. In 1920, about 12 percent of the Finnish-born population listed Swedish as their mother tongue, and just under one percent claimed Lappish and other languages; the remainder were Finnish speakers.
3. The name of the Central Cooperative Exchange was changed to the Central Cooperative Wholesale in 1930 and to Central Cooperatives, Inc., during 1956.
4. *1964 Yearbook, Central Cooperatives, Inc.* (Superior, Wis: Midland Cooperatives, Inc., 1964), p. 37.
5. Whereas the *sauna* has become a popular institution in America, the *riihi*—a building for the drying, threshing and winnowing of grain—is less well known. For lucid descriptions of these two vernacular building types see Kaups (1972; 1976).
6. Although the Finn who acquired a homestead could claim up to 160 acres of land, many did not; the majority bought 40 to 80 acre parcels from land agents, land companies and other parties.
7. Finland was a Grand Duchy of Russia from 1809 to 1917.
8. *Duluth News Tribune*, March 4, 1907, p. 5.
9. One account of early settlement in the area reported the exploits of two Finns who dragged a sled, ladened with a heavy stove, from Superior to Lakeside Township during the dead of winter. A severe blizzard slowed them down, whereupon they were forced to spend the entire night making tracks through the snow so the stove would not tip off the sled when they pulled it (Aine, 1938).

10. For a description of the land fever which gripped Ashland during this period, see the account in the "Annual Edition" of the *Ashland Daily Press*, May 1893, p. 88.
11. Oulu Township was organized and named largely through the efforts of Andrew Lauri, a tailor born in Finland's Oulu Province. Since local residents felt that Bayfield County officials did not devote enough time and money to the western area of the county, they petitioned to form their own township. After some procrastination by the County Board, Oulu Township was organized in December 1904, with Andrew Lauri serving as the first chairman. See *Historical Sketches of the Town of Oulu: Bayfield County, Wisconsin, 1880-1956* (Oulu, Wis.: Sunnyside Homemakers' Club, 1956); and *Amerikan Uutiset* (New York Mills, Minn.), Sept. 10, 1976, p.4.
12. "Our Most Thickly Populated Township," *Wisconsin Agriculturist*, Vol. 39 (Feb. 1915), p. 8.
13. For a broader summary of agricultural conditions in the cutover region and Oulu Township, I am indebted to R. Zeitlin's "The Rankinen House," unpublished manuscript prepared for the Old World Wisconsin Research Office (Madison: State Historical Society of Wisconsin), Oct. 26, 1976.
14. "Annual Edition," *Ashland Daily Press*, May 1893, p. 88.
15. *The Book of the Years: The Story of the Men who Made Clark County* (Neillsville, Wis.: Clark County Press, 1953), p. 23.
16. Also, emigration activity was more extensive throughout Finland during the post-1900 period.
17. Between 1870 and 1914, approximately 16 percent of all Finnish immigrants came from the Province of Oulu and 49 percent from the Province of Vaasa (Kero, 1974).
18. The overall figures for the communes have been derived from Appendix A of Kero (1974).
19. Of the individuals considered in the two samples, only three males and three females came directly from Finland to Oulu Township; and one male and one female made the direct crossing to Owen-Withee.
20. During and after the strike, a large number of Finns from the Copper Country moved to Detroit and rural areas of Michigan (Holmio, 1967).
21. A striking facet of Finnish-American settlement was the rather considerable amount of geographic mobility displayed by many immigrants. These moves were not undertaken randomly, however, for a communications system consisting of letters,

newspapers and person-to-person contacts directed Finns to new areas and employment opportunities in America.

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GROWTH PATTERNS, FOOD HABITS AND SEASONAL DEPTH DISTRIBUTION OF YELLOW PERCH IN SOUTHWESTERN LAKE MICHIGAN

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ABSTRACT

Yellow perch, *Perca flavescens* (Mitchill), entered shallow water (9 m) about June and spent the remainder of the summer there. About the month of October they moved to water of intermediate depth (18 - 27 m) where they spent the winter. The summer diet of adult yellow perch consisted principally of slimy sculpins, *Cottus cognatus* (55% by volume) and alewives, *Alosa pseudoharengus* (43% by volume). Perch grew to the following average total lengths during their first seven years of life: 77, 138, 175, 200, 228, 247 and 269 mm.

INTRODUCTION

The yellow perch, *Perca flavescens* (Mitchill), is important to both commercial and sport fishermen of Lake Michigan. It is a native of Lake Michigan and at one time was very abundant.

Previous researchers have studied various aspects of the ecology of the yellow perch in the Great Lakes including their distribution (Wells 1968; Smith 1968), food habits (Ewers 1933; Price 1963; Brazo 1973; Rasmussen 1973), and growth patterns (Hile and Jobes 1941 and 1942; Jobes 1952; Joeris 1957; El-Zarka 1959).

Specific objectives of the following study included the determination of their seasonal depth distribution, their food habits, and their growth patterns.

METHODS

This study was performed in the southwestern portion of Lake Michigan just north of the Milwaukee harbor. Four collection transects were established from which yellow perch were taken between May, 1974 and April, 1975. Data from these transects were combined for all calculations.

All yellow perch were collected in 152 x 2 m experimental gill nets of mesh sizes 1.27, 1.90, 2.54, 3.81 and 5.08 cm. Each mesh panel was 30.5 m long. Starting in May, 1974, three gill nets were simultaneously set on one of the four collecting transects. The nets were anchored to the bottom in 9, 18, and 37 m of water, approximately 0.8, 1.6 and 6.4 km from shore respectively. Beginning in August, 1974, two additional nets, one at 14 m deep (1.2 km from shore) and one at 27 m deep (3.2 km from shore), were set with each collection. In general the nets were set at about 1400 hr and pulled at about 0900 hr the following day.

Catch per unit effort in terms of yellow perch collected per net-hour was calculated by dividing the number of yellow perch captured in a given net by the number of hours required to make the catch.

Each fish collected was weighed to the nearest tenth of a gram and its length measured to the nearest millimeter. Scales were taken from the area below the spiny portion of the dorsal fin and above the lateral line. Stomachs were removed and preserved in 10% formalin.

All yellow perch used in the food habits portion of this study were obtained between the months of May and September, 1974, and were in at least their second season of growth. An actual count of all invertebrates ingested was made and their volume determined by water displacement.

Fish found in the yellow perch stomachs which could not be immediately identified or measured to standard length were placed in KOH, stained with alizarin-red and preserved in glycerine. The original length of the prey species (alewife or slimy sculpin), before ingestion, was then reconstructed from the known lengths of the skeletal portions still intact. Measurements of whole skeletons showed 20% of the alewife standard length to consist of the head. Seventy-five percent of the alewife standard length was occupied by the 47 vertebrae. The remaining 5% of the alewife standard length consisted of the urostyle. Similar measurements for slimy sculpins showed the head to occupy 25% of the standard length, the 31 vertebrae to occupy 65% of the standard length and the urostyle to occupy the remaining 10% of the standard length.

Volume vs length curves for alewives and slimy sculpins were generated from whole specimens and used to assign a volume for each reconstructed prey length. This procedure permitted direct comparison between the original volumes of the ingested prey species without having to compensate for differential digestion rates.

Several scales from each specimen were cleaned, mounted and read twice at a magnification of 42X. Growth with age was then calculated from the annuli measurements, according to the following proportion $L_i = (S_i)(L_t)/(S_t)$ where L_i = the calculated total length of the fish at the time of the formation of the ith annulus; S_i = the distance from the focus to the ith annulus; L_t = the total length of the fish; and S_t = the length of the whole scale from focus to posterior margin.

In temperate waters yellow perch complete 100% of the season's growth by November (Jobes 1952). Therefore, fish captured between 1 January and the formation of a new annulus were credited with an annulus at the edge of their scales. As observed in other waters (Jobes 1952; Joeris 1957) most yellow perch of southwestern Lake Michigan added a new annulus during the months of June and July.

Coefficients of condition by age and sex were calculated according to the formula $K = (10^5)(W)/(L^3)$ where K = the coefficient of condtion; W = weight in grams; and L = the total length in millimeters.

The parameters "a" and "b" of the length-weight relationship, $W = (a)(L^b)$, were estimated by the method of least squares from the log form of the equation, $\log W = \log a + (b)(\log L)$. In the above equation W = weight in grams and L = total length in millimeters.

Distribution

Of the 714 yellow perch captured in this study, 698 were taken in water depths of 18 m or less. The preferred water depth for the yellow perch captured in this study was water of shallow to intermediate depth.

The seasonal depth distribution of yellow perch followed a definite pattern as determined from catch statistics (Table 1). Between the months of October and March they were more readily captured in water 18 m deep than in shallower waters of 9 or 14 m. In May and June they moved from intermediate depths (18 m) to shallow depths (9 m). Between the months of May and September the highest catch per unit effort figures were registered in water 9 m deep. The main outward movement of yellow perch in the fall took place in the month of October.

A summer preference for shallow water and a winter preference

TABLE 1. CATCH PER UNIT EFFORT IN TERMS OF NUMBERS OF PERCH CAPTURED PER NET-HOUR IN EXPERIMENTAL GILL NETS FROM MAY, 1974, TO APRIL, 1975, IN SOUTHWESTERN LAKE MICHIGAN.

	Depth of Collection				
	9 m	14 m	18 m	27 m	37 m
1974					
May	0.54		0.28		0.01
June	2.69		0.18		0
July	1.90		0.10		0
August	0.49	0.29	0	0.01	0
September	0.62	0.38	0.04	0	0
October	0.01	0.31	0.72	0.06	0
November	0	0.08	0.22	0	0
1975					
January	0	0	0.38	0	0
February	0	0.10	0.15	0	0
March	0.03	0.08	0.13	0.04	0
April	0.24	0	0	0	0

for deeper water has also been observed for other species of Lake Michigan fish (Wells 1968). Wells suggested that fish may move into deeper water in the winter because they seek the warmer temperatures found there. Such a mechanism may also obtain for the movement of yellow perch to even deeper water in the winter.

Food Habits

Only 111 of the 531 yellow perch stomachs examined in this study contained food. The other stomachs were either empty or had regurgitated their contents during capture of the fish.

An examination of those stomachs containing food indicated that adult yellow perch in southwestern Lake Michigan were very piscivorous. Ninety-eight percent of the reconstructed volume of the stomach contents consisted of either slimy sculpins, *Cottus cognatus* (55%), or alewives, *Alosa pseudoharengus* (43%), (Table 2).

TABLE 2. SUMMER DIET OF 111 ADULT YELLOW PERCH TAKEN FROM SOUTHWESTERN LAKE MICHIGAN.

Food Item	Frequency of Occurrence	% total volume (Reconstructed)	% by Number %	% by Number No. Found
Sculpins *(Cottus cognatus)*	48% (53 stomachs)	55%	76%	103
Alewives *(Alosa pseudoharengus)*	29% (32 stomachs)*	43%	23%	31**
Other	35% (38 stomachs)	2%	NA	NA

*Includes stomachs in which the only means of alewife identification was scales.

**Does not include stomachs in which the only means of alewife identification was scales.

By number, 76% of the forage fish found in yellow perch stomachs were slimy sculpins, and alewives 23%. One ninespine stickleback, *Pungitius pungitius*, was also found. Slimy sculpins occurred in 48% of all stomachs containing food whereas alewives occurred in 29% of the stomachs.

Only 2% of the reconstructed volume of the stomach contents consisted of food other than slimy sculpins or alewives. That 2% contained the following items: (1) larval insects (0.76% total volume) — mostly caddis flies of the family Phryganeidae, also midge larvae and several unidentifiable species of insect larvae; (2) fish eggs (0.60% by volume) — mostly alewife; (3) cladocera (0.37%); (4) unidentifiable fish remains (0.17%); (5) one ninespine stickleback (0.10%).

Although food other than slimy sculpins and alewives represented only a small portion by volume of the stomach contents it did occur in 35% of the 111 stomachs containing food and therefore accounted for a considerable portion of the forage activity.

The diet of male yellow perch differed somewhat from the diet of female yellow perch, although not statistically significant at $\alpha = 0.05$, (Table 3). A rather high percentage (48%) of the females with food in their stomachs had consumed alewives. Only 24% of the

TABLE 3. FREQUENCY OF STOMACHS CONTAINING VARIOUS FOOD ITEMS IN THE SUMMER DIET OF ADULT YELLOW PERCH IN SOUTHWESTERN LAKE MICHIGAN. THE DIET IS SPECIFIED BY SEX, DEPTH OF COLLECTION AND MONTH OF COLLECTION.

		Number of stomachs in which the specified food item was observed				
	Number of Stomachs	Sculpins	Alewives	Other**	Sculpins & Other**	Alewives & Other**
Males	82	35	18	20	7	2
Females*	21	7	10	3	1	0
Sex unknown	7	1	1	4	1	0
30 ft water	96	37	28	22	7	2
45 ft water	5	4	0	1	0	0
60 ft water	9	2	1	4	2	0
May	10	2	5	3	0	0
June	24	5	11	8	0	0
July	45	24	5	11	4	1
August	10	4	1	2	2	1
September	21	8	7	3	3	0

*The stomach of one female perch taken from 30 ft of water in June contained both sculpins and alewives. For the purpose of statistical analysis it was omitted from this table.

**"Other" refers to all food items other than sculpins and alewives.

males had alewives in their stomachs. The higher female utilization of alewives could be caused by several factors. The females grow faster than the males and at an earlier point in life could prey on alewives, which on the average are larger than sculpins. Also the possibility exists that female yellow perch are more pelagic than males (Rasmussen 1973) and therefore more free to prey on alewives (a pelagic species) than on sculpins (a bottom-dwelling species).

Since the introduction of the alewife into Lake Michigan in 1949 and its subsequent dominance of the lake, the yellow perch fishery has declined. The synchronous timing of the rise of the alewife and the fall of the yellow perch suggests a possible relationship between the two events. However, data from this study indicates little, if any, interaction for food between adult yellow perch and alewives. It is my opinion that any study seeking to identify mechanisms of perch-alewife competition in Lake Michigan should include some work on the food habits and distribution of young yellow perch.

Growth Patterns

The calculated total lengths by sex and year class for yellow perch in southwestern Lake Michigan are shown in Table 4. The most

TABLE 4. AVERAGE CALCULATED TOTAL LENGTHS IN MILLIMETERS AT END OF EACH YEAR OF LIFE FOR SEVEN YEAR CLASSES OF SOUTHWESTERN LAKE MICHIGAN YELLOW PERCH.

Year	Sex	No. of Specimens	Age in Yr. 1	2	3	4	5	6	7
(Age 1)	M	5	111						
1973	F	0	-						
	C*	8	106						
(Age 2)	M	14	76	140					
1972	F	8	116	157					
	C	27	84	144					
(Age 3)	M	45	75	138	174				
1971	F	23	105	157	190				
	C	70	86	145	180				
(Age 4)	M	57	69	134	170	198			
1970	F	14	77	138	175	200			
	C	74	70	135	171	198			
(Age 5)	M	17	62	128	173	199	224		
1969	F	11	73	136	182	211	234		
	C	30	67	131	176	204	228		
(Age 6)	M	4	59	118	164	195	217	236	
1968	F	9	71	128	176	208	231	250	
	C	13	67	125	172	204	227	246	
(Age 7)	M	0	-	-	-	-	-	-	-
1967	F	4	64	131	168	202	229	251	269
	C	4	64	131	168	202	229	251	269
	M	142	72	135	172	198	222	236	-
GRAND	F	69	88	144	182	205	232	250	269
AVERAGES	C	226	77	138	175	200	228	247	269

*"C" refers to all specimens combined and includes males, females, and fish whose sex was undetermined.

rapid growth period was the first year of life during which the fish grew to an average total length of 77 mm. The first year's growth represented 31% of the total growth experienced by most specimens in a lifetime (approximately 6 years). In succeeding years growth increments were 25, 15, and av. 9.7% for the 4-5-6 years.

At each year of life females were longer than males, and at all ages less than 6 years the differences in length between males and females were statistically significant for $\alpha = 0.05$. Previous yellow perch studies have also shown females to grow faster than males (Weller 1938; Hile and Jobes 1941 and 1942; Beckman 1949; Carlander 1950; Brazo 1973).

The apparent rapid growth of the young (groups I, II, III) in this study may have resulted from the gill nets selectively capturing the largest (most rapidly growing) of the young perch.

Unlike annual increments in length, the weight increments increased with age (Table 5). A logarithmic increase in weight as length increased can be noted in Fig. 1. Again females showed faster growth than males. The correlation between growth in weight of males and females yielded statistically significant differences ($\alpha = 0.05$) for ages 2, 3, 4 and 5.

TABLE 5. AVERAGE WEIGHTS OF YELLOW PERCH IN SOUTHWESTERN LAKE MICHIGAN.

		Age in Yr.						
Sex		1	2	3	4	5	6	7
Male	No. specimens	5	14	45	57	17	4	0
	Weight (g)	13	44	74	103	142	197	
Female	No. specimens	0	8	23	14	11	9	4
	Weight (g)		82	102	128	216	249	307
Both	No specimens	5	22	68	71	28	13	4
	Weight (g)	13	58	84	108	171	233	307

The parameters "a" and "b" of the length-weight equation, $W = (a)(L^b)$, were estimated by the method of least squares and lead to the following equations. The length-weight equation for males became $W = (5.1076 \times 10^{-6})(L^{3.14})$. For females the equation was $W = (1.1015 \times 10^{-6})(L^{3.44})$. The length-weight equation for males and females combined was $W = (2.1079 \times 10^{-6})(L^{3.31})$.

The coefficients of condition indicated that the sampled yellow perch population in southwestern Lake Michigan was in good

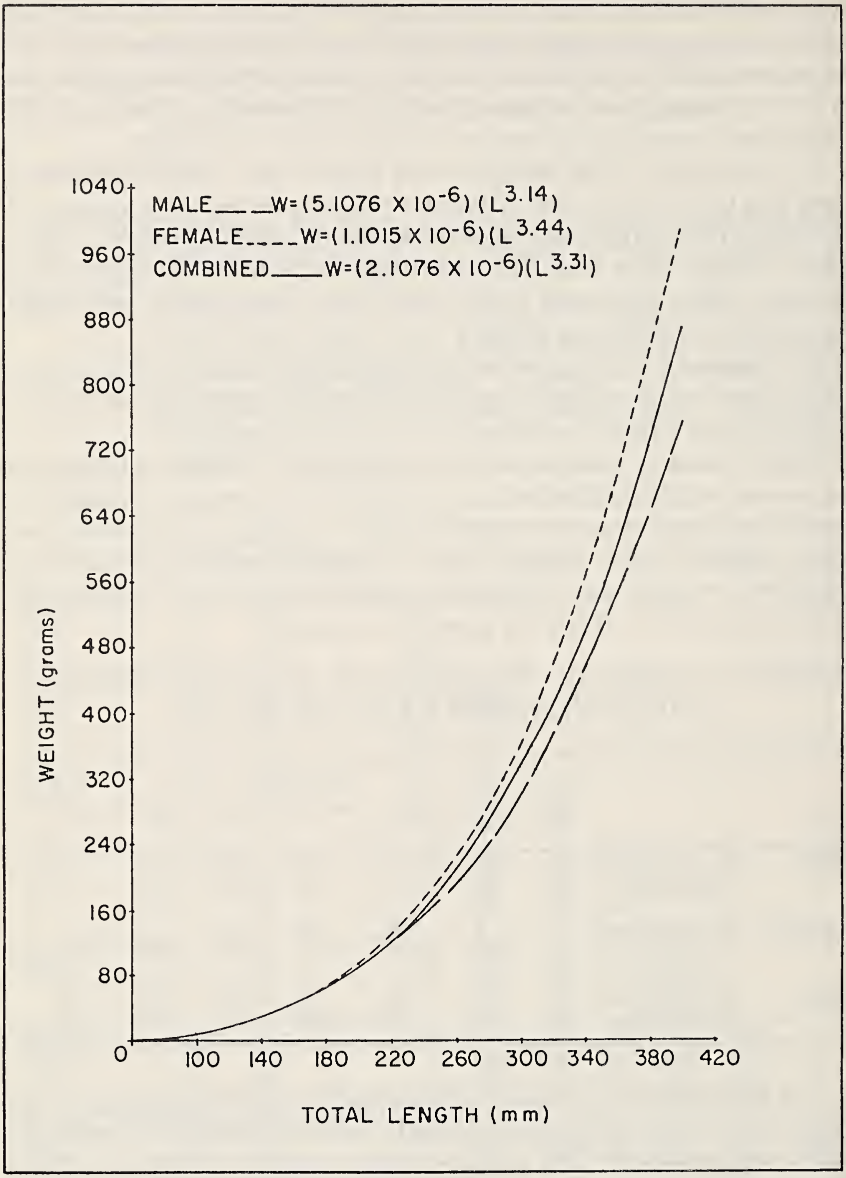

FIGURE 1. Weight as a function of total length for 557 male and 134 female yellow perch from southwestern Lake Michigan.

condition (Table 6). In general, the coefficients of condition for both males and females continued to increase for each successive year of life. Female yellow perch had higher coefficients of condition than males with statistically significant ($\alpha = 0.05$) differences for ages 2 and 5.

TABLE 6. COEFFICIENTS OF CONDITION FOR YELLOW PERCH IN SOUTHWESTERN LAKE MICHIGAN.

		Age in Yr.						
Sex		1	2	3	4	5	6	7
Male	No. of specimens	5	14	45	57	17	4	0
	Coefficient of condition	1.44	1.51	1.68	1.70	1.78	1.92	
Female	No. of specimens	0	8	23	14	11	9	4
	Coefficient of condition		1.73	1.76	1.87	2.15	2.05	2.31

$K = (10^5)(W)/(L^3)$

Of the 691 yellow perch of known sex captured in this study only 134 were females. The sex ratio was 4.16 males for every female. Although yellow perch do have a tendency to develop unbalanced sex ratios, usually the females outnumber the males. Hile and Jobes (1941) noted a 2.96:1 ratio in favor of females. Likewise Carlander (1950), Beckman (1949) and Schneberger (1935) observed the following female-weighted ratios respectively: 1.71:1; 1.56:1 and 1.31:1. Brazo, in a recent study of yellow perch in Lake Michigan (1973), captured more males than females.

A comparison between growth rates from several Lake Michigan yellow perch studies indicated that those observed by Brazo (1973) in eastcentral Lake Michigan grew considerably faster than all others. In terms of both length and weight the yellow perch in eastcentral Lake Michigan grew more rapidly than those in southwestern Lake Michigan. The growth rates observed by Hile and Jobes in 1942 for yellow perch in Green Bay and in northwestern Lake Michigan were somewhat slower than those observed in the present study of southwestern Lake Michigan. For the first five years of growth, yellow perch in southwestern Lake Michigan were longer than those in Green Bay in 1942. For ages above five years the Green Bay yellow perch were longer than those examined in the present study. At all ages the yellow perch in southwestern Lake Michigan were longer than those observed in northwestern Lake Michigan in 1942; however, as in the Green Bay population, the differences in length decreased with age.

SUMMARY AND CONCLUSIONS

The seasonal depth distribution of yellow perch in Lake Michigan followed a definite pattern. In June they entered shallow water (9 m) and remained there until September when they gradually moved to their deeper (18 - 27 m) wintering grounds.

Ninety-eight percent by volume of the summer diet of adult yellow perch in Lake Michigan near Milwaukee consisted of slimy sculpins, *Cottus cognatus* (55%), and alewives, *Alosa pseudo-harengus* 43%). The other 2% included insects, cladocera, fish eggs and other fish.

Yellow perch attained the following average calculated total lengths during their first 7 years of life respectively — 77, 138, 175, 200, 228, 247 and 269 mm. The average weights for the first 7 years of life were 13, 58, 84, 108, 171, 233 and 307 g respectively. Females grew faster than males and lived longer than males. The sex ratio was 4.16 males to every one female.

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STANDING CROP OF BENTHIC INVERTEBRATES OF LAKE WINGRA AND LAKE MENDOTA, WISCONSIN

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ABSTRACT

Significant differences existed in the number and biomass of benthic invertebrates in Lakes Wingra and Mendota. Bottom organisms are highly diversified and more abundant in Lake Mendota than in Lake Wingra. Maximum differences occur in early summer and least differences in August. *Hyalella* was found in Lake Mendota samples but not in Lake Wingra. Chironomid larvae and Mayfly nymphs were caught from both lakes, although numbers and weights were higher in Lake Mendota.

INTRODUCTION

Like other fresh water fishes, bluegills are known to feed on insects and macro-food particles (Scott and Crossman 1973 and Carlander 1973). Thus, studies on benthic macroinvertebrates of Lake Wingra and Lake Mendota will reveal if fish of Lake Wingra feed selectively on microcrustaceans or whether the macrofauna of the lake has been depleted due to the dense fish community. It is also of importance to identify the role which benthic invertebrates of Lake Wingra play on the dynamics of the stunted fish population of the lake.

Study Sites

Lake Wingra and Lake Mendota are located in Dane County near Madison, Wisconsin. Lake Wingra is a relatively shallow lake with an average depth of 3 meters and a surface area of 140 hectares. Lake Mendota is larger with an area of 3938 hectares and a mean depth of 12 meters. Study areas in the two lakes were chosen to have similar depths and substrate structures, described as mostly muddy with few silted areas.

Methods of Collection

Bottom samples were taken with a 15 X 15 cm (225 cm^2) Ekman dredge of standard weight on the same dates (or consecutive dates) on both lakes from late June through August. Twenty samples, every 2 weeks, were collected from Lake Wingra, 4 at each station at north, south, east, west, and middle regions of the lake and at comparable depths as Lake Mendota samples (2 m). In Lake Mendota the bottom samples were taken at 4 stations along a transect from Picnic Point to a distance of about 200 m south along the shore line, at an average depth of about 2 m. Four replicates were collected at each station (50 m apart). Bottom fauna were screened (500 mesh), washed with distilled water, and counted. They were then classified to major taxonomic groups. Dry weights were estimated after the samples were kept for 48 hr at 85C.

RESULTS

Lake Wingra

Maximum number of bottom animals per 225 cm^2 dredge catch was found in mid-July and the minimum number at the end of August (Fig. 1-top). Dry weights followed closely the same pattern, as shown in Fig. 1-bottom. Differences among number of bottom animals caught in mid-June and August were significant. Average number of animals per dredge varied from 8.2 in early July to 2 animals per dredge in late August. Mean numbers of animals found per dredge declined from late June till late August.

Dry weight of bottom organisms of Lake Wingra was significantly low, from July through August. Although few bottom organisms were caught in the dredge, they were relatively large. The benthic collections of Lake Wingra have poorly diversified animal community. Species of the order *Diptera* constituted 95% or more throughout the sampling period. Members of *Ephemeroptera* were seldom found and *Amphipoda* were completely absent. Members of *Diptera* made up 99% of the benthic community in August. Average number per 225 cm^2 dredge varied from 3.5 in mid-August to 2 in late August. The corresponding dry weights were 3.9 and 3.7 mg per 225 cm^2, respectively. Species of *Diptera* made up the collection of benthic organisms in late June and in July. Number of *Diptera* rose sharply from 4.3 organisms per 225 cm^2 in late June to 8.2 animals in mid-July. Similarly, the biomass (dry weight per 225 cm^2) of benthic invertebrates varied from 2.5 mg in late June to an average of 5.2 mg in mid-July.

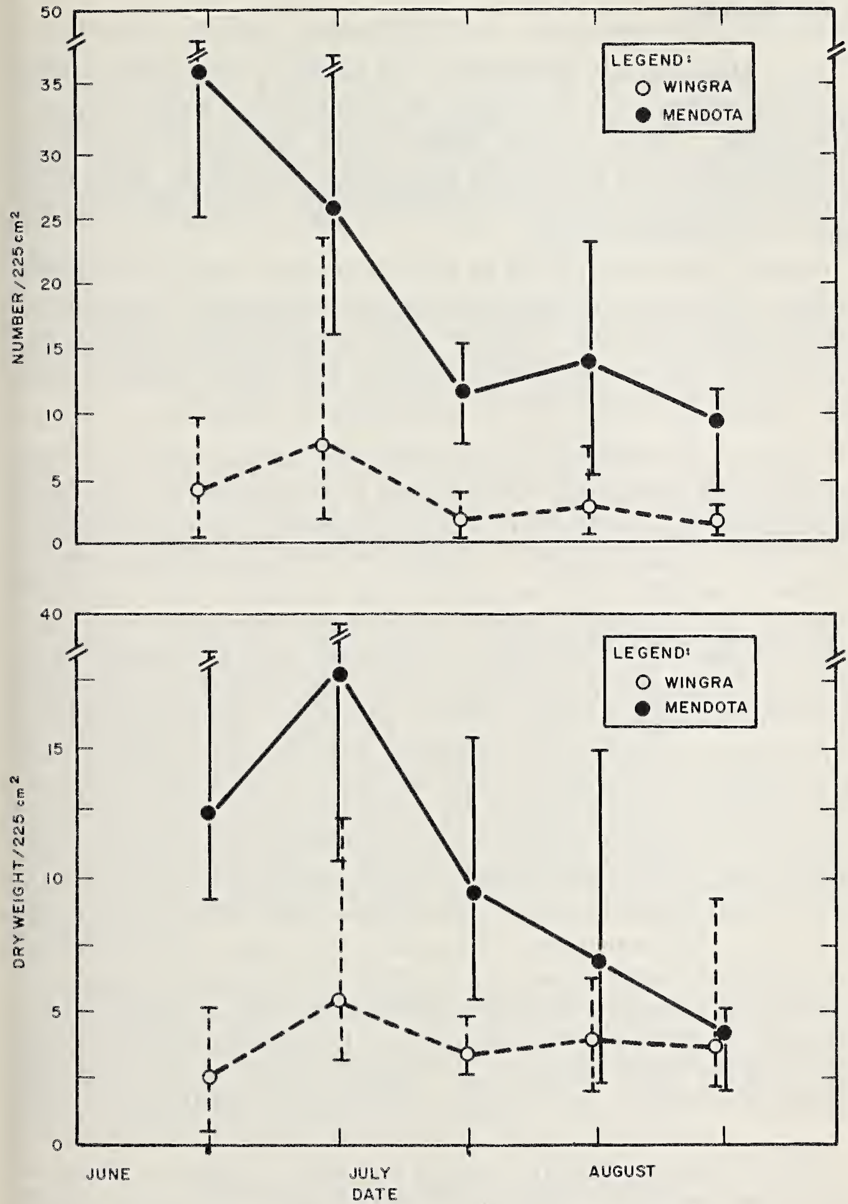

FIGURE 1. Total number (top figure) and total dry weight (bottom figure) in mg of invertebrates caught in 225 cm^2 Ekman dredge from Lake Mendota and Lake Wingra, June-August, 1972. Circles are means of 16-20 samples. Vertical lines are ranges.

Lake Mendota

Lake Mendota can be described as having a highly diversified benthic community. Members of *Amphipoda, Ephemeroptera, Tricoptera, Diptera,* and others were abundant and were represented in the collections at one time or another during the sampling period. Because of such diversity, the data are handled here in a detailed fashion.

Bottom organisms varied in abundance from mid-June through August. Dipterans and ephemeropterans constituted the bulk of the bottom fauna collected. A decline in dry weight of botton organisms per 225 cm^2 from June through August was obvious; the same can be said regarding the number of the organisms (Fig. 1).

Amphipoda. Hyalella sp. in the bottom samples were common, although not substantial. They varied in number from 1.3 animals per 225 cm^2 in June to 4.3 in August. *Hyalella* made up the bulk of the bottom fauna caught in August, with values of about 38% in number and 33% dry weight for all animals. The minimum contribution of *Hyalella* to the bottom fauna was in July when they were 3% and 1.5% of the total number and weight, respectively, of the animals caught per dredge. Data of the bimonthly samples do not show a consistent pattern in the abundance of these animals in the bottom collections. For example, from the second half of June through the end of August values for different samples were highly variable, with variation reaching 43% of the catch in the first half of July, 4.7% at the end of July, 44.2% in mid-August and 30.9% at the end of August. *Hyalella*, therefore, does not contribute significantly to the bottom fauna caught in June or July while it does in the month of August. The low values of *Hyalella* in June may mean that they were really few at this time or it could also be that *Hyalella* associate with the surrounding vegetation rather than settling at the bottom. Buscemi (1961) found few animals in the bottom samples taken from Parvin Lake, while many *Hyalella* were on the overlying vegetation. Similar observations were reported by Mundie (1959).

Ephemeroptera. Mayflies varied in number from an average of 0.5 to 2 animals per dredge and from 0.2 mg to 1.4 mg dry weight. They were available at all times but few animals were caught. They reached a maximum at the end of August with 19.4% of the total catch in terms of numbers and 18.1% in total dry weight. They have their minmum values of 5.4% and 11.1% of total number and weight, respectively, in June. Regarding their abundance, they occupy a third position after *Diptera* and *Amphipoda.*

Odonata and *Tricoptera.* Members of these groups were not significant in the bottom catch of Lake Mendota. *Odonata* make up 1% of the fauna per dredge caught in July and 0.9% of the August catch, while none was caught in June. *Tricoptera* were as scarce as *Odonata.*

Hirudinea. Although abundant in the area (personal observations), few leeches were caught in the dredge. It is possible that these animals were able to avoid the dredge because of their relatively high speed of swimming. None of these organisms was caught in June, while they made up 13.9% of the total number of organisms collected in late July and about 5% in August collections of bottom fauna. Their weights, however, varied from 6.2% to 2.8% of total dry weights of organisms collected per dredge during the same period.

Diptera. Diptera participated significantly in fauna caught throughout the summer. They constituted about 88.9% of total number of animals caught in August. Their weights constituted 75% to 68% of total weight during the same period.

Chironomid larvae comprised about 95% of all the dipterans, the remaining 5% being chironomid pupae. Mean number of chironomid larvae was as high as 33 animals per 225 cm^2 in June, 13 in July and 4.5 in August. It seems obvious that there is a descending trend from June through August which may be related to the time of emergence.

Hydracarina. Water mites, although caught in July and August, were of little importance in the bottom community. They constituted about 1.5% of the total number of bottom organisms in July and 2% in August. Mundie (1959) reported low uniform densities of water mites in all of his bottom catches.

DISCUSSION AND CONCLUSION

Extensive studies conducted on bluegill of Lake Wingra and Lake Mendota (El-Shamy 1976) indicated that fish of Lake Mendota grew faster than fish of Lake Wingra. In the same studies, all size classes of Lake Mendota bluegill were shown to have higher daily rations (food consumption) than those of Lake Wingra. The least differences existed among small fish but there were significant differences for larger fish. When the daily ration of Lake Wingra bluegill was compared to data from the literature, Lake Wingra bluegill showed smaller values than those given by Seaburg and Moyle (1964) and Keast and Welch (1968) for bluegill in other lakes.

Data from stomach analyses of Lake Wingra and Lake Mendota fish revealed the importance of the macroinvertebrates in the bluegill diet. Studies on stomach contents of panfish by other investigators (Buscemi 1961, Etnier 1971, and Baumann 1972) also emphasized the significance of the macroinvertebrates in the diet of the fish. However, stomach analysis of Lake Wingra bluegill revealed their dependence on planktonic organisms throughout the growing season. Measurements of food particles recovered from their stomachs showed an interesting characteristic: small and large fish fed on similar size food particles. In contrast, Lake Mendota fish preyed almost exclusively on benthic macroinvertebrates. They also showed a definite correlation between food particle size and fish size.

It should be emphasized that there is more energy expenditure in catching these small organisms than in catching the large organisms. Therefore, Lake Wingra bluegill actually waste more energy in feeding. Also, large organisms should have less indigestible materials relative to their body weight than do miscroscopic animals, i.e. the amount of chitin, for example, per unit dry weight in *Hyalella* or chironomid larvae should be less than that in small cladocerans or copepods of equivalent weight. Animals caught from Lake Wingra were mainly chironomid larvae and, to a very limited extent, water mites and Mayfly nymphs. *Hyalella* was completely absent and damsel flies and caddis flies were rare. In contrast, *Hyalella* was abundant and caught throughout the summer from Lake Mendota, while damsel flies, caddis flies, and stone flies were only occasionally found. Thus it is seen that Lake Wingra bluegill, by feeding on these microscopic animals, actually receive less digestible material than do their counterparts in Lake Mendota which feed on larger organisms.

In summary, then Lake Wingra bluegill feed on the small planktonic organisms available, expend a considerable amount of energy in pursuit of food, receive more indigestible materials per unit of food consumed, and attain smaller body size and weight than bluegill in other, more nutritive waters.

Other facts related to the history of Lake Wingra and its fish during the last 70 years are of interest in relation to the feeding habits discussed. Helm (1958) reported changes in species and their relative abundance as well as changes in growth rates of fish in the lake. Also, three fundamental changes in Lake Wingra over the past decades have taken place (Baumann et al. 1974a and b): 1. A decline in large predators such as northern pike and northern long nose gar, 2. An increase in the population density of pan fish, and 3. The disappearance of large invertebrates such as *Hyalella* which were reported to be abundant in the lake in the early twentieth century.

We therefore conclude that the decline in the benthic invertebrate population in Lake Wingra has played a significant role in the dynamics of the fish population in the lake.

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DISTRIBUTION OF FISH PARASITES FROM TWO SOUTHEAST WISCONSIN STREAMS

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ABSTRACT

Between 1971 and 1974, 15 species of fish parasites (three acanthocephalan, six cestode, four trematode, one nematode and one crustacean species) were recovered from 15 hosts (8 families) from the Pike and Root rivers, southeast Wisconsin. A complete parasite-host listing is included with notes on differential distribution of parasites in the two streams and related information.

INTRODUCTION

The Root River (Milwaukee and Racine Counties) and Pike River (Racine and Kenosha Counties) drain eastward into Lake Michigan. Some of the fish parasites were previously treated by Amin (1974, 1975 a-d) and Amin et al. (1973). Others were more recently recovered and additional information has now become available. A comprehensive listing of parasites and their hosts is included here for the first time. Attention is called to the differences in the infestation picture in the two streams and to the possible cause.

MATERIALS AND METHODS

All fishes from both streams were seined and examined during the autumn of every year (1971-1974) and occasionally also from the Pike River during the spring and/or summer. They were kept on wet ice until examined for parasites in the laboratory within 24-48 hours. Recovered parasites were processed as follows. Trematodes and cestodes were stained in Semichons carmine, cleared in xylene and whole mounted in Canada balsam. Acanthocephalans were stained in Harris' hematoxylin or Mayer's acid carmine, cleared in beechwood creosote or terpineol and whole mounted in Canada balsam. Nematodes were not permanently mounted but cleared in glycerol.

RESULTS AND DISCUSSION

Of 26 species of fishes (10 families) examined from the Root (R) and Pike (P) Rivers, 15 (8 families) were infested with parasites.

Fishes which were negative include: *Alosa pseudoharengus* (Wilson) (alewife) (R:5); *Esox americanus* Le Sueur (grass pickerel) (R:1); *Chrosomus erythrogaster* (Raf.) (southern red-belly dace) (P: >74); *Notropis cornutus* (Mitchill) (common shiner) (R: >35; P: > 7); *N. heterolepis* Eigenmann and Eigenmann (blacknose shiner) (R:13): *N. stramineus* (Cope) (sand shiner) (P: > 3); *Ictalurus nebulosus* (Le Sueur) (brown bullhead) (R:1); *Noturus flavus* (Raf.) (stonecat) (R:4); *Lepomis gibbosus* (Linn.) (pumpkinseed) (R:2); *L. megalotis* Raf. (longear sunfish) (R:1).

A listing of parasites recovered and their hosts follows. Host names are followed by the number examined from each stream and a symbol denoting frequency and intensity of infestation (-:negative, ± :scarce/accidental, +:light/infrequent, ++:moderate/somewhat common, +++:heavy/frequent). Asterisks denote new locality records in southeastern Wisconsin.

ACANTHOCEPHALA

Acanthocephalus parksidei Amin, 1974

Salmo gairdneri Richardson (rainbow trout) (P:2, ++ to +++)
Notemigonus crysoleucas (Mitchill) (golden shiner) (P:9,+) (R:32,-)
Pimephalus promelas (Raf.) (fathead minnow) (P:17,+)
Semotilus atromaculatus (Mitchill) (creek chub) (P: > 398, ++ to +++) (R:66,-)
Semotilus margarita (Cope) (pearl dace) (P: 54, ±) (R:665,-)
Catostomus commersoni (Lacépède) (white sucker) (P: > 231, ++ to +++) (R:479, ±)*
Ictalurus melas (Raf.) (black bullhead) (P:7, ++ to +++*) (R:1,*-)
Culaea inconstance (Kirtland) (brook stickleback) (P:11,+)
Lepomis cyanellus Raf. (green sunfish) (P: >48, +++ to +++) (R:131, ±)*
Lepomis macrochirus Raf. (blue gill) (P: >2, ++ to +++) (R:17,-)
Micropterus salmoides (Lacépède) (largemouth bass) (P: >2, ++ to +++) (R:3,-)

Neoechinorhynchus sp.

Lepomis cyanellus Raf. (green sunfish) (P: >48,+) (R:131,-)

Pomphorhynchus bulbocolli (Linkins, 1919) Van Cleave, 1919

Catostomus commersoni (Lacépède) (white sucker) (P: >231, ±) (R:479,-)

CESTODA

Biacetabulum biloculoides Mackiewicz & McCrae, 1965

Catostomus commersoni (Lacépède) (white sucker) (P: >231, + to ++) (R:479, ±)

Biacetabulum macrocephalum McCrae, 1962

Catostomus commersoni (Lacépède) (white sucker) (P: >231,–) (R:479, +)

Hunterella nodulosa Mackiewicz & McCrae, 1962

Catostomus commersoni (Lacépède) (white sucker) (P: >231, + to ++)* (R:479: +to ++)*

Glaridacris catostomi Cooper, 1920

Catostomus commersoni (Lacépède) (white sucker) (P: >231,+) (R:479: ±)*

Bothriocephalus cuspidatus Cooper, 1917

Lepomis cyanellus Raf. (green sunfish) (P: >48, +) (R:131,–)

Proteocephalus buplanensis Mayes, 1976

Semotilus atromaculatus (Mitchill) (creek chub) (P: >398, + to ++) (R:66, ±)*
Lepomis cyanellus Raf. (green sunfish) (P: >48,+) (R:131,–)

TREMATODA

Triganodistomum attenuatum Mueller & Van Cleave, 1932

Catostomus commersoni (Lacépède) (white sucker) (P: > 231,+) (R:479,+)

Ornithodiplostomum ptychocheilus (Faust, 1913) metacercariae

Semotilus atromaculatus (Mitchill) (creek chub) (P: > 398, + to ++) (R:66,–)

Posthodiplostomum minimum (MacCallum, 1912) metacercariae

Semotilus atromaculatus (Mitchill) (creek chub) (P: > 398, + to ++) (R:66,–)

Neascus sp. metacercariae

(Black spot; pigmented cysts in skin)
Specific information not available (P:+)* (R: + to ++)*

NEMATODA

Dorylamus sp.

Catostomus commersoni (Lacépède) (white sucker) (P: >231,++) (R:479,–)

CRUSTACEA

Lernaea cyprinacea Linn.

Umbra limi (Kirtland) (central mudminnow) (P: >4,–) (R:33, + to ++)
Cyprinus carpio (Linn.) (carp) (R:2, + to ++)
Notemigonus crysoleucus (Mitchill) (golden shiner) (P:9,–) (R:32,+)
Semotilus atromaculatus (Mitchill) (creek chub) (P: 398,–) (R:66, + to ++)
Semotilus margarita (Cope) (pearl dace) (P:> 54,–) (R:665,+)
Catostomus commersoni (Lacépède) (white sucker) (P:231, ±)* (R:479, + to ++)
Lepomis cyanellus Raf. (green sunfish) (P:> 48,–) (R:131,+)
Lepomis macrochirus Raf. (blue gill) (P:> 2,–) (R:17,+)
Micropterus salmoides (Lacépède) (largemouth bass) (P: >2,–) (R:3, + to ++)
Etheostoma nigrum Raf. (Johnny darter) (R:74,+)

The above data indicate that the parasitic fauna of Pike River fishes is considerably richer than that of Root River fishes. Nine of the 15 recovered parasites were common in the Pike River: *A. parksidei*, *Neoechinorhynchus* sp., *B. biloculoides*, *G. catostomi*, *B. cuspidatus*, *P. buplanensis*, *O. ptychocheilus*, *P. minimum* and *Dorylamus* sp. Only two parasites, *B. macrocephalum* and *L. cyprinacea*, were more common in Root River fishes. Two species, *H. nodulosa* and *T. attenuatum*, were about equally common in suckers (*C. commersoni*) of both streams. The above distributional pattern might be caused by the differential distribution of supporting intermediate hosts. If true, then the presumably "poorer" invertebrate fauna of the larger Root River might be influenced, at least in part, by its higher flow rate as well as its higher non-fecal organic pollutant content than in the Pike River (Southeastern Wisconsin Regional Planning Commission, 1966). However, only quantitative surveys can validate the above statement.

During the course of these investigations, annual cycles in certain parasites were observed. Root River fishes were extensively surveyed during the autumn of 1971 and 1974. During 1971, only *B. macrocephalum* was recovered from suckers. In 1974, Root River suckers were commonly infected with *H.nodulosa* (48% of 82 were infested with approximately 350 worms; about 80% were mature adults) whereas infestations with *B. macrocephalum* were very scarce. Furthermore, *L. cyprinacea* infestations were common in Root River fishes during autumn, 1971, but were absent during the same season, 1974. Root River fishes examined in 1974, particularly suckers and chubs, were relatively larger (older) than those previously surveyed from the same stream. In the Pike River, *Dorylaimus* sp. was commonly found in suckers examined during autumn, 1972. This nematode was not recovered from suckers from the Pike River during any other season or during the same season in other years. Host size associations might have been partially involved in some of the above cycles. Lighter and less frequent infestations with *L. cyprinacea* and *Dorylaimus* sp. (as well as with *T. attenuatum*) were previously found associated with increased host size (Amin et al., 1973, Amin, 1974). Future investigations might reveal the presence of additional parasites from these two streams. However, the above trend of heavier infections in Pike than in Root River fishes will probably continue if water and host conditions remain essentially unchanged.

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CHANGING ROLE OF THE EMERGENCY ROOM AND ITS ACCEPTANCE BY HOSPITAL PERSONNEL

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ABSTRACT

The hospital, in response to the changing health care needs of society, has undergone numerous transitions, since its inception as an institution of refuge for the ailing indigent. One example is the development of a "protocol" method of patient care and its incorporation into an emergency room Acute Care Unit. It was the purpose of this study to assess the feasibility, efficiency, and acceptability of care provided by the protocol method for a large midwestern hospital.

Methods consisted of clinical analysis, personnel interviews, and data comparison with other protocol studies. Sample size totaled 1,683 patients. Analysis of results adjudged the protocol method to be a feasible, safe, and acceptable means of providing health care to patients.

INTRODUCTION

Through history, the hospital has reflected society's health care needs and attitudes. During the Roman Empire, for instance, army hospitals were developed for wounded and ill soldiers; however, the concept was not embraced by the general society. The people thus relied upon traditional household medicine for their needs and ignored the potential benefits of emergency care (Scarborough, 1969).

In the eighteenth century, hospitals were viewed as a refuge for the ailing indigent (McLachlan and McKeown, 1971). Later, with the advent of anesthetics and antiseptic procedures, they became institutions where the sick went to be cured rather than to die. As a result, middle and upper class patients began to utilize hospitals along with the poor (Shryocke, 1969). This trend has continued up to the present.

Today, mounting numbers of non-emergent* patients are

*Komaroff (1974a) classifies patients entering emergency rooms as either emergent or non-emergent patients. Emergent patients will suffer permanent impairment if not treated within one-half hour, while non-emergent patients will not.

creating crises in hospital emergency rooms (E.R.s) (Ginzberg, 1971; Komaroff, 1974a). This results in inefficient utilization of E.R. staff and facilities. To cope with this problem, "protocol" methods of patient care have been designed and incorporated into E.R. based Acute Care Units (A.C.U.) (Komaroff, 1974a and b).

The protocol method (Komaroff, 1974a and b; Bragg, 1972) employs clinical algorithms (C.A.s) to appraise and manage health problems. C.A.s concentrate on the patient's primary complaint; — his age, sex, past illnesses, and current medications determining the laboratory tests, and physical examination to be obtained. After data appraisal, proper treatment is specified by the C.A.

It was the purpose of this study to assess the feasibility, efficiency, and acceptability of care provided by the protocol method.

METHODS AND MATERIALS

The study took place at a major metropolitan hospital in midwestern United States for four weeks in January 1975. The evaluation consisted of three parts:

I. *Clinical Analysis:*
   A. Determination of the four most common complaints seen in the A.C.U. This assumes that a small number of illnesses are responsible for a large percentage of A.C.U. visits (Komaroff, 1974b).
   B. Determination of the A.C.U. patient flow. This assumes that knowledge of the patient flow will identify bottlenecks in the system.
   C. Determination of the time lag (time elapsed) between a patient entering the Unit and his examination. This assumes that a positive value accrues from examining patients rapidly. Speedy examination also eliminates patient backlog at a critical juncture in the system.
   D. Determination of the time lag (time elapsed) between the patient's examination and the issuing of his final orders. This assumes the positive value of speedy patient examination will diminish, if the patient is forced to wait a prolonged time for final orders. In addition, rapid issue of final orders eliminates patient backlog at another important juncture.
   E. Determination of the number of patients given a "nurse provisional treatment plan" and having it reviewed by physicians before being discharged. This assumes a small number of tasks represent a large percentage of work in the workup of non-emergent illnesses and that the tasks are performed almost identically well by either physicians or

trained non-physician personnel (Komaroff, 1974a and b).

F. Determination of the number of patients treated by the A.C.U. but who, in reality, belonged under E.R. jurisdiction. This assumes the protocol method is efficient, if the number of treated A.C.U. patients actually belonging under E.R. jurisdiction is small (arbitrarily, the maximum limit is set at 20% of the total A.C.U. patient load).

II. *Personnel interviews:*

A. Patient interviews were conducted to ascertain their reaction to the A.C.U.'s care (personal communication). This assumes the patients' reaction may influence their recovery.

B. Nurse and physician interviews were conducted to determine the staff's reaction to the Unit's care (personal communication). This also assumes that staff attitudes may affect the delivery of care.

C. Staff interviews were conducted to determine the protocol method's feasibility in the delivery of health care (personal communication). This assumes that individuals involved with the provisional treatment plan are in an excellent position to comment on the feasibility of employing the protocol method in the future.

III. *Data comparison with other A.C. U. studies.* This permits any meaningful similarities in data to be identified.

RESULTS

Sample size totaled 1,683 patients. The four most common presenting complaints were:

Upper respiratory infection		485 (29%)
Abdominal pain		122 (7%)
Urinary tract infection		109 (6%)
Gynecological		103 (6%)
N = 1683	Total:	819 (49%)

Upon entering, the patient reported to the triage nurse and proceeded in accord with the flow in Diagram I. The mean total time spent by a patient in the A.C.U. was 119 minutes; of this total, only a mean of 12.5 minutes was spent waiting for examination, whereas a mean of 106.5 minutes was spent waiting for final orders (Table 1). Of the 1,683 patients entering the A.C.U., 159 (9%) were referred to other medical units. Of the remaining total, 1,463 (87%) were given a nurse provisional treatment plan and had it reviewed by a physician before being discharged, while only 61 (4%) were

DIAGRAM I

DIAGRAM OF ACUTE CARE UNIT PATIENT FLOW

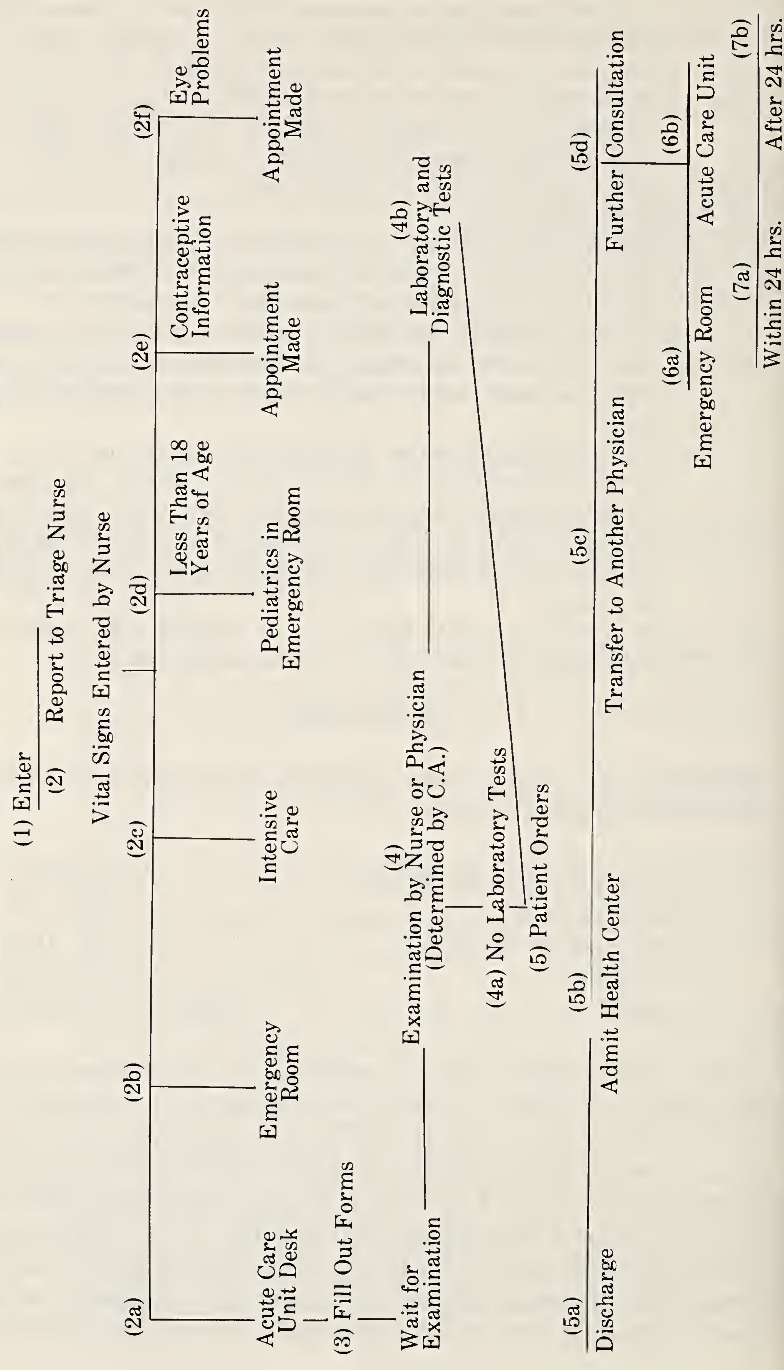

DIAGRAM I
DIAGRAM OF ACUTE CARE UNIT PATIENT FLOW

Patient enters the E.R. and reports to the triage nurse (1.2). Here, using the presenting symptoms or vital signs of the patient, the nurse selects the appropriate C. A. The C. A. assists the nurse in screening the patient for the A.C.U., E.R., or Intensive Care (2a, b, and c). If the patient is under 18 years of age, has an eye problem, or requests contraceptive information, the appropriate referral or appointment is made by the nurse (2d, e, and f).

If the C. A. determines the patient can be treated by the A.C.U., he is directed to the A.C.U. desk and waiting room (3). Here the patient completes the appropriate forms (home address, race, sex, next of kin, etc.) and waits for examination. The examination may be administered by either a nurse or physician, as specified by the C. A. (4). Laboratory and diagnostic tests, if required by C. A. or examiner, are also administered at this time (4a, b).

Upon completion of the examination and any tests, the patient returns to the waiting room to await further instructions (5). These instructions, based upon clinical data and the examiner's medical experience, are usually determined by the C. A. However, instructions deviating from the C. A. may be issued, if the appropriate physician has been consulted and permission obtained.

Final instructions include the patient's discharge, admittance to the Health Center, transfer of care to another physician, or further consultation (5a, b, c, and d). If further consultation is required, the patient is either transferred immediately to E.R. (6a) or asked to return to the A.C.U. (6b). Should the patient be requested to return, the C. A. specifies whether it should be within or after 24 hours (7a, b).

TABLE 1: TIME LAGS IN PATIENT FLOW

	From Entering A.C.U. Until Examination (min.)	From Examination Until Discharge (min.)
A.M. SHIFT	15	86
P.M. SHIFT	10	127
Average	12.5	106.5
Total Average Visit Time (min.): 119		

treated but adjudged to actually be under E.R. jurisdiction.

Fifty-one patients were interviewed. Forty-seven (92%) responded that the triage algorithm/nurse provisional treatment method of care was as good or better than that of their regular physician. Eleven nurses (the entire A.C.U. nursing staff) and six residents were interviewed. Of these, all nurses (100%) and five residents (83%) expressed approval of the Unit's method of care, and complete confidence in its ability to assess and treat patients (Table 2).

TABLE 2: RESPONSE FINDINGS

	Reaction to Acute Care Unit				Confidence in Acute Care Unit			
	Positive		Negative		Positive		Negative	
	%	No.	%	No.	%	No.	%	No.
PATIENTS (N=51)	92	47	8	4	N.A.	N.A.	N.A.	N.A.
NURSES (N=11)	100	11	-	-	100	11	-	-
RESIDENTS (N=6)	83	5	17	1	83	5	17	1

N. A. = Not Available

TABLE 3: PRESENTING COMPLAINTS

Complaint	Acute Care Unit			Kaiser - Inglewood Clinic*		
	%	No.	Rank	%	No.	Rank
Upper Respiratory Infection	29	485	1	27	797	1
Abdominal Pain	7	122	2	10	289	2
Urinary Tract Infection	6	109	3	3	87	15
Gynecological	6	103	4	3	94	13
Total	49	819 N=1683	-	44	1267 N=2909	-

*(Komaroff, 1974b)

In a comparable study at the Kaiser-Inglewood Clinic, presenting complaint data were (Table 3) (Komaroff, 1974b):

Upper respiratory infection	797 (27%)	Rank:	1st
Abdominal pain	289 (10%)		2nd
Urinary tract infection	87 (3%)		14th
Gynecological	94 (3%)		12th
N=2909 Total:	1267 (44%)		

Other findings show the mean time lag between a patient entering the A.C.U. and his being examined was 14 minutes (Greenfield, 1974a). Others report that 70-89% of protocol treated patients were discharged without significant deviance from the protocol disposition decision (Komaroff, 1974b; Winickoff, 1974; Greenfield, 1973), whereas only 2-11% of the protocol treated patients were discovered to be actual E.R. cases (Table 4) (Bragg, 1972; Winickoff, 1974; Greenfield, 1973).

TABLE 4: COMPARISON of TIME LAGS, DISCHARGED PATIENTS, and TRUE EMERGENCY ROOM CASES

Time	Acute Care Unit			Other Studies*		
	%	No.	Time (min.)	%	No.	Time (min.)
Time Lag Between Patient Entering A.C.U. and Examination	-	1683	12.5	-	212	14
Patients Given Provisional Treatment Plan Or C. A. Treatment	87	1463	-	70-89	146-226	-
Patients Treated But Were True Emergency Room Cases	4	61	-	2-11	N.I.	-

N.I.=Not Included
*(Bragg, 1972; Winickoff, 1974; Greenfield, 1973, 1974a)

DISCUSSION

Comparison of our data with other protocol studies indicates certain parallels, namely:

1. Time elapsed between patients entering the A.C.U. and their being examined (12.5 min. in this study, 14 min. in others)
2. Percentage of patients treatable by the protocol method (theoretically 87% in this study, 70-89% in others)
3. Percentage of patients treated by the A.C.U. but actually belonging under E.R. jurisdiction (4% in this study, compared 2-11% in others)
4. Patient, nurse, and physician response to provisional treatment or protocol method (this study as well as others indicates an almost unanimously positive response).

These similarities in data soundly support the conclusion reached by other authors; namely, that the protocol method is a feasible, safe, and acceptable means of providing health care to non-emergent patients (Komaroff, 1974a, b and c; Winickoff, 1974; Greenfield, 1973, 1974a and b).

In addition, other advantages of the protocol method include (Komaroff, 1974a):

1. Improving the basic education and comprehension of pathophysiology in medical students by studying the logic built into the protocols.
2. Providing medical-legal safeguards by stating explicitly what was and was not administered to the patient and by representing tested, validated standards of care.

However, the protocol method has its shortcomings. The most apparent is the tremendous amount of time the patient spends waiting for final orders. Experience suggests the delay stems from the turnabout time required for laboratory tests. Accordingly, the protocol method's efficiency might be improved, if the turnabout time for tests was reduced. A potential solution includes assigning a special laboratory fulltime to the A.C.U. Further research is necessary, however, before the final conclusion can be determined.

CONCLUSIONS

The protocol method established in an Emergency Room based Acute Care Unit is adjudged to be a feasible, safe, and acceptable means of providing health care to non-emergent patients. Further research is recommended, to determine if increased protocol efficiency would result from attaching a fulltime laboratory to the Acute Care Unit.

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OCCURRENCE OF THE BREGMATIC BONE IN THE RACCOON, *PROCYON LOTOR*

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ABSTRACT

A total of 214 specimens of *Procyon lotor* from Southwestern Wisconsin were collected and prepared for the study; of these, 140 specimens were suitable for consideration, the rest being damaged or having occluded sutures due to advanced age. Museum collections yielded 78 specimens, 48 of which were suitable for study. Four bregmatic bones were found in specimens from the study area (2.86%); one from museum collections (2.08%). Final analysis of the data placed the occurrence of the bregmatic bone in the raccoon at 2.66%.

INTRODUCTION

The bregmatic bone, an anomalous accessory bone at the junction of the frontal and coronal sutures is present in various species of mammals. Bregmatic bones may be symmetrical or asymmetrical in both shape and position, the location being best described as the center of the dorsum of the skull. They generally present well sutured boundaries to the surrounding cranial elements until the sutures are obliterated by advancing age. The exact origin of the bone is not precisely known. Many researchers (Gulliver, 1890; Wortman, 1920; Troitsky, 1932; Sitsen, 1933; DeBeer, 1937) have discussed the origin and occurrence of bregmatic bones.

Bregmatic bones have been reported in some sixty-three species of mammals belonging to ten orders (e.g. v. Jhering, 1915; Schultz, 1923). The best compilation of data is by Schultz (1923); this illustrated report includes cases of single and multiple occurrences. The only information available for the genus, *Procyon*, is that of v. Jhering (1915) who reported the occurrence in *Procyon cancrivorous* to be 45.4% (five of eleven specimens). The bone was described as a single, centrally located structure of considerable size.

This study was conducted to provide statistics for bregmatic bone occurrence in the raccoon of Southwestern Wisconsin. Several museum collections were also examined for the presence of bregmatic bones in *Procyon lotor* skulls.

MATERIALS AND METHODS

Specimens were obtained from sportsmen of Southwestern Wisconsin, during the period 15 October to 20 December 1973. Each specimen was cataloged with respect to age; sex, location and date of capture. Fresh and frozen specimens were boiled with a bio-enzyme detergent, rinsed, bleached, and dried prior to examination. A bregmatic bone was judged to be present when clearly discernible sutures along the perimeter of the bone were present.

RESULTS

Nearly 300 specimens were obtained during the study; many were unsuitable for processing due to damage during collection. Of 214 specimens prepared for the study, 74 possessed occluded sutures or were otherwise unsuitable for consideration. Of the 140 specimens suitable for study, four (2.86%) possessed the bregmatic bone.

FIGURE 1. Number 108, a specimen of unknown sex from Harrison Township.

A specimen of unknown sex from Grant County (Fig. 1) displayed the largest bregmatic bone (13 x 6 mm). The bone was medial and had well defined sutures. A male specimen from Grant County was the only specimen with multiple bregmatic bones. The anterior bone was small (9 x 2 mm) and located somewhat sinestral to the sagittal suture; the posterior bone (6 x 7 mm) was medial and showed no sign of bisection by the sagittal suture. Another Grant County specimen of unknown sex (Fig. 2) displayed a medially

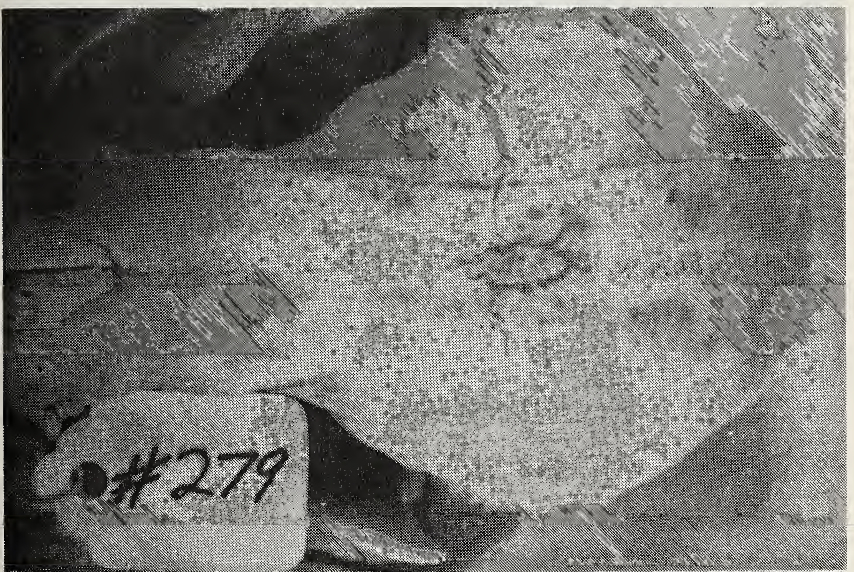

FIGURE 2. Number 279, a specimen of unknown sex from Platteville Township.

situated bregmatic bone (10 x 4 mm), and a female from Lafayette County had a medially located bregmatic bone (15 x 3 mm). Skulls without the bregmatic bone (Fig. 3) have a clearly defined intersection of the sagittal and coronal sutures. Eventually, with advancing age these sutures occlude and a sagittal crest forms.

In addition to the specimens prepared by the author, several museum collections of raccoon skulls were examined for bregmatic bones (Table 1). Of 78 museum specimens 48 of which were suitable for study, only one (2.08%) bregmatic bone was found. The specimen, of unknown sex, was one of ten specimens, five of which at the Davenport Museum, Davenport, Iowa (No. 277) were suitable for study. The sample from Southwestern Wisconsin (214 specimens, 140 suitable for study) added to the museum sample (78 specimens, 48 suitable for study) totaled 188. The final percentage of occurrence of the bregmatic bone in the raccoon was 2.66%.

FIGURE 3. Number 114, a specimen lacking a bregmatic bone.

TABLE 1: THE OCCURRENCE OF BREGMATIC BONES IN MUSEUM COLLECTIONS OF RACCOON SKULLS

Collection Location	Curator	Total Specimens	Suitable for Study	With Bregmatic
Calvin Hall, Univ. Ia., Iowa City	Holme Semken	20	15	0
Davenport Museum, Davenport, Ia.	Peter Peterson	10	5	1
McBride Hall, Univ. Ia., Iowa City	George Schrimper	2	1	0
Noland Hall, Univ. Wis., Madison	Elizabeth Pillaert	46	27	0

DISCUSSION

Bregmatic bones were found to occur in both male (1) and female (1) specimens. None of the juvenile skulls examined possessed supernumerary fontanelle bones. The anomaly does not appear to be restricted geographically nor would a genetic factor be a safe assumption based on the data obtained at this point. Examination of the literature presented two basic theories of bregmatic bone origin, one genetic (Troitzky, 1932) and one traumatic (Sitsen, 1933). More information on the origin of bregmatic bones might be obtained from a species which displays a statistically high occurrence of the bone, e.g. *Erethizon dorsatus* (Schultz, 1923). Bregmatic bones are of little phylogenetic significance, but their anomalous nature and uncertain origin arouse the curiosity of various researchers from time to time.

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TOXICITY OF ANTIMYCIN A TO *ASELLUS INTERMEDIUS, DUGESIA DOROTOCEPHALA, GAMMARUS PSEUDOLIMNAEUS,* AND *HYALELLA AZTECA*

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ABSTRACT

Antimycin A, a registered fish toxicant, was tested in the laboratory on *Asellus intermedius, Dugesia dorotocephala, Gammarus pseudolimnaeus*, and *Hyalella azteca. H. azteca* and *G. pseudolimnaeus* were very sensitive with 96 hr LC 50s $< 10\ \mu g/1$. *A. intermedius* also showed mortality at this level in one series of experiments. *D. dorotocephala* showed no mortality at 15 $\mu g/1$ of Antimycin A for eight days. The 96 hr ECT 50 values at 10 $\mu g/1$ of Antimycin A were determined for *G. pseudolimnaeus* (1.4 hr) and *H. azteca* (5.3 hr). Based on these results, the 10 $\mu g/1$ level of Antimycin A normally used in fish control would probably eliminate *G. pseudolimnaeus* and *H. azteca*, two important fish food organisms.

INTRODUCTION

Antimycin A, a respiratory inhibitor registered as a fish toxicant in 1966, has received increasing use for rough fish control in lake and stream management. Much laboratory and field experimentation has been done with Antimycin A, as a piscicide (Berger et al., 1969; Gilderhus et al., 1969; Lennon and Berger, 1970; Marking and Dawson, 1972), but there is a lack of information on the toxicity of the compound to common invertebrates. In view of the use of the chemical for a large-scale fish removal project in the Rock River, Wisconsin, we were encouraged to conduct toxicity experiments with the amphipods *Gammarus pseudolimnaeus* Bousfield and *Hyalella azteca* (Saussure), the isopod *Asellus intermedius* Forbes, and the planarian *Dugesia dorotocephala* (Woodworth).

These species are abundant in portions of the Rock River system and are important fish foods. *Gammarus spp.* are important in the diet of a wide variety of gamefish species including brown trout (Reimers et al., 1955; and Maitland, 1965), brook trout (Rawson and

Elsey, 1950), and walleye (Kelso, 1973). *Asellus spp.* are abundant in the diets of warmouth and largemouth bass (Larimore, 1957) and brown trout (Ellis and Gowing, 1957). *H. azteca* occurs in the diets of black crappie and bluegill (Seaburg and Moyle, 1964) and largemouth bass (McCammon et al., 1964).

Another consideration in the choice of these test organisms is the fact of their totally aquatic life cycles. Repopulation would be difficult in waters where they were completely eliminated. Insect species with a winged adult stage for dispersal could more easily reinvade such streams and long-term eradication would be avoided.

Lennon and Berger (1970) reported invertebrate mortalities observed in field trials, i.e. nearly total kills (99%) of rotifers, cladocerans and copepods, with partial kills of fresh-water shrimp and *Gammarus spp.* In their discussion they indicate that fall frosts may have been responsible for the zooplankton decline and postulate that the partial kill of freshwater shrimp was due to locally high toxicant concentrations. They suggest that dosage levels of Antimycin A used for fish control (10-15 μg/1) do not ordinarily adversely affect aquatic invertebrates.

Recent studies on clams (Antonioni, 1974), ostracods (Kawatski, 1973) and caddis flies and *Gammarus* (Lesser, 1972) indicate that these animals suffer mortality at low dosage levels of Antimycin A (10-15 μg/1).

EXPERIMENTAL PROCEDURE

The formulation of Antimycin A used was Liquid Fintrol Concentrate (Ayerst Laboratories, Inc.). An initial stock solution was prepared in acetone to insure uniformity and provide a stable solution. The final mixing with water for the desired treatment dosages was done just prior to the start of each experimental run. The Antimycin A stock solution was mixed according to directions of the manufacturer to arrive at the desired dosage.

Individual experiments were conducted with two-liter glass vessels containing twelve organisms of a single species. These containers were placed in a water bath maintained at 15C under constant light.

A. intermedius and *G. pseudolimnaeus* collected from the Bark River, Waukesha Co., Wis. were tested with two different types of water, Biotron tap water (Antonioni, 1974) and Bark River water collected with the organisms. In these tests, the water was aerated and the containers were covered with a plastic sheet to prevent evaporation. Three Antimycin A concentrations between 5 and 15 μg/1 were employed to determine the concentration causing a 50% mortality (LC 50).

H. azteca from Lake Mendota, Dane Co., Wis., *G. pseudolimnaeus* from Parfrey's Glen Creek, Sauk Co., Wis.; and *D. dorotocephala* from Turtox-Cambosco Biological Supply Company were tested in Biotron tap water without aeration.

In addition, time series experiments were run with *H. azteca* and *G. pseudolimnaeus*. These animals were added to the toxicant at 10 μg/1 and were then removed, rinsed, and transferred to untreated water at various time intervals. This allowed determination of the time of exposure to cause a 50% mortality (ECT 50).

All experimental animals were acclimated for 24 hr in the laboratory prior to the experiment. Observations for death were made at 24 hr intervals, and dead organisms (those failing to respond to mechanical stimulation) were removed and held in fresh water for further observation to confirm death. Sick or weak individuals were not removed.

Mortalitites at 96 hr were analysed by the graphical method of Litchfield and Wilcoxon (1949) to obtain LC 50 and ECT 50 values.

RESULTS

H. azteca was the most sensitive organism tested with LC 50 of 1.4 μg/1. *G. pseudolimnaeus* was also quite sensitive with LC 50 values of 7.2 and 9.0 μg/1. The series of *A. intermedius* run in river water gave an LC 50 of 11.8 μg/1, but the tap water series showed no significant mortality at 15 μg/1 for 240 hours. This discrepancy prevents drawing any positive conclusions for *Asellus* but indicates the need for more intensive investigation. We found no significant mortality *D. dorotocephala* at 15 μg/1 for 192 hr. These results are summarized in Table 1 and Fig. 1.

While *H. azteca* was more sensitive in terms of concentration than *G. pseudolimnaeus*, it had a higher ECT 50 at 10 μg/1, 5.3 hr compared to 1.4 hr (Table 2, Fig. 2).

DISCUSSION

Lesser's (1970) values for *Gammarus* are noticeably lower than ours. However, we used different water, a different temperature, and a different species of *Gammarus*. Any or all of these factors could account for the observed differences.

TABLE 1. TOXICITY OF ANTIMYCIN A (LIQUID FINTROL CONCENTRATE) TO SELECTED AQUATIC INVERTEBRATES AT 15°C.

Organism	Water	pH	96 hr LC 50 and 95% Confidence Interval (μg/1)
Asellus intermedius (isopod)	Bark River	8.35	11.8 (7.4-18.9)
	Biotron tap	7.45	No significant mortality at 15 μg/1 for 240 hours
Hyalella azteca (amphipod)	Biotron tap	7.45	1.4 (0.9-2.2)
Gammarus pseudolimnaeus (amphipod)	Bark River	8.35	7.2 (5.3-9.7)
	Biotron tap	7.45	9.0 (6.6-12.4)
Dugesia dorotocephala (planarian)	Biotron tap	7.45	No significant mortality at 15 μg/1 for 192 hours
	Biotron tap	7.45	No significant mortality at 15 μg/1 for 192 hours

Work with fishes has shown the toxicity of Antimycin A to decline as pH increases (Berger et al., 1969). Lesser's work indicates this to be true for *Gammarus* as well. Our data for *A. intermedius* and *G. pseudolimnaeus* show an opposite trend (Table 1), and some factor in river water may have acted synergistically with Antimycin A to cause a higher mortality.

The differences in ranking of ECT 50 and LC 50 values for *H. azteca* and *G. pseudolimnaeus* were unexpected, but similar differences in ECT 50s and LC 50s have been reported for several fish species (Berger et al., 1969).

Possible toxicity resulting from the acetone in the stock solution cannot be distinguished from Antimycin A toxicity in our experiments. No control was run, with acetone and water, since the primary purpose of our experiments was to determine whether certain invertebrates would be killed by Antimycin A as administered in the field, and field formulations used for river systems in Wisconsin are mixed with acetone.

Our studies indicate that *H. azteca* and *G. pseudolimnaeus* are susceptible to Antimycin A at levels used in fish management (10-15 μg/1). Since these fish food organisms might be slow to reinvade

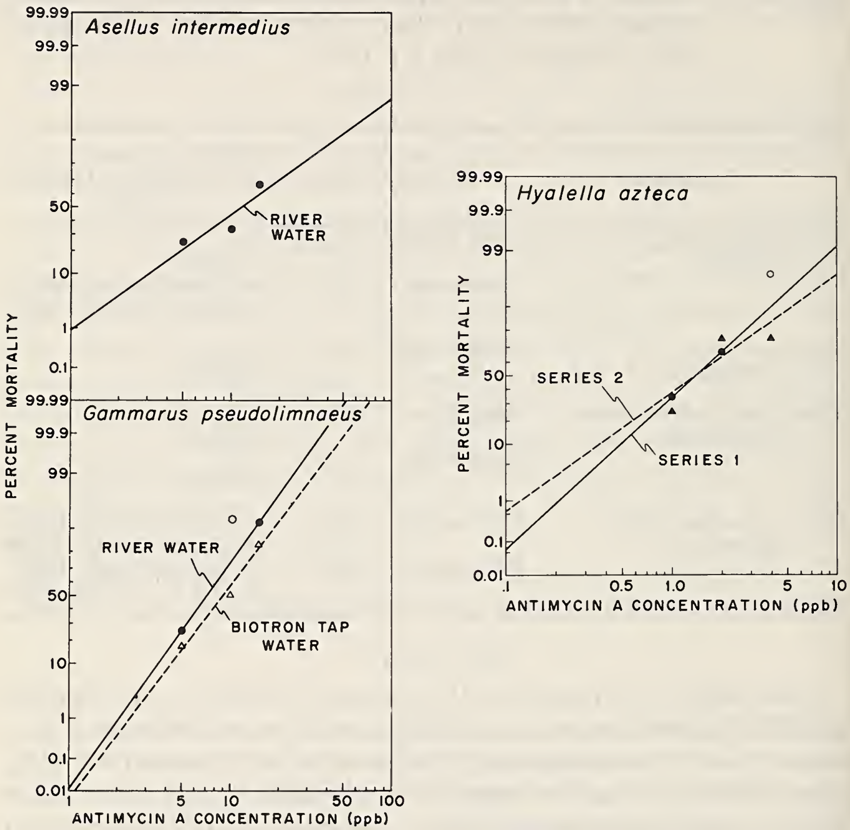

FIGURE 1—The dose effect for Antimycin A on *Asellus intermedius*, *Gammarus pseudolimnaeus*, and *Hyalella azteca*.

waters once they have been eliminated, their restocking should be considered in fish management projects. Since these invertebrates are not readily available an alternative course might be to leave some parts of the drainage basin untreated for natural repopulation.

Due to their sensitivity and ease of handling, both *H. azteca* and *G. pseudolimnaeus* are suitable for bioassay of Antimycin A. These animals might be preferable to fish for bioassay work because of easy transportation and maintenance of enough individuals.

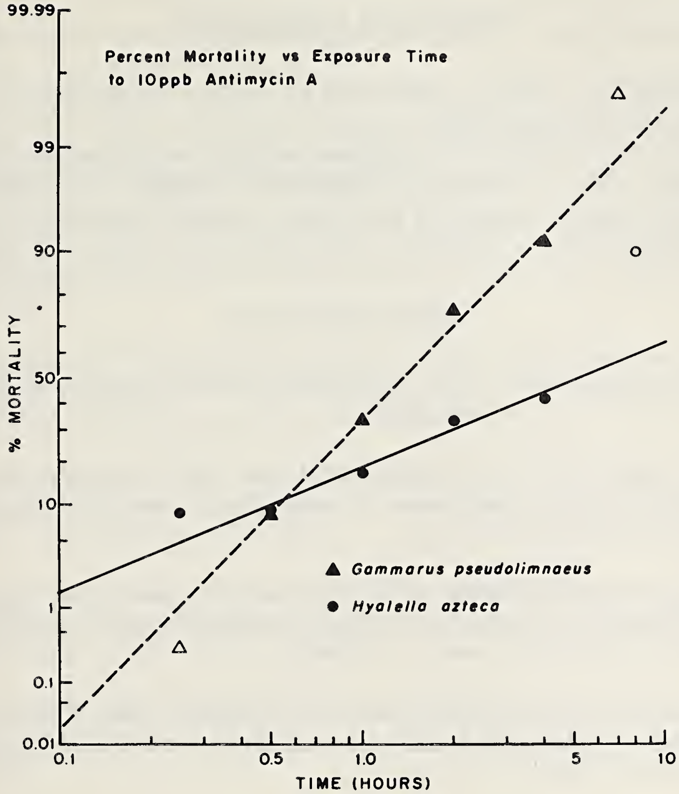

FIGURE 2—The time of exposure effect at 10 μg/1 of Antimycin A on *Gammarus pseudolimnaeus* and *Hyalella azteca*.

TABLE 2. TOXICITY OF ANTIMYCIN A (LIQUID FINTROL CONCENTRATE) AT 10 μg/1 TO SELECTED AQUATIC INVERTEBRATES AT 15C.

Organism	Water	pH	96 hr ECT 50 and 95% Confidence Interval (hours)
Hyalella azteca (amphipod)	Biotron tap	7.45	5.3 (2.3-12.5)
Gammarus pseudolimnaeus (amphipod)	Biotron tap	7.45	1.4 (0.9-2.1)

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GOVERNMENTAL BODIES CAN OBTAIN INTEREST FREE LOANS

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Government officials should learn that there are ways for governmental bodies to borrow the funds they need without being required to pay interest charges for those funds. A small service fee would have to be paid to cover the cost of servicing the loans, but that is not an interest charge.

So long as those making the loans do not have to pay interest on the funds they loan out, they do not have to charge interest from the borrowers. Commercial banks do not pay interest on the *bank credit* they loan out. They only pay interest on their reserves and on any cash they may loan out. The Federal Reserve Banks do not pay interest for the *bank credit* loans they make. They do not even have any reserves for the checks they issue. Their checks are redeemed with bank credit, on which they pay no interest.

All of us, especially government officials, will benefit if we learn of the actions taken by the people in the state of North Dakota. In the latter part of the 1800s and the early part of the 1900s they were not happy with the conditions under which they had to borrow money. Over the years, they organized politically in what was called Populist Movements. In the election of 1918, the Non-Partisan League gained control of the State government. In 1919 the State Legislature passed the laws which established the Bank of North Dakota for the purpose of "Encouraging and promoting Agriculture, Commerce, and Industry." With headquarters at Bismarck it is the only bank of its kind in the United States.

From its beginning the North Dakota Bank did not intend to compete with the existing privately owned banks, but rather to cooperate with them to best serve the needs of the people. That policy still exists. The Bank makes no loans to private corporations or individuals, with the exception of loans under VA (Veteran Administration), FHA (Federal Housing Administration), and FISL (Federal Insured Student Loans).

A State Industrial Commission composed of the Governor, who acts as chairman, the Attorney General, and the Commissioner of Agriculture, operates the Bank. Mr. H. L. Thorndal, the president, has stated that the Bank of North Dakota is able to loan to the political subdivisions all the funds they need. But the Bank usually insists that every issue of notes or bonds over $150,000 be put up for public sale and the Bank of North Dakota bids on the issue. On issues of less than $150,000, the Bank will negotiate directly with the political subdivisions for the rates and terms.

The Bank charges interest for its loans and after paying its expenses, the remainder, the profit, is turned over to the general fund of the State. In 1974 the Bank made a net profit of $9,268,770.41.

The above is what the Bank does. However, because the Bank is a government agency operating to perform a public service, it is *not necessary that it make a profit for the State.* Of course it should not incur a loss either.

As a public service, a policy could be adopted that the profits would be returned to the governmental bodies concerned in the borrowing, instead of being paid to the State. The borrowers who paid the interest then really could say, "we are paying the interest to ourselves." The result would be the same as if no interest were paid.

The people of North Dakota could go one step further. They could operate the Bank of North Dakota on a 100% *bank credit* system in a manner similar to the Federal Reserve Banks operation. The Bank could adopt the policy that it would not receive or pay out any cash. It would make loans to governmental bodies by issuing checks on itself and it would receive payments only in checks. It would be a completely cashless bank. Let us illustrate with an example:

Let us say the City of Fargo wishes to borrow $1,000,000 from the Bank of North Dakota. The City will issue $1,000,000 worth of bonds payable to the Bank of North Dakota over a period of five years, with $200,000 worth of the loan to be paid back annually. No interest will be charged, only a service fee sufficient to cover the cost of making and servicing the loan. Let us say a total flat fee of 1% ($10,000). or an annual fee of $2000 will be charged and payable, also, at the end of each of the five years.

The City of Fargo, on its part, must levy an irrevocable tax of $202,000 for each of those five years in order to make the payments. The Bank will then issue a check of $1,000,000 payable to the City of Fargo. The City will deposit the check in its demand deposit account at the Fargo Local Bank and receive $1,000,000 worth of *bank credit.* The Fargo Local Bank will then send the check back to the Bank of North Dakota and receive $1,000,000 worth of *bank credit* in its account there.

The City of Fargo then can issue checks against its account up to $1,000,000. The persons receiving the checks can deposit in any bank and receive credit in their accounts. They in turn can write checks against their accounts. Thus by everyone using checks in lieu of cash as their medium of exchange, buying and selling can take place in the usual manner.

When taxpaying time arrives, the people can pay their taxes with checks to the City of Fargo. The City of Fargo will deposit those checks in its Fargo Local Bank and receive credit for them.

At the end of each year when the payments on the bonds are due, the City of Fargo will issue a check for the amount due and send it to the Bank of North Dakota. The Bank will credit the City for the amount paid and debit the Fargo Local Bank for that amount and return the endorsed check to the Fargo Local Bank which will debit the City of Fargo's account and return the cancelled check to the City Treasurer.

That procedure will be repeated at the end of each of the five years at which time the principal will be repaid without any interest charges. The bank's cost of operations will be taken care of by the $2000 annual fee.

The reason it will not be necessary for the Bank to charge any interest on its loans is because it will not use any of its own cash and it will not have to borrow cash from anyone or pay interest to anyone. The only income the Bank will need is the amount necessary to pay the total cost of its services, i.e. the annual fee of $2000.

The reason the Bank of North Dakota can issue checks without having any cash on hand is because the Fargo Local Bank and 167 of the 170 banks in the state maintain an account with it and it acts as the clearing bank for those banks. That is the same reason that Federal Reserve Banks can write out checks with no cash needed to cash them.

If an annual interest rate of 6% were paid on that $1,000,000 loan, it would amount to $60,000 for the first year, $48,000 for the second year, $36,000 for the third year, $24,000 for the fourth year, and $12,000 for the fifth year. A total of $180,000! Whereas, the total service fee would be only $10,000.

Conclusion: The problems caused by the interest bearing debts of governmental bodies are almost overwhelming. Is it not time that some efforts be made to devise a means of freeing ourselves from the burden of those huge interest payments?

Surely, we and our government officials should at least want to benefit from the experience of the people in North Dakota. Even though the Bank of North Dakota does charge interest on the loans it makes to governmental bodies, it turns much of that interest into the general fund of the State, thus reducing by that amount, the need for levy of state taxes. North Dakota has made a good start. Let us carry on from there.

ASPECTS OF THE BIOLOGY OF *NELUMBO PENTAPETALA* (WALTER) FERNALD, THE AMERICAN LOTUS, ON THE UPPER MISSISSIPPI

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ABSTRACT

Several populations of the American lotus in the vicinity of La Crosse, Wisconsin have been studied for several years. Most of the habitats now occupied in this area did not exist before the creation of extensive backwater areas by the lock and dam system in the late 1930s. The populations studied are each relatively uniform as to certain morphological features, but usually differ significantly in these features from one another. They demonstrate high pollen fertility and few chromosomal aberrations, but relatively low seed set. Comparison of the results of inter- and intra-populational crosses carried out in 1974 indicates that the low seed set occurring naturally in these populations may not be due solely to the source of pollen in a cross, but to factors which include the nature of the pollinating mechanism, the parasitism of the plants by larvae of the Pyralid moth, *Ostrinia penitalis* (Grote), and the damage caused by *Agelaius phoeniceus* L., the redwing blackbird, seeking these larvae in the flowers of the lotus.

INTRODUCTION

This study was initiated to determine the reasons for the low seed set observed in some local populations of the American lotus. The scope of the work has expanded as more of the biology of this organism became known and its role in the ecosystem better appreciated. The area of study on the Upper Mississippi River presently possesses one of the largest concentrations of lotus in the United States. The completion of the lock and dam system on the Upper Mississippi River in the late 1930s and the subsequent formation of the so-called navigation pools, which are in essence large backwater reservoirs that aid in the maintenance of the present nine-foot navigation channel, created the habitats presently inhabited by the species in the area.

Although work has been stimulated by the unique longevity of the seeds of the Oriental lotus (Ohga, 1926a, b, c ,d; Shinano et al. 1966; and Toyoda, 1965, 1967), and although considerable anatomical, morphological, and taxonomical studies have been done with the genus (Cheadle, 1953; Cronquist, 1968; Khanna, 1965; van Leeuwen, 1963; Li, 1955; Lyon, 1901; Takhtajan, 1959; Wood, 1959; York, 1904), little has been done on the reproductive biology of the genus as it exists in nature. Meyer (1930) studied the growth and vegetative development of the American lotus, and Hall and Penfound (1944) studied certain aspects of the biology of the same species in the Tennessee Valley Administration Lakes.

METHODS AND MATERIALS

The field studies were conducted during the summers of 1972, 1973 and 1974. The populations utilized are described in Table 1. To randomly sample the populations for the morphological features measured, a string was stretched between two poles and all of the emergent leaves underneath this string and all of the flowers associated with these leaves, were sampled. An emergent leaf is usually associated with a flower which arises from the same node. The smaller floating leaves produced earlier in the growing season were never utilized for these measurements.

All crosses were carried out in the field. Flowers were bagged with Duraweld 9" x 12" pollinating bags (Scarborough, England) one to several days before anthesis, and all crosses after the first year were carried out only with flowers that had opened in the bags. The bags were identified, and the flowers were staked in order to prevent them from tipping into the water (Plate 1, Fig. 13, 14).

As it proved impossible to determine whether a certain number of flowers in a given population were produced by the same or different plants, all flowers were considered borne by separate individuals. A possible source of error, therefore, was introduced into all of the intra-populational crosses. The vegetative intermingling of different individuals, results from the fact that vegetative growth proceeds from the many tubers produced by a single plant the previous year; thus it is difficult, if not impossible, to pick out individual plants with any certainty. The experimental design called for five groups. Two consisted of flowers that were bagged without prior treatment and flowers that were bagged after the stamens had been removed. Two other groups consisted of

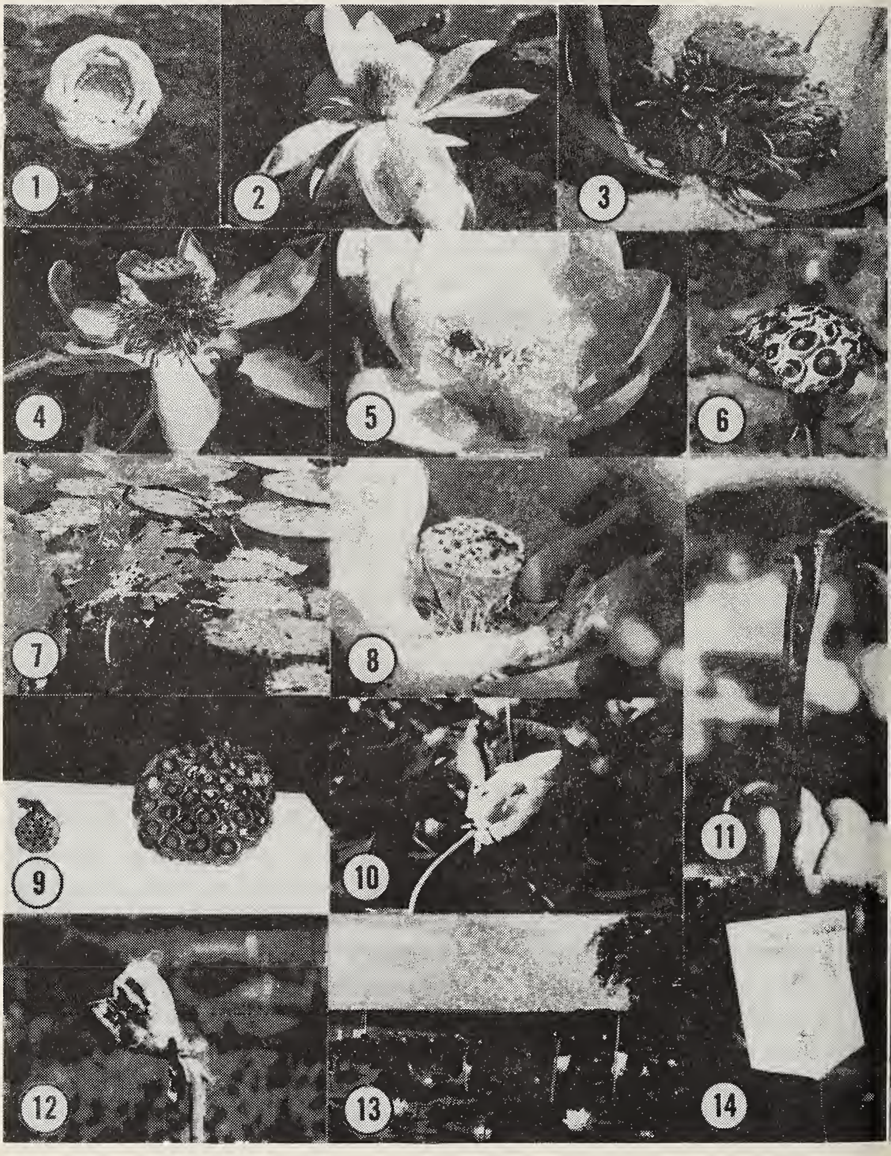

PLATE 1, FIGURES 1-14

1. Recently opened flower. X 1/5. 2. Recently opened flower with tepals pulled away to reveal stamens tightly appressed to the receptacle. X 1/6. 3. Flower on morning of third day. The perianth has spread away from the receptacle and the anthers have begun to dehisce. X 1/5. 4. Flower on afternoon of third day. Anthers have dehisced and along with most of the tepals, will soon abscise. 5. Flower on morning of the third day with the

anthers beginning to dehisce. An individual of *Apis mellifera* L. is gathering pollen. X 1/5. 6. Nearly mature receptacle with fruit visible in the carpellary pits. Several undeveloped carpels are in the undeveloped part of the receptacle in narrow and pinched carpellary pits. X 1/5. 7. Floating and early aerial leaves, showing severe damage caused by the larvae of *Ostrinia penitalis* (Grote). X 1/10. 8. A young receptacle severely infested by *O. penitalis* larvae. One nearly mature larva shown on top of the receptacle. X 1/3. 9. Undeveloped and developed receptacles. Neither the carpels nor the receptacle at left developed. X 1/5. 10. Flower damaged by *Agelaius phoeniceus* L., the redwing blackbird, as it searched the flower for larvae of *O. penitalis.* 11. Larva beginning pupation in the petiole. X 3/7. 12. Maturing receptacle damaged by redwing blackbirds. X 1/5. 13. One of the populations utilized in the study. Stakes used to prevent pollinating bags from tipping into the water. 14. Pollination control bag (9″ x 12″).

flowers that were bagged and utilized in the intra- and inter-populational crosses. The fifth group consisted of flowers (= individual as above defined) that were staked and marked, but not bagged. These open pollinated flowers were the controls.

Floral buds at the appropriate stage of development for cytological analysis were collected in a modified Carnoy's fluid consisting of chloroform: absolute ethanol: acetic acid (4:3:1). The apical portions of the perianths were removed before the buds were placed in the fluid in order to insure immediate penetration to the anthers. After 24 hours or more they were stored in 70 percent ethanol in a refrigerator until used. The cytological preparations were made by squeezing the pollen mother cells out of the anthers in a drop or two of aceto-orcein. Chromosome configurations were studied and photographed several hours after preparation.

For the germination experiments, the fruit walls were surface sterilized in a 50 percent solution of chlorox for several seconds, washed, and then nicked with a hacksaw. They were placed in flat, wide trays into each of which a constant flow of tap water was directed. The experiment terminated 10 days after the last observed germination.

RESULTS

Population structure

The populations are found in backwaters or in protected sites along sloughs out of the direct flow of water. They occur in depths from 0.15 to 1.4 m, as measured at the onset of flowering. Most of the populations were found in about 1 m of water at anthesis. Substrates vary from a relatively firm mucky sand to very soft muck. Organic matter and silt are high in the substrates at all sites. The rhizomes and tubers lie from 5 to 40 cm below the surface of the substrate, but usually between 10 and 25 cm. They are found deeper in mucky substrates than in sandy substrates.

Intra-populational morphological variation was shown to be significantly less than inter-populational variation during analysis of variance (p=.05). This tends to support the observations of Heritage (1895), Lowry (1924), Meyer (1930), and Hall and Penfound (1944), that vegetative reproduction is responsible for most of the growth in an established population. See Meyer (1930) and Hall and Penfound (1944) especially for their reviews and study of the rate and nature of vegetative spread of the lotus and the role of the tubers in this regard.

The populations appear to be isolated by the physical parameters of water depth and the rate of water flow. Given favorable conditions in a given area, a population will expand and eventually occupy that entire area. However, there will be no vegetative intermingling between two populations occupying favorable areas that are separated by an unfavorable discontinuity in water depth or flow. A fast-flowing slough, for example, may be relatively narrow, but the barrier it presents to the vegetative spread of populations on either side is probably absolute. While the intra-populational variation is relatively small, there are frequently startling differences between populations (Table 1, 2). These differences are statistically significant (p=.05.). A hypothesis concerning this inter-populational variation is yet to be tested and is the subject of another phase of this work.

Flowering

Flowering begins in this region in late July and continues until mid or late August. This is nearly 2 months later than the flowering period reported by Hall and Penfound (1944). There may be as much as a two-week difference in the onset of flowering of local populations. There are many commentaries regarding flowering (Lowry, 1924; Robertson, 1889; Taylor, 1927, to mention a few early reports). These authors recognized that variation was to be expected in floral behavior even within the same population. Fig. 1-4 show some of the stages in the flowering process. Flowers usually close during the first two nights after anthesis and open in the

TABLE 1. LOCALITIES AND MEASUREMENTS OF CERTAIN CHARACTERISTICS OF SAMPLE POPULATIONS OF NELUMBO PENTAPETALA.

Population	N[a]	Leaf blade width (cm) $\bar{X} \pm$ S.E.	Range	N[a]	Petiole L. (cm) $\bar{X} \pm$ S.E.	Range	N[a]	Peduncle L. (cm) $\bar{X} \pm$ S.E.	Range	N[a]	No. of Carpels $\bar{X} \pm$ S.E.	Range	Location, Description
I	50	26.5±4.3	16-33	50	67.3±6.7	47-79	50	87.1±8.9	57-102	80	16.6±3.4	11-24	Adjacent to boat ramp, Louis Nelson Park, French Island, La Crosse, Wis.
II	63	35.9±4.0	28-44	63	107.5±8.6	90-124	63	122.6±9.1	99-147	109	19.7±3.4	11-29	N E of boat ramp, Louis Nelson Park, French Island, La Crosse, Wis.
III	56	44.1±5.5	32-53	56	121.2±19.8	85-145	56	139.9±16.1	99-169	94	21.9±3.8	14-30	Near Wigwam Slough about 1 mile S of boat ramp, Goose Island, Vernon Co., Wis.
IV	49	33.1±4.4	25-49	49	77.5±7.4	64-90	49	92.5±10.7	70-125	37	21.0±3.8	15-30	Shallows opposite the Lawrence Lake Boat Landing, 1 mile N of Brownsville, Minn.

N[a] = number of individuals sampled for that characteristic.

TABLE 2. COMPARISON OF THE SIGNIFICANT DIFFERENCES BETWEEN THE POPULATIONS OF LOTUS UTILIZED IN THE STUDY WITH RESPECT TO CERTAIN MORPHOLOGICAL CHARACTERISTICS.

Populations (See Table 1)	Characteristics (+[a] –[b]) Blade Width	Petiole Length	Peduncle Length
I X II	+	+	+
I X III	+	+	+
I X IV	+	+	–
II X III	+	+	+
II X IV	–	+	+
III X IV	+	+	+

+[a] = significant difference exists between the populations compared for that characteristic (p = .05)

–[b] = no significant difference exists between the populations compared for that characteristic (p = .05)

morning. During the first two days the stigmas are receptive and the anthers are held tightly against the sides of the receptacle by the perianth. The flowers are protogynous and there is apparently no overlap between receptive stigmas and dehiscent anthers but this can vary, as mentioned above. None of the flowers that were bagged before anthesis and left alone produced fruit or seed. The numerous perianth parts begin to turn yellow several days before anthesis. The opening usually occurs during the morning. The experimental crosses that were successful were those made with fresh pollen and carried out before 12M.

Nelumbo pentapetala is entomophilous. The flowers attract a variety of insect visitors, as has already been shown by Robertson (1889), and from his list, as well as our observations, pollination appears to depend principally on members of the Apidae, and Andrenidae (Hymenoptera), and Syrphidae (Diptera). Individuals of *Apis mellifera*, the common honey bee, were the most frequently observed insects gathering pollen (Fig. 5). Most insect activity is over by 12M. Greatest activity occurs between 8 and 10 a.m. on a sunny day. There is no correlation between opening and closing movements of flowers and pollination by beetles here.

Development of the fruit

If pollination is followed by fertilization in a given flower, the receptacle rapidly expands in size as the fruit develops. The carpellary pits expand to accommodate the developing fruit. As the fruits shrink in the final stages of development, they come to lie loosely in saucer-shaped depressions (Fig. 6). That the development of the fruit has a direct bearing on the development of the surrounding portions of the receptacle is shown by the fact that if a receptacle has, for example, only 3 or 4 fruits developing out of a possible 25, only that portion of the receptacle surrounding the developing fruit also develops. The receptacles of flowers with undeveloped fruit do not enlarge at all (Fig. 9). Mature fruits can be gathered 4-6 weeks after pollination and are usually chocolate-brown or purplish-brown in color. I should here point out that I use the strictly botanical terminology concerning the fruit. The receptacle is not part of the fruit, and the indehiscent nut which is the fruit should not be called a seed when the entire fruit is meant.

Post-fertilization movements of the receptacle are well-documented and readily observed. Often, the portion of the peduncle below the receptacle causes the receptacle to turn (Fig 12). There is literature alluding to the receptacle breaking off at the point of attachment to the peduncle and floating, carpellary pit side downward, and thus acting as a float to disperse the fruit (Sculthorpe, 1968; Wood 1959). In the area of study, however, the receptacles often remain attached to the peduncles into the fall and throughout the winter as well, and are usually empty of their fruit by the time they do fall. The fruits sink at first but rise when germination begins. The young seedlings float for a time also.

Pollen Sterility and Cytology

The populations were sampled for pollen sterility during 1973 and 1974. Approximately 500 pollen grains were scored for each flower. Pollen which did not take up stain, and micropollen were considered sterile. The number of these kinds of pollen for each flower was averaged to yield the populational totals, reported separately for each year in Table 3. All of the populations were investigated cytologically. Most meiotic divisions appear normal, and the haploid number of chromosomes in these populations was found to be eight, as previously reported by Farr (1922) and Langlet and Soderberg (1927). Aberrations, particularly the presence of univalents, occur sporadically in all populations. The presence of univalents provides the cytological basis of the occurrence of the micropollen (Table 3) observed.

TABLE 3. SEED SET AND POLLEN STERILITY IN THE SAMPLE POPULATIONS OF NELUMBO PENTAPETALA.

Population	% Seed Set			% Unstained Pollen						% Micropollen					
	Intra-Populational Crosses (S^a)	Inter-Populational Crosses (S^a)	Open-Pollinated Flowers (S^a)	1973			1974			1973			1974		
				N^b	Avg.	Range	N^b	Avg.	Range	N^b	Avg.	Range	N^b	Avg.	Range
I	46.8(92)	58.7(254)	19.9(1097)	16	10.7	2.9-26.6	16	8.6	2.1-23.3	16	1.9	0.0-7.9	16	0.7	0.0-1.6
II	44.1(93)	48.6(675)	10.3(1346)	20	22.5	8.1-59.6	43	24.8	15.0-34.5	20	0.9	0.0-3.7	43	1.8	0.0-2.5
III	6.5(248)	17.6(888)	8.2(931)	18	10.8	2.9-22.2	16	6.3	2.4-8.8	18	2.5	0.0-11.1	16	0.6	0.0-1.7
IV	21.8(147)	33.1(175)	16.2(402)	12	12.2	6.7-20.5	12	9.4	4.1-21.5	12	1.8	0.0-3.8	12	1.1	0.0-3.4

S^a = the total number of carpels produced by the individuals utilized in a particular group. Each carpel matures into a single-seeded fruit.

N^b = the number of individual flowers sampled for pollen. Approximately 500 pollen grains were scored per flower.

Crossing Experiments and Seed Set

It was apparent after the conclusion of the first season of work that *Nelumbo pentapetala* in the Upper Mississippi is either self-incompatible or the protogynous mechanism is completely efficient. It was also apparent that seeds are not produced apomictically. No mature or developing seeds or fruit were ever found in the experimental group in which the flowers were bagged before anthesis and permitted to proceed through the season in that fashion. This was repeated each year with the same results. No seeds or developing fruit were found in the flowers from which the stamens had been removed and which were bagged, prior to anthesis and treated as the former group.

In referring to seed set in *Nelumbo*, one refers actually to the fruit, as mentioned previously, as each seed is found singly within a very hard fruit wall. There was no difficulty encountered in interpreting mature ovules as the ovules and the fruit expanded in size after successful fertilization. Frequently, fruit expanded a little in unpollinated flowers but remained abnormally small, and dissection of such a fruit demonstrated that the ovule within it had not developed. All mature fruit with seeds were taken as evidence of successful crosses.

During the course of the seed germination experiments, it was discovered that no population demonstrated a germination rate of less than 50 percent and population III had a germination rate of 77.4 percent. Despite the experimental design of the germination experiments the seeds were attacked by the water mold, *Saprolegnia;* otherwise the germination rate would probably have been greater. In any case, the relatively high germination substantiates the interpretation that fully expanded fruits contain fertile seeds.

Table 3 records all the inter- and intra-populational crosses for 1974, the year in which the mechanics of performing the crosses was perfected. For the purposes of this paper, all inter-populational crosses that occurred within a given population are combined regardless of the pollen source. The author will make available on request a list of the actual crosses made. Again, for the purpose of comparing inter- versus intra-populational crosses in a given population, the number of seeds set in the experimental individuals is measured against the total number of carpels that were present in those individuals.

Parasitism by Moths

The American lotus is liable to attack by a variety of insects. In the Upper Mississippi, the larvae of the lotus borer, *Ostrinia penitalis* (Grote), (Pyralidae), cause a considerable amount of damage in many populations. Welch (1919) has treated various aspects of the morphology, taxonomy and biology of *O. penitalis*, and a detailed description of the morphology and habits of the larvae in the Illinois River area is given by Hart (1895). The basic life history of the species has been dealt with in some detail by Ainslie and Cartwright (1922), concerning a population of the lotus in East Tennessee.

On American lotus in the Upper Mississippi River, the larvae of *O. penitalis* appear on the early emergent leaves of the plant sporadically during the early part of the growing season (Fig. 7). However, as the floral buds appear and develop, the number of larvae also increases until a peak is reached during anthesis. The early larvae on the leaves are usually not numerous enough to cause much damage, as they eat their way across the lamina to the centrally located petiole into which they bore and pupate (Fig. 11). An experiment performed in 1974 in which mature receptacles were placed in wire cages and left exposed to the elements during the winter of 1974-75 demonstrated that the larvae can overwinter in silk-lined chambers in the receptacles, and pupate in the spring. Adult moths began emerging on 17 May 1975, which was about the same time that the first floating leaves of the lotus appeared locally. This more or less confirms what Ainslie and Cartwright (1922) suspected as the manner in which the life cycle is completed.

It is the larvae which hatch from eggs placed on the flower buds or flowers that cause the greatest amount of damage to the plant, for they will cause the destruction of all or a part of the developing carpels, depending on the number of larvae and the stage of development of the flower (Fig 8). As many as 15 larvae have been recovered from individual receptacles. A plant without any larvae at all was rare in any population in 1974. Ainslie and Cartwright (1922) found that 5.9 percent of the lotus population they worked with was infested. They estimated that about 35 percent of the potential seeds in the infested flowers were destroyed. The redwing blackbird, very common in the area during the summer, amplifies the potential damage of the moth larvae, for they have learned to slash apart the flowers and the expanding receptacles in search of the larvae (Fig. 10,12). In population III for example, all of the controls were infested with larvae and most had been slashed by the redwing blackbird. This latter damage obscures that caused by the larvae and both kinds of damage obscure the number of carpels that fail to develop in a given flower due to lack of pollination and/or fertilization.

DISCUSSION

The majority of the habitats presently occupied by lotus in the study area were formerly alluvial forests, meadows, and marshes. Evidently, between the original inundation after dam building in the late 1930's the lotus moved into areas as they became favorable.

Unfortunately, we have no record of the flora of the area, except in general terms, before the locks and dams were constructed. We can assume, however, that the lotus was found, probably infrequently, in the quieter parts of the river. From these established populations, propagules in the form of seeds or seedlings would have been dispersed to new areas as these habitats became available, and this radiation permitted the juxtaposition of elements of the lotus which may have been geographically isolated along the old river. At what point these habitats became "closed" to the establishment of propagules is unknown, but the situation now is probably one where all available habitats are occupied and further increase will result mainly from the vegetative expansion of existing populations into adjacent areas that become ensilted as time passes.

It is probable that the morphological uniformity of most populations is based on a relatively low genetic variability imposed by the manner in which a population is established and is maintained. Open environments conducive to the growth of *Nelumbo pentapetala* must, as noted, be colonized by seeds or seedlings, as the tubers are not readily dispersed. The nature of the population that develops is therefore dependent upon the genetic composition of the disseminules. Once a population is established, it is doubtful whether new seedlings can compete successfully with the rapid vegetative growth of that population (Meyer, 1930). Rhizomes are long, branch regularly and frequently, and give rise to the tubers that carry the species through the winter and from which new growth proceeds the following spring.

The effect of sexual reproduction in populations of *Nelumbo pentapetala* on the Upper Mississippi River is felt over a long rather than short period. The year-to-year maintenance of populations is probably due to vegetative reproduction. However, as mentioned, seeds and seedlings must be the means of establishing populations in newly created favorable environments or in areas where the former populations have been destroyed. The mechanics of flowering and particularly the protogynous nature of the flowers indicates a strong tendency to favor outcrossing. It comes as a surprise at first, therefore, to see that sometimes there may not be a great difference between the experimental inter-populational crosses and intra-populational crosses as measured by seed set. With the information provided by seed set in the controls however, one soon realizes that the relatively low seed set observed in populations of the lotus may be due not so much to the source of the pollen, as orginally hypothesized, but rather to other factors, such as the damage caused by the larvae of *O. penitalis* (Grote). The experimental crosses were, as far as sexual reproduction is concerned, carried out under the best possible conditions for the plant. Fresh pollen was placed on all the receptive stigmas of the flowers, the flowers were searched for larvae which were removed, if found, usually at stages before they had bored into the receptacle. Also, the bags over these flowers not only protected them from extraneous pollen, but also from further infestations by the moths and attacks by the redwing blackbirds. The results of the experimental crosses indicate that, given the best possible conditions for pollination, seed set will usually be higher than one would normally expect from merely observing populations. This is true, whether one uses pollen from within a population or from a different population. An incompatibility factor is probably involved, however, particularly in population III, because all intra-populational crosses were less fruitful than inter-populational crosses. At this point it has not yet been possible to perform the critical experiment of knowingly crossing flowers produced by the same individual within a population, because it has been impossible to recognize with certainty a given individual in the field. Isolation of a single tuber in an isolated farm pond would yield the conditions whereby this could be determined with our local populations. Population III is also the one which has constantly suffered the greatest insect attacks, and the low seed set of its controls, relative to the controls in the other populations, reflects this. The results of the control group on population II may be related to the consistently higher pollen sterility in this population.

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COMPARISON OF WOODY VEGETATION IN THREE STANDS NEAR NECEDAH, WISCONSIN

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ABSTRACT

Forest stands studied west of Necedah, Wisconsin are compositionally similar but vary considerably in abundance and size measurements across the drainage catena. *Pinus strobus, P. banksiana, Quercus ellipsoidalis, Q. alba, Q. velutina,* and *Acer rubrum* are the dominant species in the area, and are generally found in the various stands, but they range from high importance status at one end of the gradient to minor importance at the other. The composition, abundance, and total stem size of stands are influenced by past physical influences, such as fires and logging, as well as by topographic and edaphic features.

INTRODUCTION

On the east side of the Wisconsin River between the Petenwell and Castle Rock flowages, 4 miles east of Necedah in Adams County, are woods that have been variously affected by human activities and physical factors. A long history of influences by Indian and white men precedes the present situation. With fire, by far the most important influence prior to European colonization, the Indian changed a large portion of the entire vegetational complex of Wisconsin (Curtis 1959). Fires were set to drive game, to improve berry crops, and to make traveling easier. In the early years of European settlement, the most important vegetational changes were caused by the reduction of fires. Most of the present pine forests date back to the beginning of protection from fires in the late 1800s (Curtis 1959). The major influence by white man upon vegetation was logging. By 1898, nearly the entire Wisconsin area had been logged. In recent times, the area has been developed mostly for agriculture, forestry, and recreation, although it is sparsely populated. A relatively rich terrestrial floral and faunal assemblage occurs here, as well as good quality aquatic habitat.

While conducting a baseline survey to determine the composition and abundance of terrestrial biota within a 2000-ha area, a vegetational gradient was detected relative to the drainage catena. Although presence of arborescent species is generally uniform across the catena, relative proportions vary considerably. The objective of this paper is to examine three wooded stands located along the catena from lowland (near the river) to upland (inland), and to describe their relationships.

The site is physically located in the Maple-Basswood Forest Region, but the woods are much like those of the Great Lake Section of the Hemlock-White Pine-Northern Hardwoods Region (Braun 1950). The wooded stands key to Curtis' Dry-Mesic Northern Hardwoods (Stand 1) and Dry Northern Hardwoods (Stands 2 and 3) communities.

Geology and Soils: The site lies in the Driftless Section of the Central Lowland Physiographic Province (Braun 1950). The terrain is generally flat with sandy plains, marshy lowlands, and low hills. The elevation ranges from 890 ft. to 950 ft.; wetlands are generally below the 900 ft. contour. The area has glacial outwash deposits. Soils range from poorly drained in Stand 1 near the Wisconsin River to excessively drained in Stand 3 away from the river (U.S. Dept. Agr. 1970).

The soils of Stand 1 are primarily of the Adrian Series with portions of the Morocco Series; both are poorly drained. The Adrian soils consist of 45-100 cm of muck overlain by sand or loamy sand. The water table is high and the soil has moderately rapid permeability with high available water capacity. The Morocco soils are coarse textured, both in the surface layer and in the subsoil with low available water capacity; permeability is very rapid.

In Stand 2, soils are of the Plainfield Series, with moderate to excessive drainage. Soils are generally sandy, overlain by acid sand on outwash plains and stream benches. They have low available water capacity and rapid permeability.

Soils of Stand 3 are of the Sparta Series which are excessively drained sandy soils with thick dark surface layers. They have low available water capacity with moderately rapid permeability.

Climate: The Wisconsin climate is typically continental. The average annual temperature varies from −8.5 to 22.4 C, with a mean of 7.5 C recorded at the Hancock Experimental Farm. The mean maximum January temperature is −2 to −4 C, whereas the mean minimum is −14.5 to −15 C. July mean maximum temperatures are 27.8 to 28.9 C and the mean mimimum is 23.2 C. The mean annual precipitation is 75.4 cm with an average of 91.4 cm of annual snowfall. Two-thirds of the annual precipitation falls during the growing season (freeze-free period, mean of 120 days). Wind is highest in winter from a general northwest direction, and lowest in the summer from south-southwest. Mean relative humidity varies from 75 to 86% at midnight and from 51 to 70% at noon.

METHODS

Wooded stands showing the least amount of recent disturbance during the life of the current generation of trees were selected for sampling in 1974-1975. Stands were also selected on the basis of uniform topography, size, and apparent homogeneity. Trees were measured by the point method, with 40 points per stand; saplings were measured by 15-m line intercepts, located at alternate points perpendicular to the transect; and, seedlings were counted in 1 m^2 circular plots, centered at each point. The presence of vines, shrubs, and herbs was also recorded in the plots and/or along line intercepts. The size classification adopted for the arborescent species was as follows: seedlings, less than 30 cm high; saplings, greater than 30 cm high, but less than 2.5 cm dbh (diameter at breast height); and trees, 2.5 cm dbh and greater. Absolute and relative values of frequency, density, and dominance were determined for trees; importance values were calculated as the sum of the relative values. Nomenclature follows Gleason and Cronquist (1963).

RESULTS AND DISCUSSION

Fifteen tree species were recorded in the present survey. Most were represented by trees with diameters 30 cm dbh and larger, a group constituting 23% of the 480 trees sampled. In Stand 1, the most mesic area, 30% of the trees sampled were 30 cm dbh or larger; in Stand 2, located approximately midway along the moisture gradient, 25% were in this size category; and, in Stand 3, the most xeric area, only 14% were 30 cm dbh or larger. Trees of representative species with the greatest girths sampled in the three stands were: *Pinus strobus*, 67.3 cm dbh; *Quercus ellipsoidalis*, 66 cm dbh; *Q. velutina*, 63.5 cm dbh; *Q. alba*, 47 cm dbh; *Acer rubrum* 44.2 cm dbh; *Pinus banksiana*, 30.2 cm dbh and *Populus grandidentata*, 30 cm dbh. Height of the three stands ranged between 14.8 and 18.0 m. The forests of this site are second growth. Extensive areas south and northwest of the study area are marsh, where aspen dominates the borders. Aspen are also locally important in several lowland areas, but are generally considered to be species of relatively short duration in any particular site. They generally mature in 40-60 years (Fralish 1975) in favorable sites and are succeeded by hardwood-conifer components. In some sites, however, aspen communities are regenerated because as nearly pure stands mature, uneven deterioration occurs leaving openings where miscellaneous tree and shrub species invade. In other sites, as a stand matures, it deteriorates rapidly and there is a rapid conversion with shade-tolerant species from the understory (Fralish 1975).

Stand 1:

Pinus strobus was the dominant tree with 10.1 cm dbh or larger in Stand 1 (Fig. 1). Common associates were *Q. alba*, *Q. ellipsoidalis*, and *A. rubrum*. The importance value of *P. strobus* (119) was equal to the sum of the importance values of the two oak species. Species in the stand that occurred less frequently were *Betula papyrifera*, *Pinus resinosa*, *Populus grandidentata*, *Prunus serotina*, and *Quercus velutina*, with a cumulative importance value of 28.

Basal area, indicating dominance, reflects the total area occupied by stems. The basal area of trees 10.1 cm dbh or larger was 37.5 m^2/ha. *Pinus strobus* contributed 50% of the basal area for the entire stand. *Quercus alba*, *Q. ellipsoidalis*, and *A. rubrum* cumulatively contributed 44.5% of the basal area.

Of the smaller trees 2.5-10.0 cm dbh, *A. rubrum* and *Q. alba* were prominent species with *P. strobus* a strong associate. These three species represented over two-thirds of the total importance value for this size class. Species of lesser importance were *P. serotina*, *Q. ellipsoidalis*, *P. virginiana*, *Crataegus* sp., *B. papyrifera*, and *Ulmus americana*.

Tree density in Stand 1 was 956 stems/ha, of which 416 stems/ha (44%) were small trees 2.5-10.0 cm dbh. The densities of *P. strobus* and *Q. alba* were nearly equal, approximately 250 stem/ha, followed by that of *A. rubrum* with 200 stems/ha. *Pinus strobus* demonstrated the most even distribution of stem sizes in the 8 size classes (Table 1), ranging from 7 stems/ha in the largest class of stems 55 cm dbh and larger, to 60 stems/ha in the 10.1-17.5 cm dbh size class; 35 stems/ha were recorded in each of two categories 2.5-6.1 cm and 6.2-10.0 cm (presented as one size class in Table 1). Greater densities were recorded of both *A. rubrum* and *Q. alba* small trees 2.5-10.0 cm dbh, than of *P. strobus* stems of relative sizes.

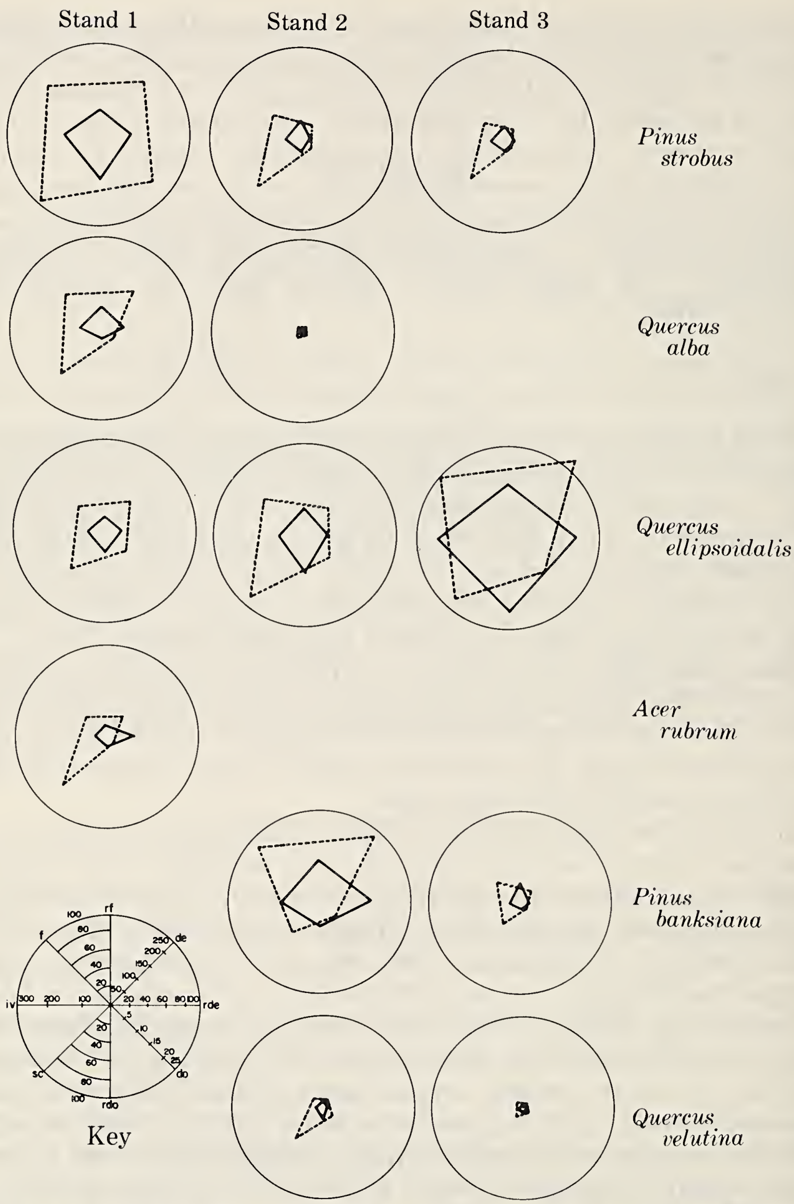

FIGURE 1. Phytographs of dominant arborescent trees. Dotted lines represent absolute frequency (f), density (de), and dominance (do) and percent representation among size classes (sc). Solid lines represent relative frequency (rf), density (rde), and dominance (rdo) and the importance value (iv). The key in the lower left indicates the scale of values.

However, the density of *P. strobus* stems in the larger classes 10.1 cm dbh and greater was 71% higher than that of *A. rubrum* and 36% higher than that of *Q. alba*.

Arborescent species with the most frequent occurrence in the seedling and sapling classes were *A. rubrum, P. serotina, Q. alba,* and *P. virginiana* (Table 1). *Acer rubrum* ranked first in both categories.

Herbs and low shrub species of the ground layer of Stand 1 were *Elymus virginicus, Cornus* sp., *Sanicula*, sp., *Smilax hispida, Pteridium aquilinum, Rosa* sp., *Carex* sp., *Geranium maculatum, Galium boreale, Desmodium nudiflorum, Maianthemum canadense, Uvularia sessilifolia, Dioscorea villosa, Lathyrus tuberosa, Lysimachia ciliata, Trientalis borealis, Lysimachia quadrifolia, Amphicarpa bracteata, Osmunda regalis, Spiraea latifolia, Onoclea sensibilis, Agrimonia gryposepala, Parthenocissus quinquefolia, Monarda fistulosa, Thelypteris palustris, Phlox* sp., *Smilacina stellata, Rhus radicans, Goodyera repens,* and *Aster* spp.

Non-tree species occurring in the sapling (shrub) stratum were *Corylus americana, Ilex verticillata, Cornus racemosa, Viburnum dentatum, Smilax hispida, Ribes missouriense,* and *Vaccinium angustifolium.*

Stand 2:

Pinus banksiana was the most important large tree species (importance value of 128.2), followed by *Q. ellipsoidalis* (94.0), *P. strobus* (47.5), *Q. velutina* (22.8) and *Q. alba* (7.5). In the small size class of 2.5-10.0 cm dbh, *P. strobus* and *P. banksiana* demonstrated nearly equal importance (100), and *Prunus serotina, Q. alba,* and *Q. ellipsoidalis* demonstrated equal values of approximately one-fourth that of the pines.

The total basal area of trees 10.1 cm dbh and larger in Stand 2 was 22.4 m^2/ha. *Quercus ellipsoidalis* contributed 39.7% of the total basal area, *P. banksiana* — 26.8%, *P. strobus* — 15.6%, and *Q. velutina* — 14.3%. *Quercus velutina* and *Q. ellipsoidalis* were the most abundant seedlings. In the sapling stratum, *P. serotina* also ranked high in frequency of occurrence.

The density of trees in Stand 2 of 942.3 stems/ha was nearly equal to that in Stand 1; however a greater portion of the stems (58%) were small trees in Stand 2. Although a greater percent of the small stems of the 2.5-10.0 cm class were *P. strobus* (37%) with the second

TABLE 1. RANK (R) OF SEEDLINGS (S), SAPLINGS (SA), AND TREES OF VARIOUS DIAMETERS IN CENTIMETERS WITH THE PERCENTAGE REPRESENTATION OF EACH SIZE CLASS PER ARBORESCENT SPECIES.

Location/Species	S	Sa	2.5-10.0		10.1-17.5		17.6-25.0		25.1-32.5		32.6-40.0		40.1-47.5		47.6-55.0		>55.0		
	R*	R	R	%	R	%	R	%	R	%	R	%	R	%	R	%	R	%	R
Stand 1																			
Pinus strobus	5		3	27.0	1	23.4	2	8.8	2	5.9	2	5.9	1	11.7	1	14.6	1	2.9	1
Quercus alba	3		2	44.8	1	24.5	1	12.3	1	9.2	1	9.2							2
Acer rubrum	1	1	1	65.4	2	15.5	3	7.7	3	3.8	3	3.8	2	3.8					3
Quercus ellipsoidalis	6	5	5	14.1	1	49.0			2	12.3	3	6.0			2	12.3	1	6.0	4
Prunus serotina	2	4	4	84.5			4	15.5											5
Prunus virginiana	4	3	5	100.0															6
Betula papyrifera			5	27.4	3	72.6													7
Crataegus sp.	6	6	5	100.0															8
Ulmus americana			6	100.0															9
Quercus velutina					4	100.0													10
Populus grandidentata									3	100.0									11
Pinus resinosa											3	100.0							12
Populus tremuloides	5	2																	13
Stand 2																			
Quercus ellipsoidalis	2	3	5	35.7	3	3.2	2	3.2	1	22.4	1	22.4	1	9.7	1	3.2			1
Pinus banksiana		6	2	42.1	1	31.5	1	18.9	2	7.6									2
Pinus strobus	3	6	1	80.7	2	9.7	2	1.9	3	3.9	2	1.9					1	1.9	3
Quercus velutina	1	1									3	33.3			1	33.3	1	33.3	4
Quercus alba	3	4	4	91.7									2	8.3					5
Prunus serotina		2	3	100.0															5
Prunus virginiana		5	5	100.0															6
Quercus macrocarpa		6	6	100.0															7

(Table 1 continued)

Location/Species	S R*	Sa R	2.5-10.0 R	%	10.1-17.5 R	%	17.6-25.0 R	%	25.1-32.5 R	%	32.6-40.0 R	%	40.1-47.5 R	%	47.6-55.0 R	%	>55.0 R	%	R
Stand 3																			
Quercus ellipsoidalis	1	2	2	16.8	1	12.5	1	31.9	1	31.9	1	4.2	1	1.4	1	1.4			1
Pinus banksiana			1	62.6	2	26.2	2	11.2											2
Pinus strobus		6	2	57.4	3	19.0	3	9.5			2	9.5	1	4.7					3
Prunus serotina	3	1	3	100.0															4
Quercus velutina	2	3	4	63.5									1	36.5					5
Prunus virginiana		4	5	100.0															6
Populus grandidentata		5																	7

*Rank of seedlings and saplings was determined by actual frequency, and rank of trees within size classes was determined by actual density.

largest being *P. banksiana* (30%), larger tree densities (10.1 cm dbh or larger) were predominantly of *P. banksiana* (58%), *Q. ellipsoidalis* (25%), and *P. strobus* (12%). Most of the large stems over 32.6 cm dbh were oaks. *Quercus ellipsoidalis* reflected the most even distribution in the various size classes.

Herbaceous species in the ground layer of Stand 2 were *Carex* sp., *Rubus* sp., *Euphorbia corollata, Smilacina stellata, Rumex acetosella, Rhus radicans,* and *Vitus* sp. Non-tree species occurring in the shrub stratum of Stand 2 were *Corylus americana, Zanthoxylum americanum, Ribes missouriense, Rubus allegheniensis, Vitis* sp. and *Cornus* sp.

Stand 3:

Quercus ellipsoidalis was the dominant tree species of stems 10.1 cm dbh and greater in Stand 3 (importance value of 212). Other species present were *P. strobus, P. banksiana,* and *Q. velutina* with importance values of 42, 38, and 8, respectively (Fig. 1). *Pinus strobus, P. banksiana* and *Q. ellipsoidalis* shared high importance values of 92.5, 90.6, and 78.8, respectively, in the small tree size class of 2.5-10.0 cm dbh.

The total basal area of trees 10.1 cm dbh and greater was 18.1 m^2/ha; *Q. ellipsoidalis* contributed 78.5%, and *P. strobus* contributed 12.7%. *Quercus ellipsoidalis, Q. velutina,* and *P. serotina* were the most abundant seedlings and saplings.

The density of trees in Stand 3 was 592.3 stems/ha. Most trees were large, with only 36.5% in the 2.5-10.0 cm dbh size class. Of the small trees, 78.5 stems/ha were *P. banksiana* and 56.8 stems/ha were recorded each for *Q. ellipsoidalis* and *P. strobus. Quercus ellipsoidalis* was the most dense large tree of 10.1 cm dbh and greater with 282 stems/ha, 75% of the total. *Quercus ellipsoidalis* demonstrated the most even distribution among size classes of any species. *Pinus banksiana* and *P. strobus* each had approximately 45 stems/ha, each 12% of the total large tree density.

Herbaceous and low shrub species in the ground layer were *Carex* sp., *Rubus* sp., *Chimaphila umbellata, Smilacina stellata, Euphorbia corollata, Apocynum* sp., *Rhus radicans, Rosa* sp., and *Lactuca biennis.*

Non-tree species in the shrub stratum of Stand 3 were *Rubus* spp., *Cornus racemosa, Vaccinium angustifolium, Rosa* sp., *Corylus americana,* and *Amorpha canascens.*

Stand Comparisons:

Stand 2 exhibited the greatest total similarity to Stand 3 in all strata (Fig. 2). The greatest similarity was betweeen the small tree strata (79%), largely due to the common occurrence of *P. strobus* and *P. serotina* in the understory. The large tree and seedling strata exhibited nearly equal similarity values, 70.4% and 69.4%, respectively, whereas the similarity between sapling strata was only 56.4%. The high percent similarity between large tree strata

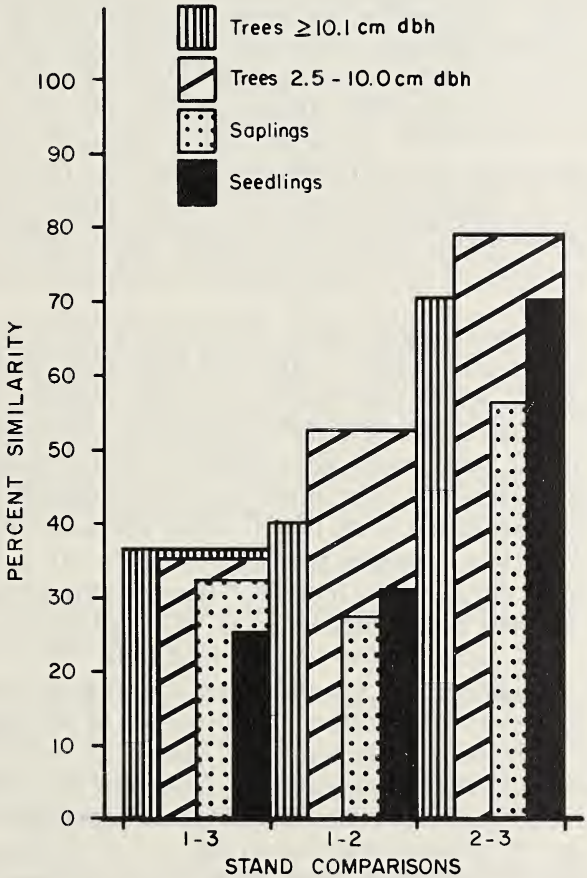

FIGURE 2. Percent similarity of stands by strata. Values are based on relative frequencies using 100 a/b, where a is the sum of the shared values of the two compared strata and b is the sum of the values exhibited individually.

was largely due to similar occurrences of *Q. ellipsoidalis*, *P. banksiana*, and *P. strobus* in Stands 2 and 3, whereas that of the seedling class was due to *Q. ellipsoidalis* and *Q. velutina*.

In a comparison of Stand 1 with Stand 2, small tree strata demonstrated a moderate similarity (51.4%), largely due to the similar occurrence of *P. strobus* and *P. serotina* in both stands. Other strata comparisons indicated less than 41% similarity. The occurrence of *P. strobus* and *Q. ellipsoidalis* in the large tree strata was similar between the two stands.

All percent similarities of strata between Stand 1 and Stand 3 were below 37%. The large tree strata demonstrated the greatest similarity (36.7%), followed by the small tree strata (34.9%), sapling strata (32.7%), and seedling strata (25.2%). In the over-story, *P. strobus* and *Q. ellipsoidalis* demonstrated the most similar occurrence in both stands. In the small tree strata, *P. strobus* and *Prunus serotina* had the most similar occurrences. The occurrence of *P. serotina*, *P. virginiana*, and *Q. ellipsoidalis* contributed most highly to the similarity index of the sapling strata. Seedlings of *Q. ellipsoidalis* and *P. serotina* had similar high occurrences in both stands.

Several phytosociological trends were seen along the drainage catena. Absolute and relative values of frequency, density, and dominance for *P. strobus* increased along the moisture gradient (Stands 3 to 1, Fig. 1). The greatest variety of *P. strobus* stem sizes was found in the most mesic area. *Quercus alba* demonstrated a similar trend; *Q. alba* was most important in the most mesic habitat, with little representation in the two most xeric stands. The trend of *Q. ellipsoidalis* was opposite that of *P. strobus;* all parameters measured for *Q. ellipsoidalis* increased from the mesic to the most xeric area. Percent representation of *Q. ellipsoidalis* stems in the size classes was equal in the two xeric stands. These trees are susceptible to damage by ground fires but rapidly regenerate afterward by sprout production. The presence of *A. rubrum* was notable only in the most mesic habitat of Stand 1. *P. banksiana* was most prominent in Stand 2, although this species was represented by a limited variety of stem sizes. Logging and fires tend to enhance conditions for *P. banksiana* at the expense of *P. resinosa* and *P. strobus* (Braun 1950). Stems were dense but of uniform size. The basal area of *P. banksiana* was low in both Stand 2 and 3. *Quercus velutina* had its greatest development in Stand 2, although it was not particularly prominent in the forests of the Necedah area. *Q. velutina* tends to grow best in sites of moderate available moisture.

Although the species is generally considered to be intolerant of shade, it is frequently found beneath *Q. ellipsoidalis.*

Total basal area of small trees 2.5-10.0 cm dbh increased along the catena, with 0.6 m^2/ha in Stand 3, 1.0 m^2/ha in Stand 2, and 1.3 m^2/ha in Stand 1. Small tree stems were most dense and represented the greatest percent of the total density of stems 2.5 cm dbh and greater in Stand 2 (549 stems/ha, 58% of total); Stand 1 had 416 stems/ha, 43% of total; and Stand 3 had 216 stems/ha, 36% of total. Basal area of trees 10 cm dbh and larger decreased across the gradient from Stand 1 to Stand 3. Similarly, density of large trees decreased across the gradient, but that of Stand 2 (394 stems/ha) approximated that of Stand 3 (376 stems/ha); Stand 1 had a density of 540 stems/ha of trees 10 cm dbh and greater. The total density of all trees 2.5 cm dbh and greater was nearly equal in Stands 1 and 2, whereas that in Stand 3 was much less.

The stability of these stands is low. In the absence of fire or other disturbances, they are essentially one-generation forests. Pines are intolerant of their own shade and may gradually be replaced by hardwoods. *Pinus strobus,* although certainly a dominant in Stand 1 and more shade tolerant than *P. banksiana* or *P. resinosa,* will probably eventually give way to *A. rubrum* and *Q. alba,* provided that the moisture regime remains constant. Due to the xeric conditions in Stands 2 and 3, successional trends will probably lead to *Q. ellipsoidalis* dominated forests. The composition and abundance of species in future forests at these locations will probably follow a similar trend along the drainage catena.

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MEXICAN-AMERICAN MIGRANTS IN WISCONSIN, WITH PARTICULAR EMPHASIS ON MIGRANT FARM LABOR

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The article sketches the immigration of people of Mexican heritage to Wisconsin and explores some aspects of the adaptions they have made, and some of the social, economic and cultural-ideological consequences of these adaptations.

The Mexican-American group is composed of Americans of Mexican heritage, many of whom are long-time residents of the United States, even before there was a United States of America in some cases. The group also contains more recent immigrants, legal and illegal, from Mexico. We call these two categories of people Mexicanos.

Most Mexicanos live in the Southwestern United States: in Texas, New Mexico, Arizona, Colorado, Utah and California (see Table 1). United States acquisition of these territories was a process attended by disputation in the mid-nineteenth century; it changed a number of Mexicans to American citizens. Systematic land expropriation, largely by informal means, left these new citizens with little regard for the U.S.A. and its justice.

Furthermore, there is the matter of continuing immigration. Emigration from Mexico to the United States occurred at a slow rate, on the basis of demand for migrant labor mainly in the Southwest, until the Mexican Revolution of 1910-1920. Attended by much civil disorder, the Revolution precipitated rapid migration to the United States (Gamio, 1930), again largely to the Southwestern U.S.A.

Focusing on the Midwest

During World II labor shortages led to the use of Mexicanos in Midwestern United States (Hill, 1948). The importation of labor from areas of labor surplus to areas of labor scarcity took two forms: either urban (and permanent) or rural (and seasonal).

Urban migration attracted Mexicano workers as cheap labor in times when labor was scarce. Since World War II the rate of in-migration to the cities has fluctuated in response to numerous factors, including job availability in the Southwest vs Midwest, the

TABLE 1. MEXICAN-AMERICANS AS A SEGMENT OF POPULATION OF THE SOUTHWESTERN

State	Total Population	Mexican-American Population	
		No.	%
Arizona	1,811,500	270,000	15
California	20,830,000	1,675,000	8
Colorado	2,110,000	187,000	8.8
New Mexico	1,085,000	356,000	32.8
Texas	11,380,000	1,883,000	16.5
**Total	37,216,500	4,371,000	11.7

*Grebler et al. 1970 pp. 605-608

**It is estimated that census gathering of data on Mexican-Americans is sufficiently in error to allow an estimated additional 700,000 individuals in the total number of Mexican-Americans in the Southwest.

general economic climate and so on. In some cases the migrants returned home, when work slackened.

Social science studies of Mexicano migrants to the urban Midwest include: Humphrey (1944) for Detroit, Mich., Macklin (1963) for Toledo, Ohio, Taylor (1930) for Bethlehem, Pa., Shannon and McKim (1974) for Racine, Wis., and Samora and Lamanna (1967) for East Chicago, Ind. The following generalizations emerge from these studies:

1. Language problems are a persistent difficulty in effective communication of the Mexicano migrant with other citizens.
2. Employment is almost entirely in blue-collar jobs of low skill levels.

This latter statement is a continuing fact. For example, Samora and Lamanna (1967) found that in East Chicago, a community with a Mexicano component dating to before World War II, 90% of Mexicanos had blue-collar jobs. Shannon and McKim (1974) found some improvement in Racine in the proportion of white collar Mexicano employees between 1960 and 1971, but the percentages are still in the range found by Samora and Lamanna.

As these blue-collar Mexicano communities grow, largely by *chain migration*[2], ethnic enclaves with discrimination and lack of social, educational and skill resources develop into persistent components of the cities involved. In Wisconsin, Racine, Milwaukee and Kenosha are excellent cases in point.

According to Shannon and Morgan's study of Racine (1966) Mexicanos were significantly worse off than either Anglos or Blacks in terms of such factors as income, education, status of employment, social participation, occupational mobility, standard of living and level of aspirations. Thus urban Mexicanos not only tend to become ethnic enclaves but their future chances are poor because they are not acquiring those things which would permit them to break out of their situation.

Let us now turn to rural Wisconsin Mexicano migrants.

In the period of severe labor shortage of the 1940s, Wisconsin farmers and canners sought outside labor to supplement the local sources depleted by military service. A major available source was Mexicano migratory labor from South Texas. The workers were skilled; they worked hard; they accepted long hours and relatively low wages, and were generally available year after year. Thus the investment of time, money and effort to provide the cyclic migrants with housing, transportation and other needs was worth it to the farmers and canners. (Hill, 1948).

Many workers were needed because of the labor-intensive system of picking and packing the crops involved. For the most part, this situation was due to the inherent difficulties of mechanization or to the small effort to mechanize those crops on the part of agricultural engineers. This fact is significant for the future of farm labor, since efforts to mechanize go forward only so long as price for the crops involved warrant it. As successful machines are built, they will be used, thus reducing the need for migratory labor to the vanishing point for that crop, local skilled labor being sufficient to fully mechanized agriculture.

In the 1940s the newly recruited Mexicanos worked so well that after the World War II they continued to be employed. In fact, particular growers and particular migrant families or crew leaders often established a vertical mutual dependence or patron-client relationship in which: inexpensive, skilled farm labor was provided at the right time in exchange for work and seasonal housing.

This relationship between farmer and migrant is often personalistic and affective (this is less likely in relation to universalistic, affectively neutral canneries). One can speak of the *paternalism* of the farmers and the *loyalty* of the migrants, which is actuated by self-interest, but often the affection seems genuine enough, nevertheless. Examples of the paternalism include growers bailing migrants out of jail following arrests on drunkeness charges, giving credit references for migrants at local businesses and even lending money to migrants to buy a farm and "settle out" of the migrant stream (Provinzano 1971). The last goes rather farther than pure self-interest would dictate. Although it is unusual, it is not strikingly out of character for at least some of the growers.

Wages

Despite the above, wages of the migrants still tend to be extremely low. The following example will indicate the problem, as it pertains to cucumber workers (WSES, 1967).

Mean hours worked per day	5.89
Mean hourly earnings, $	1.51
Mean pounds harvested per hour	79
*Mean earnings per day $	8.89
Mean earnings per 6 day, $	53.34

*U.S. farm labor in general earned $10.05 per day (mean).

The above data cover all categories of workers—adults and children working as family unit.

Computed from the migrants' average wage, $3541.77 would be the income of a family of four, all working full time for the maximum number of days migrants work, about 100. If one compares this income with the $3200 rural poverty level set by the President's Council of Economic Advisors (1969) for that year, one can see that it seems hardly worthwhile to work in such circumstances. Especially is this true considering how hard migrant work is.

Working and Living Conditions

Working and living conditions of migrant farm laborers have been exposed in television specials (e.g. CBS classic *Harvest of Shame*), countless news and feature articles in the popular press and in many other organs of communication and otherwise. Conditions in Wisconsin do not seem as bad as some described and pictured elsewhere.

Farm workers, whether field or cannery workers, work long hours, broken by gaps caused by rain, uneven ripening of produce and, frequently, poor grower organization and planning. All but the latter cause are endemic to agriculture and mostly unavoidable. The poor organization and planning of growers, however, occurs because many farmers themselves are not highly skilled managers. In order to make best use of farm labor, a farmer should plan so that the workers can be kept continuously busy. Examples include the planting of successional crops or planting the same crop in series to make hand harvesting more possible. He can also plant the crops, fertilize, and irrigate so that yield per plant makes the piece-working farm laborer feel that the effort expended is worthwhile.

Unfortunately, for both the farmer and the laborer, many farmers do not do these things well. This leads the migrant worker to seek work primarily with farmers whose fields are attractive. This is especially true of the family-type worker unit, which will establish a rather lasting tie with a particular farmer provided their experience is profitable. If it is, they may return year after year and maintain contact over the winter through occasional letters.

Cannery workers are also subject to violent fluctuations in amount and duration of work, since the crop will not wait and eighteen-hour days at a rush, succeeded by idle days, are part of the nature of the job. Canners' attempts to reduce this boom-and-bust cycle have been largely ineffective.

Farmers and canners generally provide housing as part of the overall financial arrangement. Those utilities which are provided (minimally electricity and water) may or may not be charged for. Housing is generally cramped, at times scandalously so, but is generally clean. Bathing and clothes washing facilities are often provided, but are often rather primitive and inadequate. Canneries usually provide a commissary at which food, usually cooked by a Mexicana, is provided for a fee. Old barns and even old chicken coops occasionally are provided as "housing". Luckily this is becoming rare in Wisconsin. In one instance very poor housing was provided by a farmer, but it was hard to criticize him when his own house had dirt floors. The range of variation of housing quality is rather great. Canneries will generally paint up their housing to look nice at a distance and put a good sized field between it and public highways.

The application of regulations on migrant housing through enforcement procedures is very difficult. Inspectors are few, camps are many and scattered, and harvest seasons are short enough that compliance may come after the housing has been vacated.

Problems of Organization

The migrants have little power to improve wages, working conditions or living conditions. First of all, they lack the wealth to sustain a strike. The nature of their economic resources can be surmised from the information on wages given previously. However, if this were the only obstacle to organization, they would probably have been organized effectively long ago through affiliation with larger labor unions with the resources to support a strike.

Other obstacles to organization include the following:

a. *Insecurity:* There is first of all a surplus of farm labor most of the time. Mechanization and related efficiencies, plus crop diversification has reduced job availability. Secondly, the relationship between a farm worker and employer often is not simply employee-employer, but personal and long-term as well. The worker is a "client", the farmer is a "patron". This makes the worker unwilling to offend this source of livelihood and perhaps this "friend", too. The affective component should not be ignored.

b. *Labor cost:* Planting a labor-intensive crop has depended upon a substantial supply of skilled, cheap labor. If the cost of that labor were to go too high, the farmer would tend to purchase a machine to do the job, if one exists for the crop involved, or he would switch to a mechanized crop. In the case of canneries the wealth and labor surplus factors are also applicable, whereas the long-term employer-employee relationship and mechanization factors are less significant. However, canneries are usually part of a large company which has many plants and which can afford losses at any one for extended periods. In some cases, especially if the plant is not very profitable, they may even shut down a plant troubled by labor organization (this did happen at one plant during the author's research).

The above facts lead to the disturbing conclusion that far from warmly embracing organization attempts, migrant farm workers find that such attempts threaten what they do have.

Impact of Migrant Workers on the Community

The migrant farm workers do have a substantial impact on the communities they service. First of all, although their incomes are relatively small, their aggregate buying power in this, their flush time, is considerable in the communities of relatively small population surrounding their work places. They buy food, dry goods and even durable goods. Most merchants look forward to their coming and often stock certain items especially to appeal to them (eg. pinto beans, western hats and the like).

Furthermore the migrants' presence creates jobs for people such as State Employment Service local coordinators, irrigation gangs (local people, generally), social service aides, extra retail sales employees and so on. The migrants' presence can mean community prosperity. In fact the migrants are the key to the labor-intensive agricultural system in the communities they visit and work in.

Discrimination—A Surprise?

Based upon the above description, an outside observer might expect the farm workers to be hailed as welcome, though temporary additions to the community, since after all they are indispensable to the economic life of the communities as that life is currently defined. We find, however, that this is not so. Mexicano migrants are not welcome in most local bars; they are patronized or treated rudely in retail establishments; they are treated with a wary, contemptuous suspicion by officers of the law. People say that they are drunks, that they carry knives, that they are stupid, that women are not safe around them.

One may explain these local attitudes as the normal xenophobia of an insular farming community, except for the following facts: tourists in these areas are welcome with much less hostile resentment, and the farmers tend to be less likely to share these negative attitudes (presumably personal contact reduces the tendency to stereotype). A more plausible explanation may be that of racist stereotype: Anglos discriminating against Mexicanos. There is undoubtedly more to this explanation than to the previous one, but it is incomplete as well, since Anglo farm workers tend to meet the same attitudes, *if* their occupation is known to the townspeople. Thus a complete explanation of the phenomenon of prejudice and discrimination should include xenophobia, racism plus a contempt for people who are poorly paid, transient, and live in poor accommodations. The migrants do not live the good life, as it is defined in materialistic America. Therefore they are *stigmatized.*

As should be clear from the foregoing discussion, the stigmatizing of Mexicano farm workers in Wisconsin is a complex process with many constituent elements in it. To describe the causes of the stigmatization as being due to the rapacious cruelty of farmers and canners is as oversimplified as was the portrait of Simon Legree in UNCLE TOM'S CABIN an oversimplification of the nature of slavery. If one were seeking to put together a tract with organizational ends in mind (eg. to be used to help unionize farm workers), then such oversimplification is pragmatically justifiable (but only to "fan the flames of discontent"). However, such tracts should not then be labelled social science.

Whatever circumstances may be for migrant farm workers in other parts of the country, in Wisconsin they are caught up in a system in which their desirability as workers is their low cost, their proficiency and their availability for short term seasonal work. Anything that would tend to alter any of these three factors would tend to make them less desirable employees. Since most of their employers are small, not very efficient and under-capitalized farmers who are being squeezed by cost-price pressures themselves, organization of field workers in labor unions is a very unrewarding venture. Efforts to turn cannery workers in the direction of unionization have met with more success and organizers have, therefore, increasingly focused upon this latter group.

What the Future Holds

For migratory farm workers, especially for field workers who are the majority, increasing mechanization, rampant inflation and increasing resentment of stigmatization all have led to search for alternatives to migrant agricultural work. The obvious possibility is to leave the migrant stream, and many have done this. They "settle out", in many cases simply by staying home and trying to make a go of it in places like Brownsville and Crystal City in Texas. These are places of labor surplus, and so this solution is not very satisfactory. Many settled-out migrants in Wisconsin described to the present author what appeared to them to be the limited choices available to them, which eventually brought them to take up permanent residence in Wisconsin.

Generally speaking, there are two modes of settling-out at some point on the migrant stream:

1. *Involuntary settling-out.* Those who settle out of the migrant stream out of desperation are included in this category. Often their decision has an unplanned quality. They do not know what to do: previously dependable sources of agricultural employment have dried up, financial resources of agricultural employment have been spent, relatives or friends offer as their only real aid the suggestion that they settle down in X community. The involuntary settled-out usually find X community to be the hispanic ghetto of a central city. In Wisconsin it is often Milwaukee.

   The author has seen people in this category on welfare or with very menial jobs. However, a few do succeed in finding positions of some substance, although always blue collar work. Whether they eventually find relative prosperity or not, individuals in this group tend to feel that they are not actively involved in charting their own destinies.

   Much attention has been paid to the involuntarily settled-out migrants by service agencies, both public (esp. United Migrant Opportunity Services) and private (eg. the Catholic Church). This is as it should be, since this category contains those who are most in need of aid. There is, however, another category of settled-out migrants to whom less attention is generally paid.
2. *Voluntary Settling-Out.* This category contains individuals or, more frequently, families who settle out of the migrant stream because they wish to improve their economic situation and choose to do so, not out of desperation, but because alternatives to migration seem attractive and they feel some confidence that they can manage the new life.

   The author's research on this latter group has focused on a rural area and a medium-sized city, both in Central Wisconsin. Individuals in this group are more like the indigenous Anglo population than they are like the average migrant (Table 2). They have more schooling than the average migrant (3.3 years more), are bilingual, have small families (4.4 persons vs. migrants' 7+) and, very significantly, have voluntarily settled into an Anglo community which has no coherent Mexicano community whatsoever. The author found in Fond du Lac (population approximately 40,000) that the twenty-seven

TABLE 2. SETTLED-OUT MEXICANOS COMPARED WITH NON-SETTLED-OUT MEXICANOS (SAME LOCALITY) AND WITH ANGLOS OF FOND DU LAC, 1971.

	Mexicanos		Anglo families
	Settled-out	Non-settled-out	
No. families	27	58	25
No. persons (adults+children)	120	435	92
Mean family size	4.4	7.5	3.7
% adults bilingual	100	58	--
% migrated in parental generation	97	--	6
Mean residence in city, years	16	--	22
Mean schooling adults	8.1	4.8	*10.4
% HS graduates	35	8.8 (10 of 114)	*44.2
% male laborers (construction, general)	50	--	* 4
Mean family $ income, yr	6,040	2,631	*7,837
Income range, $	Unemployed to 12,500	Unemployed to 6,100	*Unemployed to 50,000

*Source—Wisconsin Statistical Reporting Service and U.S. Census Bureau, Regional Census Data.

settled-out Mexicano families were not even aware of each other's existence in many cases. Specifically, no one family knew of more than six other Mexicano families and the mean was three.

The first problem was locating them. As a dispersed non-group, social angencies were of little help to us. We found that "Chicano ex-migrants" was more an analytical and less a folk category than we had believed possible. Finally we located them by chain identification. That is, each family knew about one or two others until we had located the full 27 families.

A few of the migrants who settled-out did so at great obvious advantage to themselves and with very little risk. One individual, for example, bought a good working farm on the outskirts of town with the money to pay for it lent, interest free, by a former employer, a local grower-patron. Such a situation is most unusual. Generally those who settled out did so to enter wage work with little risk-reducing aid.

In interviews and other contacts, as the researchers came to know the ex-migrants and to comprehend their adaptations, a contrast of the general parameters of those who voluntarily settle-out, as compared to those migrants who do not settle out, began to emerge. Some factors are quantifiable or are expressible in mutually exclusive categories as in Table 2.

This form of settling-out also was a long-term phenomenon (one family had settled-out in 1946). Mean income in 1971 was $6,040 per family, compared to $7,837 for the city's Anglos. Other comparisons are equally instructive. For example: income differentials indicate clearly that self-selected or voluntarily settled-out families earn substantially more than those who continue migrating. On the other hand, the income differential between the settled-out group and the other Fond du Lac families can generally be explained on the grounds that the settled-out group tends to be involved almost exclusively in non-managerial, blue collar laboring and related fields.

Based upon the above data, we may summarize the characteristics which separate the voluntarily settled-out migrant from the continuing migrant and, from the involuntarily settled-out migrants as follows—they:

1. have a smaller number of children
2. have a greater facility in English
3. have more formal education, often including high school graduation
4. have substantially greater income without the child labor of farm work
5. have the willingness to go it alone, even to sever supporting ties

of kinship and friendship with other Mexicanos (Provinzano, 1971).

The above characteristics (especially the last) suggest that there are in the voluntarily settled-out group, some rather "Anglicized" Mexicanos. This type of voluntary settling-out, isolated as it is from the familiarity of a Mexicano community and the support of kinsmen, generally requires that the family possess a fair skill with English, confidence that the family breadwinner can get and keep a job, relative lack of dependence on traditional supportive (kinship or friendship) ties and some sophistication at self-integration into the Anglo community.

The question which occurred to our research team at this point was as follows: Was submergence of ethnicity necessary for comfortable adaptation to an Anglo sociocultural context? Subsequently, was any anti-Mexican prejudice encountered in the community? Relevant to these questions, two of the student team members did in-depth interviews with eleven adolescents from settled-out families. Most of these adolescents (8 of 11) had been born in Fond du Lac. From this investigation the following generalizations emerged:

1. The adolescents expressed little feeling of pride in, or knowledge of *La Raza* or of Mexicanness, although one parent or both had been born in Mexico in 80% of the cases.
2. There was little knowledge of the Brown Power Movement. Cesar Chavez was just a public figure name to most of them.
3. Five of the eleven spoke only English. Places of birth: Fond du Lac 8; Texas 2; Mexico 1.
4. They seemed to be aware of discrimination on a very low and subtle level, but tended to attribute it to idiosyncracies of the individual Anglo involved, rather than a group trait of Anglos.
5. They concurred that opportunities for them were not quite what they would be for an Anglo, but seemed to feel that by hard work they could make up the relatively small inequity.

These adolescents admittedly live in a community peripheral to main, traditional Mexican-American population centers and peripheral to Chicano activism as well. However, this does not gainsay the fact that they have carried further a process begun by their parents (who express much more awareness of discrimination in Fond du Lac). The phenomenon described above may well be called the process of Anglicization and assimilation. It suggests that successful, dispersed settling-out into Anglo communities is possible, but only at the price of submergence of ethnicity. If the ideology of Brown Power does not penetrate Chicano consciousness in Fond du Lac soon, one can hypothesize attempts to "pass" as Anglos, name changing, and eventual efforts to achieve a dissolution of Chicano identifiability and consciousness.

This possibility may be viewed as not only inevitable, but desirable by many of those involved. If so, it will be interesting to see how far such dissolution goes, and also interesting to see how the darker-skinned individuals deal with color problems, especially as more inter-marriage with Anglos is attempted. Some future experience with Brown Power may be hypothesized, the results of which in Fond du Lac may be significant, though we tend to doubt it, unless the individual migrates to an area with a high Chicano population density in another city.

It is, perhaps, unfortunate that the cost of assimilation in this context at least, is the apparent loss of cultural distinctiveness and heritage. Alternatively, the involuntarily settled-out family may live in a situation that does permit the maintenance of Mexicano tradition, although often enmeshed in a spiral that spells poverty.

NOTATIONS

1. The author has been leading a team conducting research from 1969 to the present on Mexican migrant farm workers in a rural Wisconsin county as well as on settled-out migrants in a number of areas in Central Wisconsin.

2. Chain migration is a process by which migrants aid and encourage friends and relatives from the home area to join them. Obviously there is substantial potential for geometric growth.

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MADISON LITERARY CLUB

— Centennial Dinner Program —

November 8, 1977

ORDER OF EVENTS

Presiding: President Merton M. Sealts, Jr.

Toastmaster: Mark H. Ingraham

Reading of the Papers and the Poem

Foreword

It is appropriate for the Wisconsin Academy of Sciences, Arts, and Letters to offer to publish the following papers, which were delivered at the Centennial Dinner of the Madison Literary Club. The Academy and the Club have an impressive community of interests and of longevity in the Madison area, both having attained the magic age of one hundred years. Membership roles of the two organizations reveal an early and continuing interlocking of names from Dr. Joseph Hobbins (founder of the Club and charter member of the Academy) to more than fifty members and co-members at the present time. The Ella Giles referred to in the Academy's letter to President Sealts became an Academy member during the very year that she aided in the founding of the Madison Literary Club. The exchange of letters between the Academy and the Club concerning the Centennial festivities is herewith recorded.

Professor Merton M. Sealts, Jr.
University of Wisconsin
Department of English
7165 White Hall
Madison, Wisconsin 53706

Dear Professor Sealts:

On behalf of the Wisconsin Academy of Sciences, Arts and Letters, please accept, and extend to the membership of the Madison Literary Club, our sincere congratulations and best wishes upon the occasion of the centennial of the founding of your esteemed organization.

As you may know, the Wisconsin Academy was chartered by the State Legislature only a few years prior (1870) to the founding of the Madison Literary Club. In fact, Ella A. Giles, who was a principal figure in the establishment of your Club, was among the first group of women to apply for and gain acceptance into the Academy membership. Interestingly enough, this was in the year of the founding of the Madison Literary Club. In its earliest years, the Academy took the position that "science and letters have neither country, color or sex."

And so, in scholarly interest and in the spirit of fellowship that governs our two organizations, as well as in historical background and in membership, we have much in common. It is, perhaps, only natural that we therefore take special note of your one-hundredth anniversary and that we rejoice with you in your sense of accomplishment and in your hopes and plans for the years ahead.

Sincerely,

Elizabeth McCoy
Honorary President

EM:sd

11 November 1977

Professor Elizabeth McCoy
Honorary President, Wisconsin Academy
of Sciences, Arts & Letters
1922 University Avenue
Madison, Wisconsin 53705

Dear Professor McCoy:

On behalf of the Madison Literary Club I am writing to thank you for your kind letter of congratulations on the occasion of the Club's centennial.

As President for 1977-78 I had the pleasure of reading your letter to the membership at our anniversary dinner last Tuesday evening. Like Ella A. Giles, whom you mentioned so appropriately, a number of the Club's members are also members of the Academy (as I am myself), and you are certainly correct in saying that the two organizations have much in common. May both continue to flourish in the years to come!

Cordially,

Merton M. Sealts, Jr.
President, 1977-78
Madison Literary Club

THE TOASTMASTER'S OPENING REMARKS	Mark Ingraham
THE PAPERS AND THE POEM	
On Dr. Joseph Hobbins	John Mendenhall
On Charles N. Gregory	Ruth Doyle
On James D. Butler and William F. Allen	Herbert Howe
On Burr Jones	Janet Ela
On Edward A. Birge	Alfred Swan
The Tardy Muse — Votive Verses to the Madison Literary Club	Frederic Cassidy
THE TOASTMASTER'S CLOSING REMARKS	Mark Ingraham

THE TOASTMASTER'S OPENING REMARKS

Mark Ingraham

Before I let anyone else have the floor I want to make one motion and read a few statistics.

Mr. President: I move that the affectionate greetings of the Club be sent to Miss Anna (Nan) Birge who took over the duties of a co-member on the death of her mother in 1918, entertaining the Club ten times before the death of her father in 1950, when she became an honorary member. She is now ninety-four, living in the Attic Angel Nursing Home and, though not physically strong, is clear of mind. [The motion was passed by acclamation.]

For the last three quarters of a century I have been fascinated by numbers and, through my connection with the State Teachers Retirement System even before its official start in 1921, I for some time have been interested in longevity. I wish to give you a few Club longevity records and names.

There have been at least 64 persons who have been members, regular, co-member or honorary, for over forty years and this may be an underestimate, since we probably do not have a complete account of some of the earlier co-members. The record for length of membership is not that of E. A. Birge but of Mrs. F. K. Conover. Starting in 1886 she was an active member for five years as Miss Grace Clark, then for twenty-eight years a co-member, and for forty-four years an honoray member, a total of seventy-seven years! Until extreme old age she came to the meetings regularly, using the privilege of bringing a guest to secure a chauffeur. Others who were members for sixty years or more were: E. A. Birge, 73; Mrs. Charles N. Brown, 67; Mrs. D. B. Frankenburger, 65; Gertrude Slaughter, 64, the last forty as active member; Mrs. E. C. Mason, 61, the first forty-one, until the election of her husband, as an active member; and Mrs. Walter Smith, the mother of one of our speakers tonight, 60 years.

Now, since I myself want to get in on a record, I will list the names of the men who have been active members for forty-five years or more: Birge, 73; Burr Jones, 58; Harry Russell, 51; Julius Olsen, 48; Frank Sharp and Alfred Swan, 46; and Charles Slichter and myself, 45. If Mr. Swan and I are at the 125th anniversary, we still will not have caught up with Birge. I, at least, am not going to eat yogurt to try to do so.

None of us today can compete with the early members for numbers of papers, since they often gave one a year and shared an evening's spotlight with one another. Birge read 19; James D. Butler 14 (two within three months); Charles N. Gregory and Gertrude Slaughter 11 (Gertrude

Slaughter gave the chief talk at the seventy-fifth anniversary); and Burr Jones and D. B. Frankenburger 10 apiece.

I list only one hostess, Mrs. Lucius Fairchild, who between 1884 and 1923 entertained the Club in her home thirty times, all but one of these in June. I would not dare to compute how many chairs from funeral parlors went in and out of her house in those four decades.

At least thirteen buildings and thirty portions of buildings on the Madison campus are named for members of this Club. From this count I omit plaques, trees and boulders, and Madison streets. Of course there have been many opportunities, for, of the present University buildings, only North, South, and Bascom Halls were in use when the Club was founded. As far as I know, Grace Episcopal Church is the only edifice on the Capitol Square, or should I say "Soglin Mall," standing from that date. It was some time before University Hall, usually called "Main Hall," was renamed Bascom Hall after John Bascom who gave Mad Lit its first non-promotional paper—entitled "Culture". Joseph Hobbins had used the first meeting to give a "pep" talk.

ON DR. JOSEPH HOBBINS

John Mendenhall

Toastmaster's Introduction

We will now proceed to consider some of the charter members. I shall repeat a story I have already told the Club about Dorothy Reed Mendenhall, co-member 1906-35, member '35-52, and honorary member '52-64, and for some years secretary-dictator of the Club. (I know for I served as president under her benign but strict guidance.) One day Merritt Hughes was moving furniture. Perhaps it was because he had acquired a new home or maybe because of Grace's feminine desire to change things around. He was clad in shorts only. The doorbell rang. He answered, and Mrs. Mendenhall was there. "Professor Hughes?" "Yes." "I have come to invite you to join the Madison Literary Club and of course you will." In telling me of the episode, he added: "And of course I did." When her son, Dr. John Mendenhall, wants people to behave he anesthetizes them. His mother did not find that necessary. Although I have made a valiant attempt to put you to sleep, and since statistics are not as potent as ether, tonight in speaking of our founder and first president, Dr. Hobbins, John may have to follow his mother's style and deal with you awake.

(John Mendenhall spoke at this point.)

Joseph Hobbins, physician, pioneer horticulturist, and founder of the Madison Literary Club, was born on December 28, 1816 in the town of Wednesbury, Staffordshire, England. His father, also Joseph, was descended from Sir Richard Hobbins, a knight of Elizabethan times. At the age of eleven he ran away and joined the Royal Navy, fought with Admiral Lord Nelson at Cape Trafalgar and retired at the age of 27 after 16 years of faithful service in the Royal Marines. He chose to start life again in the very grimy coal-mining and industrial area of the Midlands at Wednesbury in south Staffordshire near Birmingham. He prospered over the years and became an affluent businessman.

His son Joseph, Jr., one of five children, received his early education at Colton Hall in Rugely. At an early age he developed a love for writing verse and his youthful poems were published in local periodicals. Upon leaving school at the age of 16, he was apprenticed to a Dr. Underhill in the neighboring town of Tipon, where he remained for five years. He then completed one session in 1838 at Queen's College Medical School in Birmingham where he was graduated with honors. Next came two years of study at Guy's Hospital, London, one of the great schools of the day made famous by its Chief Surgeon, Sir Astley Cooper, and the physicians

Richard Bright and Thomas Addison. After receiving his diploma and becoming licensed as a physician, he did the usual brief tour of the hospitals in Edinburgh, Dublin, Brussels, and Paris. He then set out for the United States and a similar tour of the eastern seaboard.

Aboard ship he met Miss Sarah Badger Jackson who was returning from travels in Europe with her widowed mother to their home in Newton, outside of Boston. The voyage was a long one in those days and before leaving the ship Joseph and Sarah had become engaged. He spent much of the time during his tour in America visiting her family and finalizing their marriage plans. He was to return to England and Wednesbury to set up practice and she would come over to join him, staying first with a friend of her family near Liverpool. After many delays they were married in Liverpool on October 11, 1841. The bridegroom was almost 25 and his bride a year older.

Although the prospects of success for such a well trained doctor were encouraging in his native town, Sarah grew very homesick in the dreary surroundings of the Midlands. Her health became impaired and by September, 1842 they set sail again for the United States where they established a home in Brookline, Massachusetts. There he settled down to practice, becoming a fellow of the Massachusetts Medical Society and incidentally joining a Literary Society which impressed him greatly and which he was to use as a model for the Madison Literary Club. Although Dr. Hobbins did very well in practice, his health began to fail and soon he suffered from an irresistible longing for his homeland. At about this time he and his wife became grief stricken over the loss of their first child, Elizabeth, and so after three years of practice in Brookline, they once again set out across the Atlantic in May, 1846 to return to Wednesbury. Their second child and first boy, Joseph, died soon after birth in September of that year. Both parents were again overwhelmed with grief which necessitated another change of scene. Dr. Hobbins set out on an extensive walking trip with his brother-in-law through northern England, Wales, and Scotland which he described beautifully in letters to the *Boston Star*. His wife moved to her friend's house near Liverpool until they could build their own house outside of Wednesbury.

However, both were eager for a greater change and as early as 1848 they and their relatives were investigating the possibility of emigrating to Australia, then California and finally Wisconsin. Concerning the latter they had received from Governor Farwell maps and informational material about Dane County and beautiful Madison. During this period in England, their next three children were born, all girls — one in 1848, one in 1851, and one in 1853. Dr. Hobbins, however, was unable to sell his practice and his plans for emigration were delayed. At this time he decided to try for the

Senior Examination in Surgery in Edinburgh, and was greatly disappointed when he failed.

His sister Elizabeth and her family, and his younger brother, Dr. William and his wife and their children including William's step-son, thirteen year old James A. Jackson, were the first of the family to leave Wednesbury for America and Madison in September, 1853. Joseph Hobbins, Sr., his wife, and their other two daughters and their families together with servants, left a month later. All in all, by 1854 Madison was to receive over 40 immigrants from Wednesbury.

Finally in the Spring of 1854 Dr. Hobbins and his entire household, including his wife, three children and servants, set out for the United States after an absence of eight years. In spite of a harrowing ocean voyage, which included being shipwrecked on the coast of Ireland, they finally reached New York and started their twelve day journey westward: to Chicago by rail, to Milwaukee by boat, and to Stoughton by rail, with the final stage of the journey to Madison by horse and wagon. After thirteen years of married life, numerous ocean crossings, and several changes in location of family and practice, Joseph Hobbins settled down at last in Madison and here remained until his death forty years later.

Madison, in 1854, was a rapidly growing frontier village of just over 5,000 persons. It had been declared the Territorial Capital in 1836, while a settlement of only three inhabitants! It was incorporated as a village in 1846 with a population of 626. After Wisconsin became the 30th State in 1848 with Madison the capital, growth as a governmental, financial, educational, and social center was rapid. The University of Wisconsin opened in 1849, the first railroad came late in 1854, and Madison received a city charter in 1856.

After living for two years in the countryside on the shores of Lake Monona, directly across from Madison, Dr. Hobbins realized that he could not be a practicing physician and a country gentleman at the same time and so he moved his family into a house with a large garden area on West Main Street. Here he had plenty of room to develop his own horticultural interests with an orchard, vineyard, kitchen garden and flower beds. His surgical practice grew and he soon became active in the affairs of the growing community.

The University Regents were thinking of opening a Medical School and Chancellor Lathrop appointed Dr. Hobbins Professor of Surgery, with the task of organizing the School. The plan was dropped, however, due to legislative neglect. In 1856 Dr. Hobbins was elected to the first City Council and subsequently re-elected three times. He organized a local Board of Health and made an attempt to establish a city hospital. The sum of $6,000 was appropriated and ground purchased on Gorham and

Patterson Streets. The project failed for lack of support and later in 1890 the City sold the property and used the proceeds to buy a stone quarry and a steam roller. It was not until 1898 that the first city hospital, now Madison General Hospital, was erected, after earlier attempts to use boarding houses as private hospitals had failed. Before that, medical or surgical cases had to be taken care of in their own homes or in rooming houses or hotels.

Prior to the middle of the 19th century surgery was for the most part, limited to the treatment of diseases and injuries not involving the abdominal and chest cavities. There was an increasing number of daring major operations performed with astonishing technical skill and rapidity because of a lack of anesthetics. It was in 1846, shortly after Joseph Hobbins returned to England from Boston, that Morton first used ether anesthesia at the Massachusetts General Hospital, followed the next year by Simpson's first use of chloroform as an anesthetic agent in Edinburgh. The subsequent discovery of antisepsis by Lister (his carbolic-acid spray method was first published in 1867), and the development of aseptic surgery by the German surgeons in the 1880s, together with the progress in basic anatomy and pathology led to rapid and undreamed of advances in the study and practice of surgery by the turn of the century. Indeed, one International Medical Congress in London, at that time, included such great names in this rapidly developing field as Virchow, the father of cellular pathology, Rober Koch, the discoverer of the tuberculosis organism, Louis Pasteur, the developer of the germ theory of infection, and Lord Lister. To fill out the time framework, in 1889 Johns Hopkins Medical School was opened and in 1892 Dr. William S. Halstead became Professor of Surgery at that institution, joining the great Dr. William Osler to become the leaders in medical education in the United States. The year 1894 saw the death not only of Joseph Hobbins but also the famous Austrian surgeon Theodor Billroth, the first surgeon to successfully resect the larynx, the esophagus, and the stomach.

During Dr. Hobbins' years of training, surgical specialties were largely undeveloped and the general surgeons practiced obstetrics, gynecology, orthopedics, otolaryngology as well as general family practice including pediatrics. It was such a practice that Dr. Hobbins apparently engaged in. He was described as having a quiet, substantial professional career, useful to state and town. He dearly loved his profession and stood stoutly for its old-time code of ethics. He was a member of the Royal College of Surgeons. His membership in the Wisconsin State Medical Society dated from 1856 and he had a wide personal acquaintance with the doctors of the States. By 1880 Madison had a population just over 10,000 and Dane County some 52,000. There were 20 physicians in the city, two of them women. In 1885 at the age of 69 he was President of the Central Wisconsin (later to become Dane County) Medical Society. He remained in active practice up to the time of his death nine years later.

When the Civil War broke out Dr. Hobbins, a life long Democrat, supported the Union as a War Democrat. He organized the Medical Corps at Camp Randall where the Union recruits were being drilled. His brother, Dr. William Hobbins, enlisted as a surgeon in the 8th Wisconsin Volunteers and William's step-son, James A. Jackson, age 21, enlisted as a hospital steward. Soon part of Camp Randall was used as a camp for Southern prisoners and Dr. Hobbins, as U. S. Surgeon, was in charge of the health of Confederate prisoners and Union soldiers alike. His handwritten Register of Deaths records 152 deaths among the 3,000 prisoners for the three months of April, May, June, 1862 alone. Later he was appointed Medical Examiner of Northern soldiers claiming disability, and the same Register contains detailed examinations and recommendations on over 200 such cases with his objective evaluations.

Aside from his profession and his love of art and literature, Dr. Hobbins' greatest interest was his avocation of horticulture. An inept but enthusiastic gardener when he started as a gentleman farmer in 1854, he became a practical horticulturist, experimenting in his own garden with many varieties of fruits, vines, and shrubs and importing new seeds and plants from both sides of the ocean. In 1858 he helped found the Madison Horticultural Society of which he was president for twelve years. He is said to have been responsible for the planting of lilacs and crocuses and shade trees along the streets of Madison which led to the beautiful vistas enjoyed by future generations. In 1866 he was elected president of the newly formed Wisconsin State Horticulture Society, a position he held for five years. His efforts in this field earned him the title of "father of horticulture in the northwest."

Dr. Hobbins is not listed as author of any article in national medical journals in the Index Catalogue of the Surgeon General's Library, but he did write numerous articles on medical subjects not only for the medical societies but for such layman's journals as the *Northern Farmer, Home and Health Journal,* the *Western Farmer,* and *Field, Lawn and Garden* (a monthly journal of rural affairs, art and literature). His papers ranged in subject from the harmful effects of hair dyes and cosmetics to a series of 12 articles on the "Care of the Baby."

The story of the actual formation of the Madison Literary Club 100 years ago has been written and rewritten for the 10th, 25th, 50th and 75th anniversary celebrations and the Club's Memorial to its Founder's death in 1894 and most recently for the advanced newspaper publicity for this meeting. The influence on Dr. Joseph Hobbins of his earlier membership in a literary society in Brookline, Massachusetts and his efforts after his arrival in Madison in 1854 to organize a true literary society are cited. Joseph Hobbins and Sarah his wife had over the years invited local groups of persons with intellectual and literary tastes to their home for informal discussions of some chosen topic. At intervals he tried to arouse interest in the formation of a permanent organization. Time passed. Sarah Hobbins died in 1870 after a long illness, age 55. Then in February, 1872 Josephine, the doctor's oldest daughter, married the step-son of his brother, Dr. William Hobbins, by then *Dr.* James A. Jackson. Two months later Dr. Hobbins married Mary Elizabeth McLane, the youngest daughter of a well known Baltimore scholar and publicist, whose acquaintance he had made when she visited Madison the previous summer. Louis McLane Hobbins, their only child, was born in 1874 and the family moved to a new home on Wisconsin Avenue.

Finally in September, 1877, interest in a literary club seemed right and Miss Ella A. Giles, Professor Rasmus B. Anderson, and Dr. Hobbins met to draft their plans for the organization of the Madison Literary Club. A list was drawn up of persons "of acknowledged literary taste" to be invited to the next organizational meeting on October 1st. At that time a committee was appointed to draft a constitution, which was unanimously adopted on October 8, 1877. Dr. Hobbins was elected President and re-elected annually until his death in 1894 with the curious exception of 1881, when Mrs. Joseph Hobbins (Mary Hobbins), an active member in her own name, served as second Vice President.

On Monday evening, November 5, 1877, the first regular meeting was held at the Vilas House (later to become the Pioneer Hotel) with a paper by the President entitled "The Mission of the Club." It is interesting that the original constitution in Article III (*Object of the Club*) included the purpose of "becoming better acquainted with each other" between the initial phrase relative to bringing persons together for the purpose of social enjoyment and the final phrase "promoting so far as may be, the interests of literature in Madison, Wisconsin." Sometime in later years the phrase to "become better acquainted" was dropped.

Indeed, in his 1879 report to the Club, entitled "Two Years of Club Work," after his second term as President Dr. Hobbins remarked that the combination of literature and sociability is no new thing. "It is sociability and not literature," he said "that binds us together; literature attracts but the cohesive quality is social in its character. Therefore, let us not at some future time unwisely deem the social feature of our Club of less importance than the intellectual feature."

At the November, 1884, meeting held in the Hobbins home the Doctor read his third and last paper entitled "On the Status of Our Club," which he reported as being financially as well as culturally sound. During that period the society's format had slowly changed from that of a study club to something like a lecture course with a specialist giving the evening's paper and three or four persons discussing it.

At the conclusion of the June, 1887 meeting of the Club at the residence of General Lucius Fairchild, Professor Charles M. Gregory, in behalf of the Membership, presented to Dr. Hobbins a portrait of the doctor "as a memorial of your great services and of our warm gratitude." The portrait, which we have with us tonight at this meeting, was by Professor James R. Stuart, a member of the Club and one of the most talented and prolific artists of the period. It was accepted at that meeting by the State Historical Society of Wisconsin, "there forever to be preserved - - - - - - - - - as the enduring memorial of a good man and a good life." In thanking the members, President Hobbins urged them to "continue our interest in this society not only for our own sakes, but for the sake of those who come after us for you have assurances enough in the good you have gained from it to make you feel as I feel that we can leave our children few better legacies than a love for literature."

In Dr. Hobbins' last years most of his efforts were given over to organizing and conducting the literary club. He was described as a man of noble aspirations, high integrity, warm sympathies, and sound judgment, with the old-time hospitality of the English. As he grew older he "shook off all tendencies to melancholy, joined forces with the younger generation and lost none of his keen regard for the things of the day." There still exists a letter of resignation "for personal reasons" in his handwriting and with his signature dated April 2, 1892, that was either never presented or turned down by the Club for he continued as President in spite of failing health. In late January, 1894, he "gently succumbed" to what was diagnosed as "la gripe" and died on the evening of January 24, 1894 at a quarter past six o'clock, aged 77 years.

In the memorial tribute of his Madison Literary Club it was said that "those who knew him best, as physician, friend, and counselor, loved the dear old Doctor best — and no warmer praise than this can man earn."

ON CHARLES NOBLE GREGORY

Ruth Doyle

Toastmaster's Introduction

It is sometimes dull, boring, or even disagreeable to appear before a legislative committee. However, it was always pleasant to attend meetings of the Joint Finance Committee when Senator Porter and Assemblyman Ludwigsen were co-chairmen. Occasionally, even with their skill, one had to wait beyond the appointed hour before the University budget or the needs of the retirement system came up for consideration. On one such occasion a young, vivacious assemblywoman spoke clearly, persuasively and briefly for some budget item—an item which I have long since forgotten and bet that she has too. After she finished, Senator Porter leaned forward and in fatherly tones said: "Young lady, you would make a great legislator if only you were a Republican." That was the first time that I heard Ruth Doyle speak. I look forward to hearing her now discuss Charles N. Gregory.

(Mrs. Ruth Doyle spoke at this point.)

Charles Gregory was born in New York State in 1851, and moved with his family to Madison when he was very young. His father was an early mayor of Madison and the family was prominent in the political and social life of the growing city.

He was graduated from the University of Wisconsin in 1871 and in the following year, at age 22, from the Law School. He was awarded an L.L.D. from his alma mater in 1901.

He practiced law in the firm of Gregory and Pinney from 1872-1894, when he resigned to become Associate Dean of the Law School, in which position he served more or less happily until 1901. I say "more or less" because in his preserved correspondence there is at least one, and perhaps several, letters of resignation addressed to the Regents, citing his dissatisfactions with the treatment of the Law School and with his own salary, which had not been increased for several years running. It is an occupational attitude of law school deans, since the establishment and spread of legal education in the United States. In 1898, Dean Gregory read a paper to the Section on Legal Education of the American Bar Association, bearing the poignant title of "The Wage of Law Teachers." He reported on the under-support of law schools and the under-payment of faculty, mentioning a certain unnamed University in which the College of Agriculture received $75,000 annually, while its law school, with the same number of students, existed on its revenue from fees, about $14,000.

He concluded: "I mentioned this . . . to some of its faculty and expressed my pleasure at the liberal support of the science of Agriculture, and my hope that the science of law might at some time be as well maintained. They pointed out, with some heat, the usefulness of the Agricultural School, and said one of its professors had invented a convenient apparatus for testing milk. I was glad of this excellent achievement. I recalled that one of the law professors had published an able work on Evidence (a convenient apparatus for testing truth) and intimated that a good quality of justice was as important as a good quality of milk."

He nevertheless devoted a substantial period of his life to the administration of law schools. In 1901, when he left Madison, never to return, he became the Dean of the Law School at the University of Iowa and subsequently at George Washington University, where he retired in 1914.

Mr. Gregory was a prodigious writer. His works, which were widely published in Law Reviews and other scholarly organs, dealt with a wide variety of subjects from the Alaskan boundary disputes to tariff reform and election reform, and to the Law of Blockade. At the time of his death he was serving as one of the editors of the *American Journal of International Law*.

There are other dimensions to the life and accomplishments of Charles Gregory. He was a natural leader of the Madison Literary Club of his day—his reputation as a poet led to his designation by his admirers as the "Bryant of the West." His many papers presented to the Club dealt with such various subjects as Jeremy Bentham, Recent American Poets, Modern English Ballad and its Makers, Lawyers and the Makings of Them, and the Improper Use of Money in Elections. One of his papers was entitled "Paintings in Madison with Specimens Thereof." He himself was a prominent collector of paintings and other artisitic treasures.

Another great light went out on same day that Mr. Gregory died in 1932. The issues of the *Capital Times* and the *Wisconsin State Journal* which carried his obituary also reported the funeral services of the renowned Carl Russell Fish, professor of History. At the time of his death, Mr. Gregory was described by his friend A. O. Barton of the *State Journal* as "scholarly and aristocratic," with "cultured manners, an interesting and attractive type of gentleman that flourished in the smaller Madison of his day."

His business associate, law school colleague, and life-long friend Justice Burr Jones said of him that "his fine scholarship and love of the best literature gave him a leading place in the literary circle in our city." He "loved social life," added Justice Jones, and "there was something in his mode of dress and bearing which led strangers to think of him as an aristocrat . . ., but there were few among us who were more solicitous for the welfare of our fellow man. He was full of sympathy for dumb animals and would show a righteous indignation over any cruelty toward them . . ."

There is a postscript to the life of Charles Gregory. All of his papers, his treasured artifacts, and his paintings were bequeathed to the State Historical Society of Wisconsin. They were returned to Madison in October, 1932, in a huge locked van, which, by agreement, the driver was never to leave unattended. When the driver became ill in South Bend, the van was locked in a warehouse until a relief driver could be obtained. The opening of the exhibit was an event highly publicized in the Madison, Chicago, and Milwaukee newspapers.

Included in the collection were drawings attributed to Raphael, Michaelangelo, Tintoretto, Rubens, and Holbein. Mr. Gregory had paid modest sums for his collected items, using a prominent London art dealer as agent. Professor Lawrence Schmekebier, noted professor of art history, proclaimed the drawings to be fakes. He described one as obviously the work of an eleven-year old girl. The family, friends and admirers of Mr. Gregory reacted strongly, pointing out that Mr. Gregory was a man of great integrity, a connoisseur who dealt only with reputable dealers in Europe. The controversy termed by the press an "art war," raged for weeks, and was widely reported in the Wisconsin press. The Historical Society called on experts from the museums of New York, Detroit, and other places. Conclusions were mixed. The experts from the Metropolitan agreed with Schmekebier; those from Detroit agreed with Mr. Gregory's choices.

In recent years, the paintings and drawings from abroad have been housed in the Elvehjem Art Center. The American works, held by the Historical Society, were returned to the family, the last member of which—a niece—has recently died.

The statement of a former Director of the Historical Society, Mr. Joseph Schafer, seems an appropriate conclusion: "While the Society regrets that the drawings are not all they are supposed to be, yet it is glad to know the mislabeled drawings are good in themselves and will serve a useful purpose." Which I am told they do to this day.

Toastmaster's Comment

I side with Gregory rather than Schmeckebier, since my best arguments could not convince the latter that mathematics is an art. How could we expect him to recognize a Rembrandt!

Young lady, you would make a great member if you were not a co-member. I want to tell you one thing more about Mrs. Doyle. She told me that she not only accepted the chance to speak, but desired it as the only opportunity for her to speak as a co-member. But with all her insight, she is not a historian. By tradition and long ago in print, wives and husbands of members "rank as co-members with full power." Mrs. Mendenhall and Mrs. Bleyer each gave a paper as co-members; Mrs. Burr Jones, two; and Mrs. Slaughter, five. This custom should be revived. Perhaps Women's Lib flourished better before it had that label.

ON JAMES D. BUTLER AND WILLIAM F. ALLEN

Herbert Howe

Toastmaster's Introduction

There are many good reasons to study calculus. I do not care by which path a man walks, or perhaps swims in the trackless waters of Mendota, so long as he gets to heaven. The next speaker chose to seek the secrets of calculus, not to build bridges or to forecast the stock market but to understand Zeno. Welcome, anyhow! He studies medicine, not for health which is maintained by exercise, but for the classical derivation of its terms. We have had a great tradition of classicists: our last president, Paul McKendrick; Ray Agard; Moses Slaughter; Grant Showerman; two secretaries, Katherine Allen and Annie Pitman; and two charter members, William F. Allen and James D. Butler. It is these two whom Mr. Howe, himself a classicist, will discuss.

(Herbert Howe spoke at this point.)

From the days of its foundation the University was caught up in the struggle over the proper purpose, method, and content of college education, and the two men I should like to consider with you, both founding members of this Club, might well serve as exemplars of the two sides. Their backgrounds were not unlike, and one succeeded the other as Professor of Classics. Yet between their personalities and aspirations for the University lay a vast gulf, a gulf which, however, did not affect their relations with each other. One of their common interests was this Club, to which both contributed as essayists and officers.

James Davies Butler was a New Englander, born in Vermont in 1815. He graduated from Middlebury and went on to Andover Divinity School. His plans of entering the ministry were interrupted when he took a long trip to Europe, but on his return he served several churches in the East and in Ohio, combining his ministry with teaching and lecturing. In 1858 he came to Madison as Professor of Classics, replacing Obadiah Conover in the chair on the twelfth ballot by the Regents. He was a gentle and witty man with an enormous store of out-of-the-way knowledge, but complained of his intellectual loneliness. One suspects that he did not greatly enjoy his contact with his classes. During the Civil War he served as Chaplain. When the Board of Regents was reorganized in 1866, his appointment was not renewed. He left the faculty in 1867, but lived in Madison until his death in 1905, though he spent a great deal of time travelling and lecturing. Most of his writing—he was a voluminous contributor to magazines, especially the *Nation*—was rather slight, but his paper on "*The Hapax Legomena of Shakespeare*," first given before this Club, received the applause of as great a scholar as Halliwell-Phillips. He travelled widely and often, in Europe and the Near East, and when he was 75 years of age took a long trip around the world, with such side excursions as a voyage 2000 miles up the Yangtse. He was one of the first to cross the country on the new transcontinental railway, and on a side trip on the way managed to get lost in the Yosemite, only to be saved by a former student of his, one John Muir. Meanwhile he was a popular and prolific lecturer, in the great age of that form of teaching. We may have our suspicions of "Mental Culture among Teachers," given five years before he came to Madison, but I can only applaud the taste of a generation which turned out fifty times to hear him speak on "How Dead Languages Make Live Men." His greatest success was "The Architecture of St. Peter's," which he repeated 100 times, once in Rome. He kept up his activities to the end, and was, indeed, appointed chaplain to the State Senate when he was 80. He died in 1905.

Butler never wrote a book, and he seems to have viewed scholarship as a source of personal pleasure, rather than as an arduous and demanding pursuit. His successor, William Francis Allen, graduated from Harvard in 1851, fifteen years after Butler left Middlebury; but when Allen went abroad it was to study Roman history and antiquities at Berlin and Göttingen. Until 1862 he taught school in the East, and then worked during the Civil War with the Freedmen's and Sanitary Commissions. After the war he taught at Antioch, and came to Wisconsin in 1867 to replace Butler. As a teacher he was an immediate success. As a scholar he was productive in several fields, in Latin and in mediaeval history. Allen, his brother Joseph, and J. B. Greenough of Harvard collaborated on a number of school Latin texts. I suspect that I am not the only person here who studied from them, for they continued in use down to the Second World War. But Latin was not Allen's only field. When he first came he taught both ancient languages and history, the last being scarcely more than a perfunctory reading of a standard text. By 1871 he was freed of the obligation to teach Greek, and in 1886 he finally moved entirely, as a teacher, into history. From the beginning he insisted that his students should use primary sources, and he approached history topically rather than chronologically. He worked zealously for the growth of the University Library, as librarian after 1871. He was on the committee which responded to the horrendous report of the Board of Visitors that the health of women students was being ruined by their arduous intellectual work. He made one of his greatest contributions to the State in the years just before his death, when he and his student, assistant, and successor Frederick Jackson Turner arranged a series of lectures on the history of the Northwest, which later grew into the University Extension program.

Allen's last service to the University was an unintentional one. In the fall of 1889 a furious row had blown up over the matter of hazing; tempers were being lost, and Regents, administration, faculty, and students were being forced into positions from which they could not retreat. On December 9 Allen suddenly died. The quarrel was swallowed up at once in sorrow at his loss, and neither side resumed it later.

The papers the two men read to this Club show extraordinary diversity of subject. Butler wrote on Luther's Rock of Refuge and the Sanctuaries of St. Elizabeth; The *Hapax Legomena* of Shakespeare; English Folk-Lore; The Portraits of Columbus; The Character of Sir John Falstaff; Wonders of the Western Wild; Taychopera, or the Four Lakes Country; Our Composite Nationality; Lord Vernon's Dante; Dante, His Quotations and His Originality; Some Cities of the Great Moguls; Shakespeare as a Cicerone in Foreign Travel; The Names of Our Club Associates; and The Vocabulary of Shakespeare. Many of them were travelogues, and there is not a single paper on a classical subject. Allen wrote on Freedom of Thought and Speech; The Duke of Milan; Shakespeare as a Person; The History and Methods of Wood-Engraving; Coriolanus in History and in Shakespeare; The Roman Forum; and Historical Fiction.

Mrs. Allen, who continued in the Club until 1924, read several papers after her husband's death, on American Labor in New England Cotton Mills; Ann Grant of Laggan; Minstrelsy of the Scottish Border; and Dorothy Wordsworth. Their daughter Katharine, who like her father taught Latin and lived until 1940, was more a specialist: her papers reflected the growing professionalism of the times: Catullus; Records of Rome on the English Border; Ovid; and Seneca.

Butler belonged to an age in which universities tried to produce men capable of becoming talented amateurs in many fields; Allen led the way to a time which demanded highly trained professionals. They may serve as paradigms of the pressures which still beset not only our civilization, but each of us individually. Mad Lit, numbering this pair and others like them among its founders, may fairly claim to have become a synthesis of their virtues, and to have rejoiced for a century in making congenial talents as diverse as theirs.

ON BURR W. JONES

Janet Ela

Toastmaster's Introduction

Conjugalism is an official policy. But we have something else. If you want to be nasty, you call it "nepotism." If you want to be nice, you call it "hereditary genius." If you want to pun, you call it "gild by association" and spell it either with or without a "u." Whatever it is, we have lots of it. We have already had one speaker (J.M.) of whom both parents were active members of the Club. The same was true of Max Mason. In the cases of the Mendenhalls, the E. C. Masons, the Slaughters, the Conovers, and the Bleyers, both husband and wife were active members in succession. Now the Hartley Howes are members simultaneously. Katherine Allen was the daughter of William F. Allen; her mother gave four papers when an honorary member. "Father and son" are represented by the Spohns, the Beattys, the Weavers, and the Kiekhofers. The Frautschi brothers each served as president. But the championship goes to Janet Ela: her grandfather Burr Jones was a charter member and presided, post-presidentially, at the fiftieth anniversary meeting at which Birge was the chief speaker; her grandmother Olive Jones gave two papers and served as the second secretary of the Club; her father Walter Smith, long the University Librarian, was a member for thirty-eight years; her husband Walter Ela served as treasurer for seven years; and she herself as secretary for two years—in spite of which she is not tired of the Club. Her memories tonight will center around the charter member, Burr Jones.

(Mrs. Janet Ela spoke here.)

Mine is a happy assignment tonight. I speak about someone I knew intimately and loved very much — my grandfather, Burr W. Jones. If, in my knowledge that Burr Jones was the perfect grandfather, I tend to portray him also as the perfect Mad Lit member, this is not wholly a matter of bias, for the qualities that made him so endearing as a grandparent are ones that our Club values too.

Here is the grandfather of my early memories: a grown-up who spun marvelous stories and knew a very great deal but who was always eager to hear what you knew too, who relished cards and guessing games but didn't care who won, knew how to joke and tease without ever hurting, made comfortable space for every newcomer in his life, while you knew that your own place next to him was always safe. I am describing a happy man, generous and genial. But not bland. This Club does not cherish us if we are sociable only. In 1877 when our Club began, Burr Jones was a young lawyer of 31, the same age as the incorporated village of Madison. During his many years of membership, he grew into an eminent lawyer, teacher and judge, and he brought to Club meetings wisdom in his own profession, experience in politics, legal and social reform, plus seasoned tastes in literature, history and biography.

Obviously I did not know the young man, nor the boy who came before that. When Grandfather was 87, he wrote an informal little book called *Reminiscences of Nine Decades*, and it is from this account that I fill in the earlier years. Burr Jones was born March 9, 1846, in a log farmhouse in the vicinity of present-day Evansville, Wisconsin. His parents, of Welsh and English stock, were recent comers from up-state New York and Pennsylvania to the small mortgaged farm they worked. The father died when Burr was eight, and four years later, his mother married a neighboring widower, named Levi Leonard. His mother was ambitious for her boy to get an education, and the stepfather, though he had not completed grammar school, was an avid reader and a non-conformist in temperament, who helped to whet the boy's curiosity about ideas. Burr went through the available schools, a one-room schoolhouse and the Evansville Seminary, always doing heavy farm chores after school and during the summers. He then taught school for a bit, traveled around Iowa selling books, and managed at last to get to Madison to work his way through the University.

I find myself wondering how many of the early members of Mad Lit came from so lean and austere a background. Some faculty members, recently arrived from the East, may have been of a second or third generation that knew comfort and culture, but if other members were natives of Wisconsin, still a frontier state, they may have had origins as humble as Grandfather's. He recorded that among the University student body of about 200 in his day, he knew only two boys whose parents were wealthy enough to pay their tuitions.

The farm drudgery must have been highly distasteful to Burr Jones. He describes it in his Reminiscences with matter-of-fact neutrality, but it was wholly edited out of the boyhood that yielded stories for his grandchildren. Some ex-farm boys, turned prosperous, buy land in the country for nostalgic reasons. Not Burr Jones. He was absolutely urban and intellectual in his interests. He had no taste for gardening, a notable lack of manual and mechanical skills, and scant interest in athletics. He did a little fishing in earlier years, played sociable golf in later years. However, at no time in his life was he physically heavy or lethargic. He had a trim figure, a quick springy step, and it may well be that his ritual devotion to long walks was the secret of his remarkably good health.

In 1868 a law school had been founded on the Madison campus, in which one year's work earned a degree. In 1871, at age 25, Burr Jones emerged with this degree and began to practice law in Portage. Within months he was invited to be a junior partner by an established lawyer in Madison, and from that time on, his law offices were always in this city.

In 1872 he married Olive Hoyt, and they bought a house on Langdon Street near Frances, a site that Olive's Monona Avenue family called "way across town." This was the first of three houses owned by Burr Jones, all of them on Langdon Street. Some of you will remember the third house, at 17 Langdon, and its hostess, the lovely Katharine Macdonald who was Burr Jones' second wife. The house into which I fit Mad Lit meetings most suitably is the second one, at 112 Langdon, where Burr Jones lived some 35 years, a house which in my childhood was often filled with exciting guests. Indeed this ornate and marvelous house which Burr and Olive built, with its six fireplaces, its innumerable bay-windows and surprising L's, a tower room on the third floor, a billiard room on the ground level facing the lake, is background not only for actual memories, but my fertile source for stage sets whenever a 19th century novelist is skimpy with interiors. There was even a transom over one of the bathroom doors for Sherlock Holmes' *Speckled Band.*

It was in the same year as his marriage, 1872, that Burr Jones made his first foray into politics. He was elected Dane County district attorney and served for four years. In 1882 he was drafted by the local Democrats to run for Congress and won on a fluke, because there were two quarreling opponents on the other ticket. When Jones tried for re-election, the Republicans, having closed their rift, resumed their normal strength in the district and sent Robert M. LaFollette to Washington for his debut. Burr Jones thoroughly enjoyed his one term in the House, and he must have known that he had many qualifications for political success. He was a hard and conscientious worker, an excellent speaker and debater, who never had to resort to heavy rhetoric or sarcasm. He made sure that he knew his facts and then won easy rapport from an audience with his good-humored, conversational style. His Congressional defeat was doubtless disappointing at first, but on the whole he was relieved that attachment to the wrong party had nipped his ambitions quickly and sent him back to the profession he loved.

Soon after his return from Washington, in 1885, he was invited to become a lecturer at the Law School, and this sideline to active practice brought him deep pleasure. He devoted one day a week to classroom work for thirty years and took a very keen interest in his students. And I am sure that students ranked him high as a teacher, for I witnessed in various little trips about the state, the warmth, almost adoration, with which his "old boys" greeted him.

On the other hand, if I have suggested that Burr Jones was a first-rate practicing lawyer, I have been dealing with hearsay evidence, for I never actually heard him in conference with a client or speaking before a jury. We must indeed be cautious on the admissibility of evidence, for this is the territory in which Burr Jones won his widest reputation. During the 1890s, on request from the Bancroft-Whitney publishing firm, he worked diligently on a reference book which enjoyed good fame and strong sales in the course of numerous revisions and updatings. Students and lawyers throughout the country knew *Jones on Evidence*.

In 1920 Governor Philipp asked Burr Jones to fill a vacancy on the state Supreme Court. Jones, now 74, demurred at first, but because his health was excellent, he decided to accept. His six years on the bench were a great satisfaction to him; the work was heavy and the schedule more confining than his private practice, but he enjoyed the close working companionship with other scholars of the law.

So far I have not said much, have I, about my grandfather's role in Mad Lit, but I trust he has come through to you as a man who would be very much at home in this good Club. He was a member for more than 57 years, from the club's origin until his death on January 7, 1935. He prepared ten papers, the first in 1879, the last in 1932, and I shall read you their titles. But first let me note that it was Mrs. Burr Jones who spoke in December 1878 on the subject Life in Attic Greece. It was not until four months later that her husband read his initial paper. In those very early years, there was no fine distinction between member and co-member.

These were Burr Jones' ten titles in the order of their presentation: The Law of Primitive Societies, Growth of Socialism, Richard Cobden, The Management of the Anti-Slavery Agitation in the United States, The Expensiveness of Cheap Money, Chief Justice Marshall, The Homicide Problem in the United States, John Bright, Wendell Phillips, The Independence of the Bar. Recurring themes in these titles indicate constancy in Burr Jones' interests—the law itself as a subject, social and economic reform especially as it involved slavery and free trade, pleasure in studying the lives ot public figures who were leaders in his fields of interest.

I certainly cannot make out a case from these titles that Burr Jones was the full Renaissance Man, familiar with all fields of human knowledge. The fact is that he had very little background in any of the physical or biological sciences, almost no ear for music, appreciation but little expertise in the visual arts, and no small hobbies such as collecting stamps or railroad timetables. Curiously this absence in him of what we call hobbies never even occurred to me until a short time ago while I was preparing this essay. We tend nowadays to regard the hobby-less person with pity, as a slave to his work or a bore without inner resources. With Burr Jones, nothing could be farther from the truth. He loved the law but it was not his master, for he had two other pursuits which he loved with equal fervor and with great indulgence. One, he loved good books as only a person can who has craved them early and won them against odds. Two, he enjoyed the diversity of human nature more thoroughly than any one I have ever known. He had a talent for exploring the minds and hearts of others and it was a talent of great purity: he probed you gently with questions about yourself, not as a trial lawyer, a doctor, a novelist or any other specialist might do who planned to put findings to work, but simply because he wished to understand what *you* were doing and thinking. And you *knew* that nothing you said would ever be used against you. It will give you some measure of how genuine and rare his exploring method was when I say that even during my early teens it never embarrassed me that my grandfather asked my friends so many questions. It pleased me that even the shyest, most awkward of them liked his way of getting acquainted and flowered under his attention. Indeed he was never a "big talker" himself but in almost any informal gathering he was somehow the natural leader who encouraged conversation to flow in spontaneous fresh channels.

I regret that I do not know the text of any of the ten papers that my grandfather prepared for this Club. I feel confident that they were thoughtfully written and persuasively read, though not necessarily the most brilliant papers the Club has known. It is in the role of creative listener that Burr Jones was most surely a perfect Mad Lit member.

ON EDWARD ASAHEL BIRGE

Alfred Swan

Toastmaster's Introduction

In Birge's time the minister of the First Congregational Church was almost ex-officio a member of this Club. Eugene Updike came to that church in 1890 and became a Club member the same year. The election of Charles H. Richards in 1879 had been equally prompt. Alfred Swan came in 1930 but, although he was invited to join at once, he postponed membership a year to find out if we, i.e. our forebears, were respectable. His predecessor, Robbin Barstow, came to the church in 1924 and, if we can believe the semi-centennial booklet, was elected to the Club in 1825, a bit of predestination more befitting a Presbyterian than a Congregationalist. You might think that Birge believed every Congregational minister had *ipso facto* "acknowledged literary taste," the official criterion for membership. But that is not my theory. I hold that, being of some influence, Birge saw to it that only those *with* literary taste became pastors of his church.

Be that as it may, a warm friendship based on mutual interest and mutual respect grew between Edward Asahel Birge and the present senior member and former president of this club, Alfred Swan, who will speak on his great parishioner.

(Alfred Swan spoke here.)

To compress the near century of the life of Edward Asahel Birge into ten minutes, or to compass the five decades through which he served our University in five pages, would be to achieve an abbreviation that a typewriter cannot effect. First to be foreshortened, therefore, should be the more familiar facts of his life.

Though born in 1851 in Troy, New York, it was by accident of the fact that his father, a Connecticut Yankee, had moved there in the furniture manufacturing business. The young Birge spent many summers on a Connecticut farm. In Troy the family affiliated with a Presbyterian Church, where Edward learned the Westminster Shorter Catechism. But later in Madison he gravitated into his more ancestral Congregational Church, where he was for many years Deacon and Deacon Emeritus. He knew more theology than some of his ministers.

At Williams College, where he studied under John Bascom and Mark Hopkins, he graduated second in his class in 1873. Made a member of Phi Beta Kappa in his junior year, he later became a Life Senator of that organization, and appeared on several of its national program. He did graduate work at Harvard, at first under Louis Agassiz the Elder, where, by the fortuitous discovery of water fleas in a nearby pond, he became interested in *Daphnia* and in the life of fresh water lakes. He ended by becoming the world's leading limnologist. President Bascom brought him to Wisconsin in 1875 as an instructor in botany and zoology in the Academy. The closing of the Academy in 1880 gave the young scientist the chance to take the following year at Leipzig University, although his doctorate was at Harvard.

When Birge came to Wisconsin there were 249 students on the campus. When he retired in 1925 there were 8,142. What he would think of the 39,000 here now, we can only surmise. He served as Dean of the College of Letters and Science 1891-1918, as Acting President 1900-1903, and as President 1918-1925, after which he technically retired. But for another quarter century he pursued his research, wrote papers, and enriched the life of the community and the state. He went to his science office, in what is now appropriately called Birge Hall, to within eight weeks of the end of his life.

The field laboratories of the limnologist extended from Lake Mendota to Trout Lake in Vilas County. During the summers in Vilas County he got no haircut, for two reasons, he said:—to save money, and to find whether there was any relation between long hair and poetry. The muse did not touch him; and when he returned to Madison he paid Mr. Schubert, his barber at the University Club, for two haircuts. Only five feet seven but quick of step, he wore the last Grover Cleveland walrus mustache in these parts, and beneath a white pompadour and bushy brows flashed the sharpest black eyes that ever looked across a dean's desk.

He said he tried usually to vote Democrat, when they didn't spend too much money. He reported that his father thought the slavery issue might have been settled without a civil war. In 1894 he was a charter member of the University Cooperative Book Store. But he was no social reformer, and once said he sometimes feared the rise of the lower classes. He therefore endured, with or without patience, pulpit and platform pressures. If he did not like the sermon, he said he could always read the hymn book. He could read any book almost as rapidly as one would turn the pages. On Sunday afternoons he read the New Testament, in Greek.

It was his special interest to prepare pre-medical students with sound science courses, before they went on to Johns Hopkins Medical School, where his son took his M.D., but died in the flu epidemic of 1918. Upon the loss in the next year of his wife, Anna Grant, the only feminine member of his high school class at Troy to go on to "higher education," their daughter, Anna Grant Birge, left her library position in Chicago to become his official campus hostess. "Nan" Birge, now a nonogenerian at Attic Angels Home, has attended many meetings of this Club, and recalls most of its charter members. With the aid of Governor Emmanuel Philipp, in 1921 Dr. Birge achieved one of the great goals of his career in the establishment of the Medical School and the construction of the University Hospital, now about to be moved to the far west side of the campus.

After World War I, struggles ensued over requests by the Social Science Club to bring Scott Nearing and Eugene Debs to the university. President Birge distinguished between such appearances before clubs and the same speakers addressing the entire campus, which latter, he felt, would be construed by the public as approval of their positions. When in 1922 Upton Sinclair made a special appeal to the Board of Regents to be heard, and was granted permission, he proceeded in a newspaper interview to say, "It is a class struggle and President Birge is on the side of privilege." Whereupon Sociologist E. A. Ross, who had been expected to introduce the visitor, indignantly declined to do so, saying, "I have never experienced from Dr. Birge, as Dean or President, the least pressure to say or not to say, to do or not to do, anything my conscience prompted."

It was inevitable that anti-evolutionist William Jennings Bryan should call evolutionist Birge an "atheist." The attack drew from President Birge a public letter to his then pastor, the Rev. Edward Worcester, indicating that to him science and religion were in different realms, but that to him also religion was not inferior to science. That in the same year Upton Sinclair, whose son was a student at the university, called Dr. Birge a "desiccated biologist," made it possible for the eminent educator to point out, with some glee, that he was being attacked from both sides.

In the election of 1920 Florence Bascom, daughter of John Bascom, and therefore not to be confused with spritely Lelia Bascom, her kinswoman, wrote Birge, "Were you among those that stoned the prophet?" To which he responded, "Nobody stones a prophet. He always stones somebody else's prophet. . . . You must tell me whose prophet has been stoned." To which Miss Bascom returned, "I am sure you know the prophet to whom I alluded, the only prophet now in public life . . . and the more shame if he is not your prophet. The prophet is Wilson, and the stone is a Harding vote." Birge had the last word, "To tell the truth I had supposed the prophet was LaFollette. . . . I am quite ready, however, to accept Wilson as a prophet, all the more because he made such a mess of things as an administrator. That ordinarily goes with the prophetic temperament. I voted for Cox, and you must decide whether that is throwing a stone or a bouquet at the prophet."

If there was acerbity in such repartee, there was notable warmth in his sudden change in the nature of his last commencement address as President of the University. Robert Marion LaFollette died on June 18, 1925, causing President Birge to begin the address of June 22 with a quotation from Rome of 1900 years before:

"Leaders are but mortal;
the commonwealth is everlasting;
therefore let us resume our wonted duties."

"Fifty years ago," said the President, now himself four-and-seventy, "Robert M. LaFollette and Charles R. Van Hise were here together near the beginning of their college studies, and in that year they were both enrolled in my college classes. Both received their college degrees at the commencement of 1879. Comrades throughout their college days, they remained comrades after graduation. Van Hise followed the academic life. LaFollette entered law and politics. But diversity of occupation did not effect a similar difference in common ideals of life, nor did it interrupt the intimacy of their friendship."

It is a happy fact that Dean George Sellery, in his *Memoir of E. A. Birge,* turned in the section on "The Religious Man" to Prof. Max Otto to provide report on notes taken from Birge's thirteen St. Paul's Day addresses at St. Andrew's Episcopal Church, 1930-1942, that is, between the ages of 79 and 91. Birge said he was drawn to St. Paul because the Apostle was a university man. And warmly did he appreciate Max Otto as essentially a religious man. The studies were scored on 3x5 cards, and are not in manuscript. But remarkable as they are, they do not include the whole perimeter of Dr. Birge's religious outlook.

On September 19, 1949, he talked with his then pastor, who profited thereby, about an experience when he was a Junior at Williams College in 1872. A felon on his left thumb, which permanently disfigured that minor member, forced him home for some weeks recovery. At that time he translated Goethe's *Faust*. In reading the "Prologue in Heaven," where the archangels appear, he said, he had come over him a sense of entering into the knowledge of the reality of God that he had never had before, and which he felt was equivalent to the experience of a new birth. To him it was the admission by the door of literature to an appreciation of ultimate truth. And he remarked that it had not come to him by the door of science, although that was to be his field of action in the years ahead.

Such was the mind and mood of the man who moved through mediaeval scholasticism, through renaissance humanism, and through modern science, without losing touch with any of them. And such was he who gave us 19 papers, from "George Eliot's Novels," November 4, 1878, to "A House Half-Built," November 12, 1936. We cannot retrieve them all, for the George Eliot paper was, with all his early science papers and specimens, lost in the burning of old Science Hall in 1884. The introductory part of "A House Half-Built" is briefly autobiographical, and discusses the relation of scientific to ultimate knowledge. But we would do well to keep in mind his discovery of how fresh-water lakes keep house, by turning themselves upside down each autumn and each spring, as in each case cold water sinks and warm water rises. The homily might induce us to do a bit of house-cleaning in our own files from time to time. This might apply to the 800 papers heard by this club in its First Century, as a considerable portion of them repose in not too orderly array in the archives of the State Historical Society of Wisconsin. But here we confess our debt to our charter member, Edward Asahel Birge, who so eagerly sought and so diligently served the fellowship of this Club.

In 1955 Max Otto said of him, "Dr. Birge is no more gone than the world is gone in which he was active." That world—the house of his ancestral faith, the limnologist's life on the fresh water lakes, the University which he so faithfully and ardently served for fifty years—is nowhere more completely exhibited than in his legacy of papers to the Madison Literary Club. Consider the amazing range of the 19 papers he presented here:

Nov. 4, '78 — George Eliot's Novels.
Mar. 3, '79 — Mandeville's "Travels".
Mar. 1, '80 — Christopher Marlowe.
Apr. 3, '82 — Lamarck.
Oct. 2, '85 — Darwin's Influence on the Thought of the Century.
Apr. 11, '87 — Earthquakes.
Sept. 10, '88 — Life and Death.
Apr. 14, '90 — The Germ Theory of Disease.
June 13, '92 — Science (Sic Granum Sinapis.)
Apr. 8, '95 — Problems of Lake Life.
Oct. 10, '98 — Huxley.
Dec. 12, '04 — Darwin in His Letters.
Jan. 13, '08 — William Morris.
Jan. 9, '11 — Coeli Enarrant (The Heavens Declare).
Dec. 14, '14 — Stevenson — Twenty Years After.
Nov. 10, '19 — In Lucem Gentium (For a Light to the Nations).
Dec. 12, '25 — Lucerna Corporis. (Lamp of the Body.)
Dec. 8, '30 — Lakes.
Nov. 12, '36 — A House Half-Built.

THE TARDY MUSE or VOTIVE VERSES TO THE MADISON LITERARY CLUB

Frederic Cassidy

Toastmaster's Introduction

Today we have had something that physicists call a "chain reaction," and politicians a "domino effect." Such sequences often lead to an explosion. This morning our president was given a manuscript, then it was passed to me, and now the explosion will be read by Mr. Fred Cassidy.

(Frederic Cassidy then read his poem.)

Come, come, my Muse, bestir your laggard feet,
(Iambic, and pentameter most meet)
Refurbish, please, your somewhat rusty wit
To sing in rousing praise of Old Mad Lit!
All hail, Mad Lit (and sometimes snow or rain)
Nothing deters our worship at your fane!

Sing first—or better, *say*, to spare our ears—
Who sought this lively dueling of peers?
Who sought the verbal challenge to fling out,
And tease some bold opponent to a bout?
Who longed to meet on Mondays once a month
With sage and critic—even him who pun'th—
In cordial fellowship of town and gown
Where each can hope to put his fellow down?

Hobbins it was, whose wish to hob and nob
With few "selected" spirits—not the mob—
Called all together on Guy Fawkes's day
A parliament where each could have his say,
With Giles and Anderson and Bascom too
One hundred years ago—a weighty crew,
Of literary taste already known,
To share the fruits of culture with their own.

Can reminiscent Muse resist the urge
To chronicle great names—as those of Birge,
A founding father, loyal to a fault,
And always handy with the Attic salt?
Adams, Van Hise, and Frank, and Turner too,
Historic names; Thwaites, Ely and Evjue;
Uncommon Commons, Vilas, Slichter, Snow,
Vinje and Fairchild, Wilcox—see them go—
Dewey and Olson, Draper—splendid row!

Closer to memory—voices still recalled—
Sellery, Slaughter, Schorger never palled;
No more did Knaplund, Kiekhofer the Wild,
Hagen or Ela. Helen White so mild,
Classic Orsini, geographic Clark,
All struck with the flint of wit and made their spark,
Fire of the mind that shields us from the dark.

The clock approaches eight; we take our seats.
Agog with hope of intellectual treats.
It's on the dot—the chair makes warning sounds—
The eager speaker to the lectern bounds—
Shuffles his papers, mugs the microphone,
And lo! Another meeting's on its own.
Wisdom and anecdote take even turns,
The avid audience chuckles as it learns:
Too soon the allotted time has ticked away—
But have no fear—there's other things to say.
Two commentators vie to share the bed,
And tell the speaker what he should have said.
Enthusiasm grasps them in its power
And fifteen minutes swell to half an hour.
But when the heart is warm and the mind is stirred
Who would be churlish, counting every word?

The meeting's open for discussion now.
Our bright ideas shudder, bend, and bow

As ruthless critics, smiling ear to ear,
Rend them to shreds with crocodilean tear.
The shattered speaker hears but daren't reply.
(His chance to score comes later, by and by!)
His partisans defend him to the death;
Opponents struggle to the final breath.
Nothing can save him from a hopeless doom
Except refreshments in the adjoining room.

Mad Lit! Yes, mad indeed, but kindly mad—
The truth? The truth—most pleasant times I've had,
And disappointments few indeed. Mad Lit,
It's been a pleasure knowing you. You fit
One of my wants—we share—to meet the kind
Of people we're at home with, feed the mind
With interests other than our own—enlarge
The borders of our world—take charge
Of fresh ideas, mark the shadows cast
By wisdom for the future from the past.

My Muse salutes you with no future fears
She vows you'll live another hundred years!

F.G. Cassidy
8 Nov., 1977.

TOASTMASTER'S CLOSING REMARKS

My deep affection for this Club tempts me to speak further but also keeps me from doing so. Rather I quote from the account of the fiftieth anniversary: "In concluding, Mr. Jones expressed the wish that the group gathered to celebrate the hundredth anniversary might have as pleasant an evening." We project these wishes forward.

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1870 - 1970

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*Dr. Elizabeth F. McCoy TRANSACTIONS Editor, former President and Honorary President, died March 24, 1978. Forest Stearns was appointed Interim Editor shortly thereafter, and now serves as Editor.

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Contributors are asked to submit two copies of their manuscripts. Manuscripts should be typed double-spaced on 8-1/2 x 11 inch bond paper. The title of the paper should be centered at the top of the first page. The author's name and brief address should appear below the title and toward the right hand margin. Each page of the manuscript beyond the first should bear the page number and author's name for identification, e.g. Brown-2, Brown-3, etc. Identify, on a separate page, the author with his institution, if appropriate, or with his personal address to be used in *Authors' Addresses* at the end of the printed volume.

The style of the text may be that of scholarly writing in the field of the author, but to minimize printing costs, the Editor suggests that the general form of the current volume of TRANSACTIONS be examined and followed whenever possible. For Science papers, an abstract is requested. Documentary *notations* may be useful, especially for the Arts and Letters papers, and should be typed and numbered for identification in the text, such *notations* as a group, should be separate from the text pages and may occupy one or more pages as needed. References should be typed alphabetically at the end of the manuscript. The style of the references will be standardized as in the current volume to promote accuracy and reduce printing costs.

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THE CALIFORNIA-WISCONSIN AXIS IN AMERICAN ASTRONOMY

Donald E. Osterbrock
University of California—Santa Cruz

INTRODUCTION

Many astronomers are vaguely aware of a California-Wisconsin axis in American astronomy, but few realize just how many astronomical associations there are between the two states. A very large fraction of American astronomers have made the pilgrimage either eastward or westward between the Badger State and the Other Eden at least once in their careers, if not more often, and quite a few telescopes have made the same journey too, so that it is almost impossible to think of American astronomy without recognizing the connections between the two states.

The reasons for these ties are not hard to find — the two great American observatories founded in the nineteenth century, Lick Observatory of the University of California and Yerkes Observatory of the University of Chicago, located at Williams Bay, Wisconsin, dominated observational astronomy for many years, and each worked as a magnet, attracting astronomers from the other. When the Mount Wilson Observatory was built near Pasadena, in the early years of the twentieth century, it was at first very largely a Yerkes operation, and contributed even more to the traffic in astronomers between Wisconsin and California. The University of Wisconsin was an initially small but growing additional factor in this traffic, and Palomar Observatory, completed just after World War II, eventually became the largest factor of all.

LICK OBSERVATORY

Let us begin at the beginning. Lick Observatory was built as a result of the generosity of James Lick, an eccentric millionaire whose fortune was based on land speculation in downtown San Francisco at the time of the Gold Rush. Lick, who was born in Pennsylvania but who had spent over twenty years as a cabinet- and piano-maker in Argentina, Chile and Peru, liquidated his South American business and arrived in San Francisco in January, 1848, with $30,000 in cash. Almost immediately he began buying lots, the first at the corner of Jackson and Montgomery Streets for $270, and after gold was discovered on the American River he was able to buy more and more land at more and more advantageous prices as everyone else in San Francisco tried to get a stake together and head for the gold fields (1).

Toward the end of his life, Lick decided he wanted to use part of his by then vast fortune to leave a monument to himself. His first idea was to build a pyramid in downtown San Francisco larger than the Great Pyramid in Egypt, but his advisers persuaded him to drop this plan and instead found an observatory with a telescope "superior to and more powerful than any telescope yet made." The observatory was built on Mount Hamilton, near San Jose, a site picked by Lick himself; it was completed in 1888, 12 years after his death, and Lick's body was brought from San Francisco to a tomb in the pier of the telescope, where it remains to this day (2).

The observatory and telescope were built under the dynamic leadership of Captain Richard Floyd, the President of the Board of Trustees of the Lick Trust, and Thomas Fraser, the Superintendent on Mount Hamilton, who had been the foreman of Lick's San Jose property. The 36-inch telescope lens, at that time the largest in the world, was made by Alvan Clark and Sons, the Massachusetts opticians who figured the optics for all the large refractors of those days. As President of the Lick Trustees, Captain Floyd was responsible for staffing the Observatory, and in 1880, long before it had been completed, he wrote to James C. Watson, an outstanding theoretical astronomer who was at that time the first Director of the Washburn Observatory of the University of Wisconsin, and tried to awaken his interest in moving to Lick. Watson was guardedly enthusiastic and replied "Perhaps when the time comes I may enroll my name as one of the candidates for the directorship of your observatory . . . [N]otwithstanding the ties that bind me here, I am for the best scientific opportunity while I live" (3). Alas he did not live, but died less than three months after writing this letter, of pneumonia contracted while observing in the cold Wisconsin night air (4).

Figure 1. — Edward S. Holden 1846-1914. He was successively Director of the Washburn Observatory of the University of Wisconsin, President of the University of California, and Director of its Lick Observatory, Mount Hamilton, California. Lick Observatory Archives.

Instead of Watson, the first Director of Lick Observatory was Edward S. Holden, Watson's successor as Director of the Washburn Observatory. Holden was a product of Washington University and of West Point, and the protege of Simon Newcomb, Director of the Nautical Almanac Office and the most distinguished American astronomer of his day (5). Holden was appointed Director at Washburn on Newcomb's recommendation in 1881, while also acting as scientific advisor to the Lick Trust, but after only a few years in Wisconsin he accepted the position of President of the University of California in 1885 to be close to the scene of action until the observatory was completed. First light was seen through the 36-inch telescope on a bitterly cold night in January 1888; in June of that year the observatory was turned over to the University and Holden stepped up from President of the University of California to Director of Lick Observatory (6).

GEORGE ELLERY HALE

Only two years later, George Ellery Hale, who was to found Yerkes, Mount Wilson and Palomar Observatories, visited Lick Observatory with his bride on their honeymoon trip through the West. Hale, the son of a Chicago elevator magnate, had had a strong scientific interest from childhood, an interest that was encouraged by his father, who bought him the prisms, spectroscopes, gratings and telescopes he needed for his Kenwood Observatory in the backyard of the family mansion on Drexel Boulevard. Hale went to M.I.T., where he was a good student though he was far more interested in the experimental work he did on solar photography for his undergraduate thesis than in the formal courses. Two days after graduation he married his childhood sweetheart, and then began the honeymoon trip which took him two months later to Lick (7).

Hale was tremendously impressed with the telescope and the Observatory; Holden in turn was impressed with Hale and offered him a chance to stay and use the telescope, but he decided instead to go back to Chicago, build up his own observatory, and keep himself available for a faculty position at the then new University of Chicago.

Hale was a unique character in American astronomy. Scion of a wealthy family, he was accustomed from childhood to deal with the rich and powerful as an equal; yet at the same time he was a highly creative scientist who invented the spectroheliograph while still an undergraduate, never had time to complete formal graduate training, pioneered the science of astrophysics, and made many important observational contributions to the study of the sun and its magnetic properties. Above all he was an organizer of science and a builder of observatories.

By 1892 Hale was an Associate Professor at Chicago as part of a package deal in which his father promised to give the University the instruments of the Kenwood Observatory, if the University in its turn would raise the funds for a larger observatory. That same year Hale met Charles T. Yerkes, the tycoon who controlled the Chicago El system, and within a few weeks persuaded him to commit himself to building "the largest and best telescope in the world." Yerkes had been presold on the idea by President William Rainey Harper of the University of Chicago, but Hale had clinched the deal. Luckily the 40-inch glass blanks for the lens were available in the United States. They had been ordered by the University of Southern

California, which hoped to build an observatory on Mount Wilson, but lost all its promised funds when the Southern California land-speculation bubble burst in 1892. Yerkes bought the blanks from USC, Alvan Clark and Sons started grinding them into lenses, and the planning of Yerkes Observatory began (7). Apparently Yerkes himself was only willing to consider locations for his telescope close to Chicago, and the site on Lake Geneva was eventually chosen on the recommendation of Thomas C. Chamberlin, who before coming to Chicago as head of the Geology Department had been successively Instructor at the Normal School at Whitewater, Professor of Geology at Beloit College, Chief Geologist of the Wisconsin Geological Survey, and President of the University of Wisconsin (8). University of Wisconsin (8).

Yerkes, like Lick before him, proved a slippery source of funds, and tried several times to withdraw his support, but in the end the 40-inch telescope was built and first light was seen through it in May 1897. It is still the largest refracting telescope in the world, the Lick 36-inch is the second largest, and both are in regular use as research instruments. The Yerkes Observatory building, designed by Hale, was obviously greatly influenced by his visit to Lick, as the two observatories are very similar in external appearance, and inside too.

One of the first graduate students at Yerkes Observatory was William H. Wright, a native of San Francisco who had done his undergraduate work at the University of California and received his B.S. in Engineering in 1893. He was interested in astronomy and stayed on for two more years at Berkeley studying mathematics, physics and astronomy, and then in his one year at Yerkes got into the new field of astronomical spectroscopy. He returned to California as a member of the Lick staff in 1897, where he remained until he retired in 1944; he was Director from 1935 until 1942. Wright made many pioneering spectroscopic investigations at Lick, particularly of gaseous nebulae and novae or "new stars" (9).

Likewise at Lick Observatory there were graduate students almost from the beginning, although there never was a complete program of courses until the faculty moved to the Santa Cruz campus in 1965. The first group of graduate students at Lick numbered six, of whom two had done their undergraduate work at the University of Wisconsin (10). One of these two, Sidney Townley, who was born in Waukesha, went from Lick to the University of Michigan, where he earned his Sc.D. in 1897, and then a few years later joined the Stanford faculty where he taught astronomy in the Applied Mathematics Department for many years.

Even before the Yerkes 40-inch was finished, Hale had begun thinking of a larger telescope. He realized that the 40-inch is close to the upper limit of practical size for refractors, and that the new telescope would almost certainly have to be a reflector, in which the light is collected and focused by a large parabolic glass mirror rather than a lens. In 1894 Hale's ever supportive father provided the funds to buy a 60-inch glass blank from France, and to pay to have it figured into a mirror. He agreed to give the mirror to the University of Chicago on condition that the University provide the mounting, dome, auxiliary instruments and necessary operating expenses. Hale wanted to locate the new reflector, when it was built, in a site with more clear weather than southern Wisconsin, and after a trip to California in 1903 he definitely decided on Mount Wilson. Neither Yerkes nor the University of Chicago was able to furnish even the funds necessary to pay the salaries of the astronomers at Yerkes Observatory, but nevertheless in 1904 Hale established a Solar Observatory on Mount Wilson. He was in close touch with Andrew Carnegie and his Carnegie Institution of Washington, which before the year was out, put up the money to found the Mount Wilson Solar Observatory (as it was originally known, for the first instrument was a solar telescope) and mount the 60-inch telescope. Though there was some unpleasantness with the University of Chicago about the ownership of the glass blank for the mirror, eventually it was handed over and by December 1908 the new 60-inch telescope was mounted and in use (7).

Long before this, Hale had turned his attention to building a bigger telescope, and in 1906, two years before the 60-inch was completed, he had managed to persuade John D. Hooker, a Los Angeles iron and oil magnate, to provide the funds for a 100-inch mirror (7). Much more Carnegie money was required before the 100-inch telescope was completed on Mount Wilson in 1917, the third successive largest telescope in the world built under Hale's direction, the first of them in Wisconsin and the other two in California. After his retirement, he also secured the funds for the 200-inch telescope, which is still the largest telescope in the world, though he didn't live to see it completed; it was named the Hale telescope at the time of its dedication in 1948, and the Mount Wilson and Palomar Observatories were renamed the Hale Observatories in 1968, the hundredth anniversary of Hale's birth.

EARLY LICK ASTRONOMERS

When the Lick Trust officially handed over Lick Observatory to the University of California in 1888, the staff included, in addition to Holden, four astronomers, S. W. Burnham, E. E. Barnard, John Schaeberle and James Keeler (11). Burnham was an indefatigable double-star observer, who for many years had been court reporter and later clerk of the Federal Court in Chicago. In the evening he would measure close double stars with his own telescope in his backyard observatory, where the young George Ellery Hale, as a boy of fourteen, met him and first saw a Clark refractor. Burnham had an excellent 6-inch, which he took with him when he went out to Mount Hamilton in 1879 as a consultant to the Lick Trust. He stayed for two months, observed many double stars, and pronounced the atmospheric transparency and seeing excellent (12). It was on the basis of this report that the final decision to build the observatory on the Mount Hamilton site that Lick had chosen was confirmed.

After his return to Chicago, Burnham set up his telescope on the University of Wisconsin campus in Madison, where he went on weekends to take advantage of the clearer and darker Wisconsin skies. This telescope, which Burnham had used in the Mount Hamilton site test, was acquired by the University of Wisconsin (13), and was mounted for many years in a small dome just off Observatory Drive, between the old Washburn Observatory (where the Institute for Research in the Humanities is now located) and the old Director's House (now the Observatory Hill Office Building). The telescope is now in use in one of the domes on the roof of Sterling Hall, while the old dome has been moved to the Madison Astronomical Society's Oscar Mayer Observatory, off Fish Hatchery Road.

Burnham finally went professional when the 36-inch was completed at Lick Observatory, and Holden persuaded him to join the staff. However, it soon turned out that Holden, a West Point graduate, expected to run the observatory as its commanding officer, supervising personally the research of all the astronomers on the staff. Relations became strained at the isolated and underfunded observatory (14), and after only four years at Lick, Burnham returned to the tranquility of Chicago. When Yerkes Observatory was founded a few years later, Hale managed to lure him out of retirement with a position which allowed him to come to Williams Bay on weekends to observe, while keeping his apparently not-too-demanding courtroom job in Chicago (15). Burnham together with another renegade from the Lick staff, Barnard, was present when the 40-inch Yerkes refractor was first turned on stars, clusters and nebulae in 1897, and Hale quoted the two of them as agreeing that it was "decidedly superior" to the Lick refractor (7).

Barnard was a native of Tennessee, a poor boy who became a self-taught photographer, an amateur astronomer, and eventually a pioneer of celestial photography. He discovered the fifth satellite of Jupiter, the first to be discovered since Galileo's time, with the Lick 36-inch in 1892, as well as several comets, so his name was well known to the public, and it was a severe blow when he left in 1895 to accept a position at Yerkes (16). Before he came to Lick, Barnard wrote that he looked forward to working under Holden, but within a few short years he came to resent him as a petty tyrant, and when he resigned, though he thanked the Regents profusely, he could not bring himself to mention Holden's name (17, 18, 19).

The first of the original Lick staff to go had been Keeler, who became Director of the Allegheny Observatory in Pittsburgh in 1891. Burnham and Barnard were classical astronomers of the old school, but Keeler was a pioneer astrophysicist, applying the new methods of spectroscopy to investigate the nature of the stars and planets. Keeler and Hale were the two American apostles of this new-fangled science, the one specializing in stars and nebulae, the other in the sun. They were personally close, and corresponded often. Keeler was present along with Hale and Burnham when the 40-inch lens was first tested on stars in an improvised mounting at Alvan Clark's optical shop in Massachusetts, and he gave the principal address at the formal dedication of Yerkes Observatory. For several years Hale tried very hard to lure Keeler away from Allegheny to join the Yerkes staff, but he never made the move to Wisconsin, returning instead to Lick in 1898 as Director after Holden had been forced out (20).

Back at Lick, Keeler applied his personal efforts to using the recently acquired Crossley (36-inch) reflector for celestial photography (21, 22). At about the same time, George Ritchey was using the 24-inch reflector at Yerkes that he himself had made, for a similar program (23, 24). Previously, professional astronomers had thought almost entirely in terms of refracting, or lens telescopes, but Keeler and Ritchey proved that reflecting telescopes had tremendous advantages for photographic work by obtaining pictures of clusters, nebulae, and galaxies revealing details never seen before. A reflecting telescope is achromatic, which means it brings light of all colors to the same focus, its silvered or aluminized mirror does not absorb blue light, as the lens of a refractor does, and it can be much shorter than a refractor with the same aperture, which makes it both less expensive to build and more effective for photography of faint nebulae and galaxies. Hale had realized even before Keeler's and Richey's results that the big telescopes of the future would be reflectors, not refractors, and had put this conclusion into practice by getting his father to buy the 60-inch glass blank from France. When Hale went west to Mount Wilson, the mirror went along, as did Ritchey, who was put in charge of the optical shop in Pasadena. He finished the 60-inch mirror there after the Carnegie money came through, designed the dome and telescope, and took some of the first photographs with it after it was put into operation on Mount Wilson in December 1908 (25).

In addition to Ritchey, Hale took with him to California Ferdinand Ellerman, Walter Adams, and Francis Pease; and Barnard, though he never joined the Mount Wilson staff, also came as a temporary visitor (7). This was almost the entire Yerkes first team, except for Burnham and Edwin Frost, Hale's successor as Director, and the mass exodus must have caused a certain amount of bitterness among those left behind. Ellerman was originally a photographer, who had been at Kenwood with Hale before going to Yerkes. On Mount Wilson he went western in a big way, sporting a ten-gallon hat, mountain boots, a pistol, cartridge belt, and hunting knife the first time he showed Adams the trail up the mountain (26). Pease was trained as a mechanical engineer, but both these men became highly skilled observers and instrumentalists, who could make complicated equipment work and get results under the primitive conditions on Mount Wilson (27).

Many of Hale's associates had little formal training in astronomy, and he not only directed their scientific work, but also, as a sort of intellectual Prince Charming, widened their horizons with his tales of the books he had read, the travels he had made, and the famous men he had met, in the gatherings on cloudy nights around the fireplace at the Casino, and later the Monastery, the observers' lodgings on Mount Wilson (26). Walter Adams, however, was a trained scientist who eventually succeeded Hale as Director of Mount Wilson Observatory. Son of Congregational missionaries in Syria, Adams did his undergraduate work at Dartmouth, where he came under the spell of Frost, and followed him to Yerkes, where he worked closely with Hale. Adams' combination of scientific knowledge and ability with observational skill, strong character and physical toughness made it natural that Hale should depend more and more upon him (28).

Hale was a highly neurotic individual, who worked extremely intensely and felt the heavy responsibilities of his position more than most men, perhaps partly because he accomplished more than most men. He suffered a nervous breakdown in 1910, and Adams took over as Acting Director for a year. From that time onward, Hale had progressively more difficulty concentrating, with occasional severe headaches, frequent depression (25), and sometimes even departures from reality (7). He withdrew more and more from active research, spending long periods of time resting or traveling, as Adams became increasingly responsible for the detailed supervision of the observatory, first as Assistant Director in 1913, and then as Director in 1923, when Hale resigned (28). Over the years until he himself retired in 1946, and even after, Adams made many important research contributions, particularly in high-dispersion stellar spectroscopy. He stamped Mount Wilson with his own image of quiet conservative competence, which it retains to this day.

Hale not only brought faculty members from Yerkes Observatory to Mount Wilson, but telescopes as well. In addition to the glass blank for the 60-inch mirror, he wanted badly to take the Snow telescope, a fixed horizontal instrument with a coelostat, especially designed for observations of the sun, to get started at the Mount Wilson Solar Observatory. However, neither Miss Helen Snow of Chicago, donor of the funds with which the telescope had been constructed, nor Frost, the Acting Director at Yerkes, wanted to let it go. Yet within a few months the ever persuasive Hale had convinced them to let him have it, and the Snow telescope was soon transported west and mounted in its own building on Mount Wilson, where it is still in use for special solar observing programs (29).

Hale also managed to persuade Hooker, who later provided the funds for the 100-inch mirror, to put up the necessary money to bring Barnard and the Bruce photographic telescope from Yerkes to Mount Wilson to photograph the southern Milky Way, inaccessible from Wisconsin, but this was planned as a temporary expedition and both instrument and observer soon did in fact return to Yerkes. The Bruce telescope was mounted for many years in a small dome between the Yerkes Observatory main building and Lake Geneva, but it was removed and the building demolished in the 1960s.

Over the years of Hale's directorship several more Yerkes products joined the Mount Wilson staff. Charles St. John was a late bloomer who received his Ph.D. from Harvard in 1896 at the age of 39, and then became Professor of Physics and Astronomy and eventually Dean of the College of Arts and Sciences at Oberlin College in Ohio. His heart was in research, however, and he spent several summers at Yerkes, working on solar observational problems. In 1908, when St. John was 51, an age at which many scientists are shifting into adminstration, Hale offered him a job at Mount Wilson, and he moved west, where he pursued an active solar research career well beyond his formal retirement (30, 31).

Alfred Joy, a graduate of Oberlin, was teaching at what is now the American University in Beirut at the time of the Lick Observatory expedition to Egypt to observe the solar eclipse of 1906 at Aswan. Joy joined the expedition and became so interested in astronomy that he returned to the United States for summer volunteer work at Yerkes in 1910 and 1911, and a year's study at Princeton, and then was taken on the Yerkes staff in 1914. After a year at Yerkes, however, he made the move to Mount Wilson, and worked there the rest of his life in stellar spectroscopy. Though he "retired" in 1948 at the age of 65, he continued observing at the telescope until he reached 70, and still came to the Pasadena offices of the Observatory almost daily until his death in 1973 at the age of 91 (32, 33).

Another eventual Mount Wilson Observatory staff member, Edison Pettit, was born and educated at Peru, Nebraska, and then taught astronomy at Washburn College in Kansas for several years. However, in the summer of 1917 he went to Yerkes Observatory, and he liked it so well he returned there as a graduate student for two years until he was offered a job at Mount Wilson, where he remained until his retirement in 1955. He was a dedicated solar and planetary observer, who also pioneered in the measurement of stellar radiation with thermocouples (34).

Surely the Mount Wilson astronomer who had the most impact on the public was Edwin Hubble, who received his Ph.D. degree at Yerkes in 1917. He had been a student at the University of Chicago, where he worked as a laboratory assistant to Robert Millikan, the Nobel prize-winning physicist who later became president of Caltech. When he graduated from Chicago in 1910 Hubble was awarded a Rhodes Scholarship and went to Oxford for three years to study law. He practiced in Kentucky for a year, but then decided astronomy was the only thing that really mattered to him, and he returned to Chicago and to Yerkes where he did his thesis with the 24-inch reflector, Ritchey's old telescope, photographing faint nebulae (35). Hubble was offered a position at Mount Wilson, but when he had finished his thesis and passed his final oral examination in 1917, he joined the Army and sent a telegram to Hale, "Regret cannot accept your invitation. Am off to war." He was mustered out a Major in 1919, and immediately joined the Mount Wilson staff.

Hubble was technically a rather poor observer, as his old photographic plates in the Mount Wilson files show, but he had tremendous drive and creative insight, and within a few years he was able to distinguish between galactic and extragalactic nebulae and to understand and prove the physical natures of both of these classes of objects. He soon grasped the correlation between the red-shifts and distances of galaxies, and used it to explore observationally "the realm of the galaxies," the modern version of the title of his epoch-making book. Hubble was a more outgoing character than most astronomers, a fine speaker who projected a hearty, soldierly, Rhodes-scholar image, and who had a wide circle of friends outside astronomy and university life (36, 37). He had an excellent sense for public relations, and was constantly called on for radio talks and popular articles. On one occasion in the 1940s the Mount Wilson spectroscopists, concerned that people might think that cosmology was the only problem studied at the observatory, arranged a press conference at which they planned to let the world know of their own contributions. Reporters were invited from the Southern California newspapers and even from the national magazines. Hubble was not notified of the press conference, but of course heard of it from his newspaper friends; he wandered into the library where it was in progress and the reporters, bored with the accounts they had heard of spectroscopy of carbon stars, spectroscopy of M giants, and spectroscopy of cepheid variables, asked if Dr. Hubble had done anything in the line of spectroscopy. He modestly disclaimed any personal involvement, but launched into a gripping explanation of the age and origin of the universe as revealed by Mount Wilson observations, emphasizing the role of spectroscopy as practiced by his collaborator Milton Humason, and this was the story that the newspapers and magazines used (38).

There were tremendous personal contrasts between the transplanted Kentuckian Hubble, and the frugal New Englander Adams, but these two Yerkes products were the outstanding observational astronomers of their generation.

WASHBURN OBSERVATORY

One of their contemporaries, Joel Stebbins, was undoubtedly the greatest astronomer the University of Wisconsin ever had on its faculty, a man who in his career very closely linked California and Wisconsin. Stebbins, a native of Nebraska, attended the state university there as an undergraduate, and then went to the University of Wisconsin for one year as a graduate student, but George Comstock, the one and only Professor of Astronomy at that time, recognized his abilities and advised him to move on to a bigger observatory with more research opportunities. Stebbins nearly decided to go to Yerkes to work with Hale, but instead decided on Lick, where Comstock had spent one summer as a research volunteer. After he earned his Ph.D., Stebbins' first position was at the University of Illinois, where he began to experiment with the photoelectric cells with which he revolutionized astronomy. He returned to the University of Wisconsin in 1922, where he remained as Director of Washburn Observatory and Professor of Astronomy until he retired in 1948. During these years he observed almost every type of astronomical object photoelectrically, with cells and multipliers which, because of their high photon efficiency and linearity, made possible for the first time the accurate quantitative measurement of the brightnesses and colors of stars, clusters and galaxies (39).

Stebbins maintained his contacts in California, and was often invited to bring his photoelectric photometer west to observe with the big California telescopes. He spent 1926-27 at Lick Observatory as Alexander Morrison Fellow, and in 1931 was appointed a Research Associate of Mount Wilson, where he went for several months' observation nearly every year until he retired. Like many another ex-California astronomer, Stebbins keenly felt the cold Wisconsin winters, and he had planned to live in Pasadena after his retirement at the age of 70, but his and all other Research Associateships were terminated in an economy move and he had to abandon this dream (40, 41). Instead he became a Research Associate at Lick Observatory, and moved to Menlo Park, California, making weekly trips to Mount Hamilton for ten more years, participating actively in the research with collaborators on the Lick faculty (42).

Stebbins returned to Madison to give the principal address at the dedication of the then new Pine Bluff Observatory in the Town of

Cross Plains in July 1958, and an oil portrait of him, presented to the University at that time, is on display in the foyer there.

Stebbins' student and the first Ph.D. in Astronomy at the University of Wisconsin, was C. M. Huffer, who previously had gotten his master's degree at Illinois in 1917 and then spent five years in Chile with the D. O. Mills Expedition of the Lick Observatory. This was an observing station with a 36-inch reflector, maintained for several years at Cerro San Cristobal, in the outskirts of Santiago, in order to make radial-velocity measurements of stars in the southern skies inaccessible from Mount Hamilton. On his return to the States in 1922 Huffer went to Wisconsin, where he received his Ph.D. in 1926, joined the faculty, taught and did photoelectric research, initially with Stebbins, until he retired in 1961. He then began a new career at the California State University in San Diego, teaching astronomy to numerous students until he retired again in 1969, and he now lives in Alpine, California, near San Diego.

Another Wisconsin product, Albert Whitford, was an undergraduate at Milton College, and then did his graduate work in Physics at the University of Wisconsin. After receiving his Ph.D. in 1932, Whitford went to Mount Wilson Observatory and Caltech for two years on a post-doctoral fellowship, and then returned to Wisconsin, where he collaborated closely with Stebbins, particularly in photoelectric measurements of interstellar reddening, of globular clusters, and of galaxies. Much of the observing was done at Mount Wilson, where Whitford continued to go as a guest investigator after he had succeeded Stebbins as Director of Washburn Observatory. In 1958 Whitford left Wisconsin to become the eighth Director of Lick Observatory, and was responsible for the completion of its 120-inch reflector, which had been begun under his predecessor, Donald Shane. Whitford gave up the directorship at Lick in 1968, and retired from the faculty in 1973, though he continues to live in Santa Cruz and spends much of his time on astronomical research.

Two other of Stebbins' students who went on to become members of the Lick staff were Gerald Kron and Olin Eggen. Kron, a native of Milwaukee, did his undergraduate work at Madison and worked as an assistant to Stebbins, making several observing trips to California with him (42). He did his graduate work at Lick Observatory, and then worked there on the faculty from 1938 until 1965. Eggen, who was born in Orfordville, (Whitford used to refer to him as the other member of the Rock County Astronomical Society), was a graduate student at Wisconsin, where he received the second Ph.D. ever granted in Astronomy. In 1948 he became a member of the Lick faculty, where he stayed until 1956, afterwards going to the Royal Observatory in England, to Caltech, to the Australian National University, and most recently to the Cerro Tolols Interamerican Observatory in Chile. Both Kron and Eggen are experts in photoelectric photometry, which they had first learned at Wisconsin, and then applied at Lick, particularly to research on globular clusters and on color-magnitude diagrams, respectively.

YERKES OBSERVATORY

Stebbins was not the only Wisconsin astronomer to retire to California. One of his predecessors was Frank Ross, who had been a member of the Yerkes faculty for fifteen years until he retired in 1939 and moved to Altadena. Ross was born in San Francisco, and did his undergraduate and graduate work at Berkeley where, in 1901, he received one of the first two Mathematics Ph.D. degrees given by the University of California. His training was in celestial mechanics, and he worked at the Carnegie Institution for several years on orbital computations of planets and satellites, but then went to Eastman Kodak as a research physicist, specializing in lenses and photographic techniques. He was invited to join the Yerkes faculty as a photographic expert in 1924, and his main contribution there was a photographic survey of the sky that went beyond Barnard's earlier work and revealed many new features of the interstellar matter in our Galaxy. As the outstanding astronomical photographer of his day, Ross was invited to Mount Wilson to use the 60- and 100-inch telescopes to study Mars and Venus in the late 1920s and many of his photographs taken then were very widely used and reproduced for years afterward. After his retirement Ross had an office in the Mount Wilson Observatory, where he worked as an optical consultant until his death in 1960. He designed the Ross corrector lens that is used for almost all direct photographs of nebulae and galaxies taken with the 200-inch telescope, as well as the 20-inch Ross astrograph lens used for the fundamental proper-motion program at Lick Observatory (43, 44).

Just a year before Stebbins moved from Illinois to Madison, Otto Struve emigrated from Russia, by way of Turkey, to Williams Bay. Struve was born in Kharkov, where his father was Professor of

Figure 2. — Otto Struve 1897-1963. He was successively Director of the Yerkes Observatory of the University of Chicago, Williams Bay, Wisconsin, and Chairman of the Berkeley Astronomy Department of the University of California. Here he is shown standing outside Yerkes Observatory. Yerkes Observatory Photograph.

Astronomy; his grandfather and great-grandfather both had been Directors of Pulkovo Observatory, and his uncle was a famous astronomer in Germany. Struve as a very young man served as an officer in the Russian army in World War I, and then after a short interval as a student, in the White army fighting the Bolsheviks. After the collapse of the Whites, he managed to flee to Turkey, and eventually was brought to Yerkes Observatory by Frost in 1921. Struve completed his graduate work and received his Ph.D. in 1923, and continued on the Yerkes faculty until 1950, when he left to become Chairman of the Berkeley Astronomy Department of the University of California. Struve was an outstanding stellar spectroscopist, who in his observational efforts applied the new results of quantum mechanics, particularly on ionization and excitation, to trying to understand stellar atmospheres and the physics of stellar evolution. He worked single-mindedly at astrophysical research and produced a prodigious number of papers, particularly on stellar rotation, binary stars and peculiar stars of all kinds. Struve was appointed Director of Yerkes Observatory when Frost retired in 1932, and he picked and led the brilliant staff that made it famous in the 1940s and 1950s (45). They included Gerard Kuiper, a Dutch astronomer who was at Lick Observatory for two years as a post-doctoral fellow before joining the Yerkes staff in 1936, and W. W. Morgan, a 1931 Yerkes graduate who remained on the faculty there, and in fact was elected President of the Village Board of Williams Bay for two terms in the 1940s. Morgan was a Morrison Fellow at Lick in 1955, a Visiting Professor at Caltech in 1957, and over the years made several extended visits to the Mount Wilson and Palomar Observatories for research work with the collection of photographs of galaxies there.

CALIFORNIA

During Struve's years there was a constant traffic of astronomers back and forth between California and Wisconsin. Two Californians who did observational theses at Lick and received their Ph.D.s at Berkeley, and then joined the Yerkes staff in 1939 were Daniel Popper and Horace Babcock. At Yerkes they broadened their experience and skills in stellar spectroscopy, and after a few years returned to California, where Popper is now a senior professor at UCLA, while Babcock has recently retired as Director of Hale Observatories. His father, Harold Babcock, who was born in Edgerton but moved to California at an early age, was a member of the Mount Wilson staff before him. A gentle, sensitive soul, Harold Babcock idolized Hale; his long poem "In 1903" describing Hale's first visit to Mount Wilson ends with the stanza (46)

> "How fortunate that little group of men
> Whom in those next swift years he chose to be
> His friends and colleagues in the appointed task
> Of realizing what he had foreseen!
> We cannot speak the things we wish to say,
> But bright and clear within our inner hearts
> Devotion's timeless flame burns on."

Fifteen years after these lines were written, Harold and Horace Babcock, working at the Hale Solar Laboratory in Pasadena, proved the existence of the general magnetic field of the sun, an observation Hale tried very hard to make himself, and would have applauded if he had still been alive (47).

During the 1930s two German astronomers, Walter Baade and Rudolph Minkowski, emigrated to America from Hamburg and joined the Mount Wilson staff. Baade, the first to come, originally had a Wanderjahr (1926-27) in the United States on a Rockefeller Fellowship, in the course of which he spent several months at Yerkes, at Lick and at Mount Wilson (48). He loved to tell stories about his summer in Williams Bay; it was during the days of Prohibition and the landlady of the boarding house in which he stayed was a strict Teetotaler, while her two sons, approximately Baade's age, were not, at least whenever they could get out from under Mother's eyes. It was a situation that appealed to him and he could never forget their escapades, in which he himself was fully involved, hiding cases of beer in a tent in the back yard, in the woods around the house, or under his bed (49). Baade's great contribution to astronomy, the recognition of the two stellar populations, young stars and old, was the result in part of the fact that he, technically an enemy alien, was one of the very few astronomers not involved in military research in World War II. As a result he had a large amount of observing time with the 100-inch telescope, in skies made dark by the Southern California wartime dim-out, and was able to photograph extremely faint stars in neighboring galaxies.

Minkowski, who came to Mount Wilson in 1935, four years after Baade, was responsible with him for the identification and interpretation of the newly discovered radio sources in the 1950s. After his retirement from the Mount Wilson and Palomar Observatories, Minkowski was a Visiting Professor at Madison in 1960-61, and then moved to Berkeley, where he was a Research Associate for several years until his death in 1976.

After World War II, when the Caltech administration decided to build up an astrophysics department to match the 200-inch telescope, the first new faculty member to be brought in was Jesse Greenstein, who came from the Yerkes faculty in 1948, followed in succession by Guido Münch, a Yerkes Ph.D. who had stayed on the Yerkes faculty, myself, a Yerkes Ph. D., and Arthur Code, a Yerkes Ph.D. who had joined the University of Wisconsin faculty. Only after these four appointments was the magic Wisconsin circle broken, and the next new faculty member came from Princeton. In those same years several other Yerkes students and faculty members were moving west to the big observatories in California. Louis Henyey, a Yerkes Ph.D. and faculty member until 1947 went to Berkeley a few years before Struve; John Phillips, a Yerkes Ph.D. who stayed on there as a lecturer for two years, went with Struve; and Su-shu Huang, another Yerkes Ph.D. and lecturer, went a year after Struve. Armin Deutsch, a Yerkes Ph.D., joined the Mount Wilson and Palomar Observatories in 1951, while William Bidelman, another Yerkes Ph.D., joined the Lick Observatory faculty in 1953 after three years on the Yerkes faculty. Basically, all these men were carrying the Yerkes spectroscopy tradition to California. A counter movement brought Harold Johnson from Berkeley, where he earned his Ph.D., to the Wisconsin faculty in 1949 and then to Yerkes in 1950, and Aden Meinel from Berkeley to Yerkes in 1949. A few years later, Helmut Abt, who earned his Ph.D. at Caltech in 1952 and then spent one year at Lick as a post-doctoral research fellow, joined the Yerkes staff.

RECENT PAST

In the more recent past, when the University of Wisconsin administration decided to expand to a full-fledged graduate program in astronomy, it brought Arthur Code and myself from Caltech in 1958, and within a few years we were joined by John Mathis, who had received his Ph.D. at Caltech in 1956, and later by Robert Parker and Christopher Anderson, both Caltech Ph.D.s, and by Jack Forbes, a Berkeley Ph.D. When Forbes left Wisconsin, he was replaced by Kenneth Nordsieck, a University of California-San Diego and Lick Observatory product. Half the present University of Wisconsin astronomy faculty members are linked by graduate training or previous faculty experience in California.

Likewise, at Yerkes the present Director, Lewis Hobbs, is a University of Wisconsin Ph.D. who had a post-doctoral research position at Lick Observatory before returning to Yerkes, and his two immediate predecessors were also closely associated with California. William Van Altena, the Director before Hobbs, is a Berkeley Ph.D. who did his thesis at Lick, while C. Robert O'Dell, the Director before Van Altena, is a Wisconsin Ph.D. who was a post-doctoral fellow at Mount Wilson and Palomar Observatories and then a faculty member at Berkeley before returning to Williams Bay. The two newest faculty members at Yerkes, Kyle Cudworth and Richard Kron, are recent University of California Ph.D.'s from Lick and Berkeley respectively.

At Lick Observatory at present nearly all the senior professors have Wisconsin connections. George Herbig, Merle Walker and Robert Kraft are all Berkeley Ph.D.s who spent some time at Yerkes, Herbig as a post-doctoral fellow in 1950-51, Walker as research associate in 1954-55, and Kraft as an assistant professor in 1961-63. I am a Yerkes, Ph.D. and the third director of Lick to come from the University of Wisconsin faculty. Joseph Wampler did his graduate work at Yerkes and received his Ph.D. in 1963 before coming to Lick, first as a post-doctoral fellow, and then joining the faculty in 1965. Among the associate professors, Joseph Miller was a UCLA undergraduate, then did his graduate work at Madison and received his Ph.D. in 1967, and then came to Lick, while William Mathews spent one year as a graduate student at Yerkes before transferring to Berkeley. George Blumenthal did his undergraduate work at the University of Wisconsin-Milwaukee before getting his Ph.D. at San Diego in 1970, and then coming to Santa Cruz as an assistant professor two years later.

At the present time the only ex-Wisconsinite on the Hale Observatories staff besides Greenstein is Jerome Kristian, who grew up in Milwaukee, did his graduate work at Yerkes, and was a faculty member at Madison from 1964 until 1968 before going to California. And at Berkeley there are no astronomical immigrants from Wisconsin except Phillips and Harold Weaver, a Berkeley Ph.D. who was a post-doctoral fellow at Yerkes in 1942-43 before returning to the University of California in 1945. However, the other University of California campuses are full of them. At San Diego, Geoffrey and Margaret Burbidge did post-doctoral research work at Yerkes in 1951-53 when they first came over from England, then after a year back at Cambridge went to Caltech for three years where they were very active in opening up the field of stellar nucleogenesis. From Caltech they returned to Yerkes, where Geoffrey Burbidge was on the faculty and Margaret Burbidge was initially a research associate and later a faculty member during the years 1957-1962 and then they went to UCSD, where they both are faculty members. At UCLA two of the eight present astronomy faculty members are Wisconsin Ph.D.s — Harland Epps and Holland Ford. In addition, in the California State University system there are three more astronomy faculty members who did their graduate work at the University of Wisconsin, Burt Nelson and C. T. Daub at San Diego, and Joseph Boone at San Luis Obispo.
Boone at San Luis Obispo.

Over the years, from Holden and Hale's days down to our own, about half the Wisconsin astronomers have had strong California ties, and vice versa. No other pair of states are so intimately linked astronomically. Probably in future years there will be more California-Arizona connections, because of the growth of the Kitt Peak — University of Arizona complex in Tucson, but there is little sign that the California-Wisconsin ties have slackened yet.

ACKNOWLEDGMENT

I am deeply grateful to many friends and colleagues for suggestions, ideas and comments on the California-Wisconsin Axis. I am particularly grateful to Mrs. Mary Shane, Mrs. Frances Greeby, and my wife Irene for locating research material for me in the University of California libraries and in the Lick Observatory Archives, which are deposited in the Dean E. McHenry Library of the University of California, Santa Cruz. All dates and appointments not specifically referenced in this article are from contemporary editions of *American Men of Science.*

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THE STOUGHTON FAVILLE PRAIRIE PRESERVE: SOME HISTORICAL ASPECTS

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The Stoughton [W.] Faville Prairie Preserve is part of the once-extensive Crawfish prairie that covered about 1,800 acres in the Milford and Waterloo townships of Jefferson County. This paper traces the history and describes the background of the Stoughton [W.] Faville Prairie Preserve and the man for whom it was named.

Ever since I was a small boy with orange stains of bloodroot-blood on my fingers I have had an interest in wildflowers. It was not until I was a graduate student living at the Faville Homestead Farm north of Lake Mills that I became physically and emotionally involved with prairie, prairie wildflowers and Stoughton Willis Faville. The scenario follows.

There was a move afoot in the mid-1930's by my major professor, Aldo Leopold, Chairman of the Department of Wildlife Management, University of Wisconsin, to set aside a permanently protected tract of virgin prairie for esthetic and scientific purposes. I knew little of this in August 1939 when I arrived on his doorstep at the University.

He was also attempting to find a group of cooperative farmers on whose land he could practice wildlife management and undertake wildlife research. Such a group was found at Lake Mills. Stoughton W. Faville and his son-in-law, Frank W. Tillotson, were the key persons in Leopold's attempt to develop a program for training students and for helping the farmer get the most from the wildlife on his farm.

Leopold wrote to P. E. McNall a Professor of Agricultural Economics, on February 27, 1936:

"As I told you, I think the Faville Grove and Lake Mills community would be an excellent place to make a really serious test of the idea of reconnecting people with land." And, "I am beginning to realize that the extraordinary personality of Stoughton Faville offers a very valuable focal point which would help greatly to get the community started in this direction." Leopold was correct on both assumptions as was borne out by the events of the next ten years.

The following anonymous abbreviated historical summary found in the University of Wisconsin Archives describes how the Department of Wildlife Management (now Wildlife Ecology) became involved in the formation of the Faville Grove Wildlife [Experimental] Area and ultimately in the creation of the Stoughton Faville Prairie Preserve.

"In 1931 Professor P. E. McNall, advisor to the Milford Meadows farm, Lake Mills, Jefferson County, Wisconsin, asked Professor Aldo Leopold of the University of Wisconsin what the prospects were of increasing wildlife on that farm. After examining the land, Mr. Leopold's opinion was that the venture was worth trying. A winter feeding program for upland game birds carried on largely by Mr. Sam Kisow of Lake Mills formed the basis for subsequent developments involving local participation. A program for involving high school students was also part of the developing idea.

"The Faville Grove Wildlife Experimental Area was a 2,000-acre tract of land composed of the farms of S. W. Faville (Frank W. Tillotson, manager), William Hildebrandt, W. W. Kinyon and son, Ben Berg (the Reverend Mr. Leroy Partch, owner), Milford Meadows (Mrs. C. J. Lawrence, owner; John Last, manager), Otto Lang, part of the Lynn Faville farm, and a leased portion of prairie land. (Fig. 1).

"The area is located about two miles north of Lake Mills, Wisconsin, on County Trunk Highway G [now Wisconsin Highway 89], and contains typical southern Wisconsin cultivated lands, pastures, tamarack swamps, one of the best virgin prairie relics in the state, and small-unit hardwood woodlots, some of which are free from grazing.

"One of the main purposes of the area is to demonstrate that scientific planning and methods can result in a *game crop* as well as a plant crop, and that the two can be combined on the same area to the farmer's benefit. Even if it had no other advantage, the presence of wild life on a farm makes it a more interesting and more desirable place on which to live.

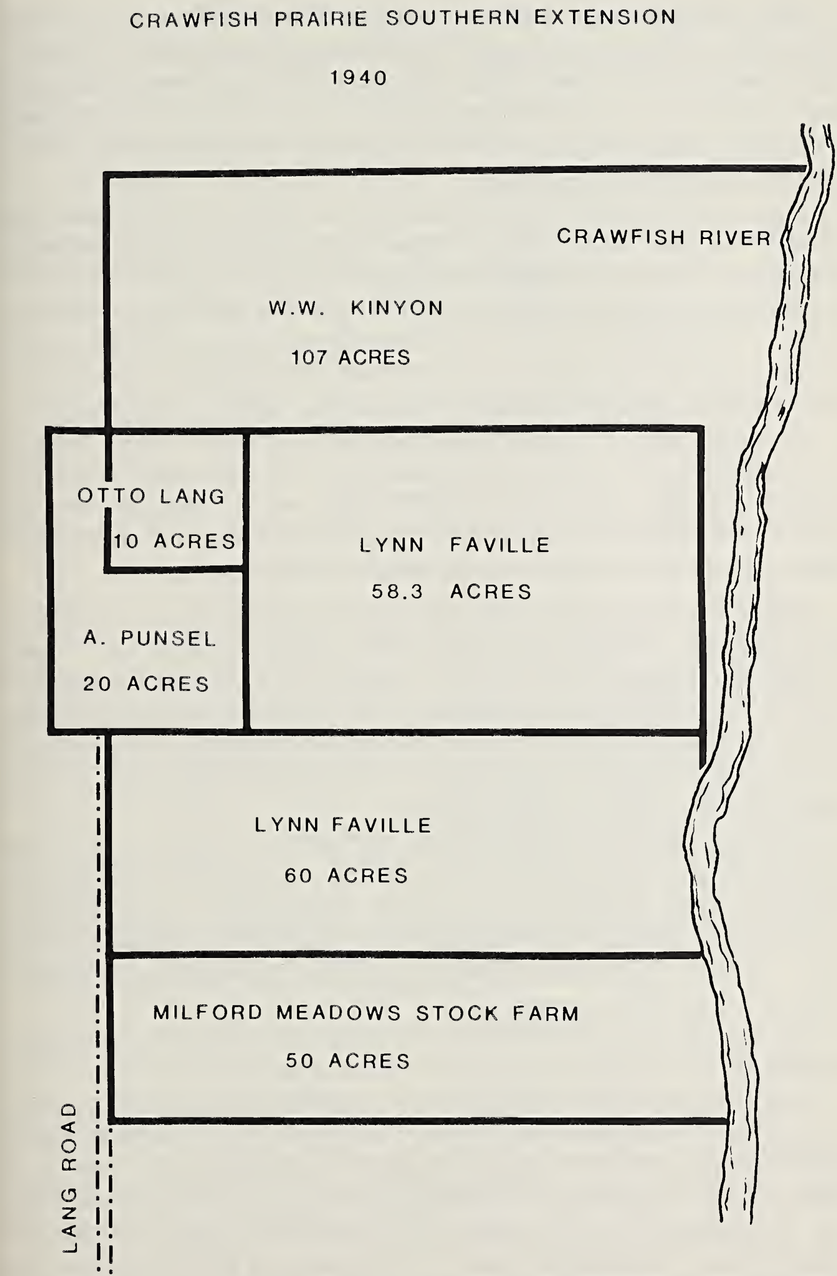


Fig. 1 Land holdings on the Crawfish Prairie 1940.

"The scientific data that were collected included: growth studies of certain woody plants under various conditions; study of prairie plant succession; observation of game-bird movements through censusing and banding; investigation of effects of differential sex-mortality in the nesting of bob-white quail; quail irruption study; and several lesser projects.

"Any ambitious farmer, of course, wishes to improve his farm, but usually he has little time to spare beyond his actual farming activities. To overcome this handicap, the University of Wisconsin furnished graduate students, under the guidance of Mr. Leopold, to supervise planting operations, gather scientific data, and otherwise carry out the management plan previously drawn up. Cooperation was given by several departments in the College of Agriculture.

"To gain and hold the much needed interest and help of townspeople, Sam Kisow acted as a local advisor, and filled this position in an admirable manner. He was a sportsman and conservationist who understood wild life and kept in touch with all the latest conservation thought and developments.

"Most important of all, each farmer member went out of his way to cooperate. Without this help the project would have been impossible. It should be strongly emphasized here that the farmer, not the scientist or the investigator, was the key man in the success of this type of program. Without the farmer's complete cooperation, interest, and advice, there can be no such thing as wild life restoration or game management."

This area was used from 1935 to 1941 as a training site for University graduate students in wildlife management. At least 10 students were stationed at (several lived with a farm family) "Faville Grove" and received training or completed research on the area. I was the last of the full-time students to be part of this area-oriented research program.

The last paragraphs of this history deal with the basic philosophy and set forth the primary tenet in this cooperative effort.

"One caution: Wild life is not a miracle crop; it does cost something in time, labor and money, and no farmer should go into it with the idea that it is a 'get rich quick' enterprise. However, it is safe to say that the man who is willing to apply the principles of wild life management to his farm will eventually reap a harvest of pleasure and satisfaction from the presence of wild things on his land, in addition to the monetary reward derived from the sale of hunting privileges, if he so desires.

"It is hoped that the management techniques being worked out on the Faville Grove area can in the future be applied to a much larger proportion of farm lands. If this can be done, it is not improbable that the once abundant wild life resources of American farms can in some measure be restored.

"Wisconsin is one of the few states in the country which is experimenting with this cooperative method of restoring game on farms. Consequently all those who aid in the Faville Grove or similar ventures are helping toward the solution of one of the most serious problems in conservation, namely, the retaining of wild life as a true American heritage."

In this context, the basic idea of managing wildlife was expanded to preserving plant communities apart from any relationship to wildlife, although the two are inseparable. The intrinsic value of a plant community as a biological entity was regarded as having the same integrity as any animal or group of animals; so taught Aldo Leopold. It is not surprising that Leopold's students held the same view of prairie as their teacher. In this environment prairie wildflowers became part of a student's ecological education.

Once cooperation with the farmers was achieved, Leopold began to explore broadening the scope of biological activities, particularly prairie preservation, on the newly formed research area and thus his students became involved as well. At that time he was a member of the Arboretum Committee, administering the 1100-acre University of Wisconsin Arboretum and Wildlife Refuge on the outskirts of Madison. He interested two botanists from the committee, John T. Curtis and Norman C. Fassett, in the Faville area and together they attempted unsuccessfully to get the university to purchase the critical parcels identified as virgin prairie. Arthur S. Hawkins, a Leopold graduate student, was the key person in the initial reconnaissance of the Crawfish Prairie.

At this time (October, 1938) Leopold reported (U. W. Archives) to one of the landowners, a Mrs. Emmons Blaine, whose financial means were greater than one might derive from farm income alone, as follows:

"To carry forward the botanical work the university needs land on which remnants of the native vegetation still exist, and on which experiments can be conducted without risk of disruption."

The botanical work referred to were plots to be established by John T. Curtis. I have not been able to find what or where these plots were or whether they were ever established as described in the letter. The needed land had been tentatively selected as early as 1937, by Hawkins and Leopold. The basic unit was 107 acres north of the present Stoughton Faville Prairie Preserve which was offered for sale by Mr. W. W. Kinyon because he had moved from rural Lake Mills to Madison. His attorney, Robery P. Ferry of Lake Mills, was sympathetic to the idea that Mr. Kinyon's holding be used for educational and scientific purposes.

Some of Ferry's letters are curt and express impatience with Aldo Leopold, who was struggling to get a financial commitment from any quarter to purchase that part of the prairie. The normally slow land transaction of the latter part of the "great depression" was made urgent because the Federal Land Bank of St. Paul held a lien on the property. Taxes were mounting on the land awaiting a new owner. For the next two years hopes were raised and then fell; the necessary funding was a now-you-have-it now-you-don't will-o'-the-wisp. One constructive step was an appraisal of the 107 aces made by three local farmers, John Last, F. W. Tillotson and L. H. Crump. Their appraisal was $17.50 per acre. The report was sent to Leopold who paid the appraisers' bill, three appraisers at $2.00 and $1.00 automobile transportation—$7.00. P. E. McNall apparently had written (U.W. Archives) on September 15, 1938 to these men as follows (in part):

"Gentlemen:

"Please be advised you are requested on behalf of the University of Wisconsin, Division of Game Management to act as a committee of appraisal for the purpose of appraising and setting a fair sale value on the following parcels of land;

"Kenyon-Crump (sic) farm, northerly 107 acres

"C. C. Faville 60 acres [father of Lynn and brother of Stoughton];

"Mrs. Angus Lange, east one-third about 20 acres.

"A. Lange, 10 acres."

(These lands were the prime wildflower areas on the Crawfish prairie.)

This letter, an unsigned copy in the University Archives, was doubtless written and sent by P. E. McNall since he calls the Department of Wildlife Management a "division" and closes with "Very truly yours." Leopold letters usually closed with "Yours sincerely." By what authority this request was made I do not know, nor for that matter do I know why Leopold paid the appraisal bill.

The initial overture for purchase was made earlier on May 24, 1938 by three members of the University's Arboretum Committee, but the letter (U. W. Archives) appears again to have been composed by P. E. McNall and was addressed to Mr. Ferry as follows:

"Dear Mr. Ferry:

"Referring to our conversation concerning the activities of the University in the vicinity of Lake Mills.

"The University is desirous of acquiring for scientific purposes the north half of the northeast quarter of Section 19, Township 8 North, Range 14 East, and that part of the west half of Section 20 lying west of the Crawfish River and northerly of the southwest quarter of the southwest quarter of Section 20. This comprises, as you know, 80 acres of pasture land adjoined by a narrow strip of 127 acres along the river.

"Will you kindly ascertain from Mr. Wallace Kinyon what the purchase price would be, including the cost of the release of the lands from the Federal Farm loan which we understand to be a lien upon the same? Your prompt reply will be appreciated, as we would like to complete the purchase within the next few weeks if practicable".

E. M. Gilbert, N. C. Fassett (U. W. Department of Botany) and Aldo Leopold were the signers. The request for a prompt reply so that the purchase could be completed "within the next few weeks" was pure optimism. I found no administrative commitment by the University to encourage or culminate such a transaction.

Aldo Leopold now (October 1938) had in his hands a fair land value of $17.50 per acre for Crawfish Prairie land. Only ready cash was needed to close the deal. The Federal Land Bank balked at the appraised price and sent its appraiser who reassessed the land at $25.00 per acre (October 17, 1938), however they later relented. Delay appeared to be inevitable when on November 2, 1938 Attorney Ferry wrote (U. W. Archives) to Leopold:

"Mr. Kinyon is in receipt of advice from Federal Land Bank that arrangement will be made to approve the acceptance of the $17.50 price per acre, upon his advice that such a sale has been definitely arranged and closed. I believe no definite offer has been received from the University. Will you kindly forward an offer in duplicate.

"In expressing your offer include a statement that the expense of continuing the abstract and any incidental expense of releases, conveyances, etc. must be paid by the seller. We will endeavor to have those terms accepted by the Land Bank as coming out of the sale price. It is obvious Mr. Kinyon would not particularly care to turn the entire purchase price over to Land Bank and pay for the abstracts, etc, himself.

"I believe your early attention to this matter is desirable as the Land Bank has many transactions and the persons involved are apt to forget about this very shortly".

This was good news indeed for Leopold as he was fending off the urgent thrust of an attorney who wanted to rid himself of a bothersome transaction and a Federal Land Bank equally anxious to close what was undoubtedly a "small potatoes" land sale. Leopold replied (U. W. Archives):

"Dear Mr. Ferry:

"I am delighted to know that you and Mr. Kinyon have made the prairie tract available at the appraised price.

"I think I have made it clear, but I should repeat, that the University does not yet have this fund in the bank. However, I think there is an excellent chance that it will become available in a few weeks. I will keep you posted.

"Yours sincerely,"

Again the *few weeks* was a forlorn hope. Apparently P. E. McNall was the intermediary to sources of University funds and also private funds as there were no records in the Department of Wildlife Management files to indicate otherwise, or to assume that Aldo Leopold was involved in fund raising.

In an undated longhand letter (U. W. Archives) by Leopold to P. E. McNall that was either never sent, or was a copy of a letter that was sent, or was the original letter returned to Leopold, the writer pleads for news of financial support available from either the University or private sources. It reads:

"Mr. Kenyon (sic) called on me yesterday. It appears he is rather "out on a limb," having induced the bank [Federal Land Bank] to segregate the prairie tract, [so the purchaser could buy only that which he needed] and now is confronted with an interest payment Feb. 1 and taxes March 1. Do you have any news as to whether we might have a chance to present this matter?" These guarded words in the last line would seem to suppose that the financial arrangements were either confidential or very tentative or both! To whom this matter was to be presented is also a moot question. I surmise it was to Mrs. Emmons Blaine.

At this point it becomes clear that an effort was being made by McNall to encourage Mrs. Blaine to make a private contribution to the University so that public purchase of the land could be made.

Meanwhile Mr. Ferry was becoming restive with just cause. He minces no words in his November 9, 1938 letter (U. W. Archives) to Leopold:

"May I urge upon you the fact that you are essentially dealing with the Federal Land Bank, which is a very large organization with many affairs. I believe it is of the utmost desirability that speed in completion of this project be made a matter of the first order of business in order that the parties to whom the various explanations have been made will not have lost track of it, otherwise we may have to begin all over again."

But one more time fate intervened as stated in a letter (U. W. Archives) to Mr. Ferry from Aldo Leopold (December 1, 1938).

"I regret to report that the prospective donor has been called to California by illness, and we are accordingly unable to settle the matter of funds for the land until her return, which is expected in a couple of weeks. I am sorry to leave you out on a limb, but it is the best I can do. The prospect of an actual donation still continues excellent.

"Needless to say I appreciate very much the pains you have taken to arrange this matter and I shall press it to a decision as fast as I possibly can."

Mr. Ferry wrote again (U. W. Archives) on December 27 pleading for definitive decision but leavened his reaction to Leopold (in part):

"Is there no way in which this matter can be completed within a reasonable time, including a reasonable sum over and above the appraised amount for taking care of the taxes which have accrued, together with incidental expenses?" and further:

"I appreciate all the elements of the situation are not under your control. I see no reason however why a definite result should not be readied with reasonable promptness."

This was the first time that Mr. Ferry's response did not imply that the elements were under Leopold's control. Reasonable promptness was not to be.

In the spring of 1939 Mr. Ferry, who had not been concerned with the prospective donor of funds now suspected it was a person whom he knew and he was mildly piqued that he was not brought into the picture earlier. He wrote (U. W. Archives) to Mr. Leopold on April 17, 1939:

"The grape-vine telegraph recently brought to my attention a fact which might have a bearing on the gift appertaining to the 107 acres of the Crump farm [Kinyon farm]. The conclusion may be entirely erroneous and is based on a good deal of deduction. It would seem the parties making such a gift would either be persons devoted to science or persons interested in the community. If persons interested in the community are involved, and you will recollect the donors have not been disclosed, it is probably [sic] there is only one family in that neighborhood able and who might be interested in making such a donation. This particular family might have perfectly good reasons for not desiring to have any dealings with or confer a benefit upon Mr. Kinyon."

and closed with this:

"If the family [unmentioned] I refer to are involved in this donation, it seems a bit strange they have not called upon me personally and confidentially in regard to the matter. That, however, would be for them to decide. This is only a suggestion and is made for whatever it may be worth."

This brought no disclosures from Leopold but he wrote (U. W. Archives) rather sharply that to his knowledge personal differences were not influencing the donors' attitude. He replied on April 24 as follows:

"The proposed donors are, I think, fully aware of Mr. Kinyon's status in the matter of the 107 acres, and as far as I know it has been taken for granted all along that his [Kinyon] motives were entirely beyond question. In fact, no one has at any time raised any question of anybody's motives. On the contrary, I have heard several favorable comments that you and Mr. Kinyon have inconvenienced yourselves personally to keep this thing open."

Very likely Attorney Ferry could have acted as a general representative to the benefit of all concerned, had he been asked. It is here that all correspondence ends and I suspect that in spite of Mr. Ferry's "request and recommendations," Mr. Kinyon sold his holdings to a Mr. Ed Stockel sometime during the fall of 1939. The sale to the University now hinged largely on Mr. Stockel, who had set a rather substantial price on his newly acquired land. I was not able to determine how substantial.

The ephemeral donor, if indeed it was Mrs. Emmons Blaine, was perhaps frightened off by a much larger request ($10,900) for financial support presented to her in a letter (U. W. Archives) from P. E. McNall dated February 9, 1939. The prairie purchase was $1,900 of the request. In any event, no support came from that quarter in 1940 or subsequently to my knowledge.

Another compounding factor was an effort by Aldo Leopold and other members of the Arboretum Committee to purchase or lease parts of the Hope Lake Bog and Wollin's woods, both near Lake Mills. Neither effort was realized, at least not in the 1940s. There was at that time no Nature Conservancy or Audubon Chapter to come to the rescue.

In another effort or in sheer desperation Leopold tried to interest the Wisconsin Conservation Department (now DNR) in purchasing two adjacent tracts as part of its wetlands acquisition program. A letter (U. W. Archives) dated August 9, 1940 to Fred R. Zimmerman in charge of the wetlands project, reads as follows (in part):

"Dear Fred:

"I take it that the Faville Grove refuge is stalled by reason of the price asked by Mr. Stockel.

"It occurs to me that you might break the deadlock by getting a satisfactory option from Lynn Faville. This would include not only the unpastured tract of prairie, but also his pasture lying just to the south, a total of about 110 acres. This would include the well and that part of the slough most valuable for reflooding. In effect, this move would be shifting the refuge southward, and we would lose the Stockel pasture but still make fair provision for wildflower conservation on Lynn Faville's meadow. Once we got this far, I think Stockel would come down, for he has a heavy mortgage and I think needs to reduce it."

. . . and

"The Commission must know that there are few land deals which go through satisfactorily at the first try."

Apparently the conditions, the land or the price did not fall within the directives concerning the wetland acquisition program. I found no reply to the suggestion or any follow-up by Leopold. (I spoke with Fred Zimmerman on May 8, 1976 and he recalled the request but none of the details.) It was at this point in the spring of 1940 that I became the student manager at the Faville Grove Wildlife Area, at the time when a new effort was to begin on the floundering prairie wildflower program.

Arthur S. Hawkins rekindled my interest in wildflowers, particularly those of the prairie. At the time, he was a waterfowl biologist for the Illinois Natural History Survey, but he returned to Faville Grove as often as possible, since he was courting Elizabeth Tillotson, granddaughter of S. W. Faville. (They were married on the prairie in the summer of 1941.) On those occasions when he came to Lake Mills we usually spent some time together on the prairie. In the spring of 1940 the new owner (Ed Stockel) of the coveted prairie land announced that he intended to put cattle onto this remnant of virgin prairie. Although fully cognizant of what this meant to those who tried so long and so hard to save the land, he now intended to use it as pasture. He was adamant to any delay.

Leopold had not been idle. He interested Mr. Philip E. Miles, a family friend from Madison, in the prairie preservation idea. Mr. Miles and his wife agreed to purchase a part of the prairie as a wildflower preserve, but it was too late. The long-sought-after piece (107 acres) had just become pasture.

I had been able to get permission from Stockel (at Aldo Leopold's suggestion) to move clumps of small white lady's slippers (*Cyperpedium candidum*) from his pasture (Fig. 2). They were transplanted in the north half of the adjacent tract owned by Lynn Faville (nephew of S. W. Faville) as this parcel was the next target for acquisition.

Fig. 2 The small white lady slipper (*Cypripedium candidum* Muhl.) (Aldo Leopold photo)

Fortunately he (Stockel) had only about 14 heifers in the 107 acre pasture during the first summer. Thus, that year there was little apparent damage to the lady's slipper plants. Cattle use in subsequent years proved devastating.

As student game manager on the Faville Grove Wildlife Area, it became my responsibility (for reasons I do not know) to contact Lynn Faville and ask if he was interested in selling the parcel in question. I had never met Mr. Faville but found him to be a pleasant, affable person and easy to communicate with. As I left his farm on that summer afternoon, he had agreed to sell at a price below what he "could have gotten elsewhere" if all preliminary and closing costs were also assumed by the buyer. This information including the asking price was relayed to Aldo Leopold, and thence to Mr. and Mrs. Miles. As I recall, the price was $25 an acre, the price Mrs. Miles (pers. comm. 1976) also remembers.

I was informed that Charles A. Rockwell, the Jefferson County Surveyor, would do an official survey. I helped Mr. Rockwell in this effort by holding the Jacob's staff and was thus able to learn of boundaries that heretofore had been vague. The area turned out to be 58.3 acres instead of the 60 originally assumed. Mr. Miles paid for this survey and, with Mrs. Miles, purchased the tract (ca March 1941).

Permission to move wildflowers from Stockel's pasture to the Lynn Faville tract across the fence to the south resulted in three separate operations as follows:

(1) On May 12, 1941, Aldo Leopold, A. S. Hawkins and I dug clumps of sod containing 50 small white lady's slippers and transported them, using an old door as the litter, to the extreme northwest corner of the L. Faville 60 acres where they were planted (Fig. 3).

(2) On May 15, 1941, Lyle K. Sowls and I transplanted 160 small white lady's slipper plants in sod clumps taken from and to the same areas as above.

(3) On May 19, 1941, Aldo Leopold, I. O. Buss, A. S. Hawkins and I moved 24 small white lady's slipper plants from Stockel's pasture to the south side of L. Faville's pasture where they were planted opposite the artesian well located in the southernmost Faville parcel.

Max Partch, now professor of botany at St. Cloud State College, St. Cloud, Minnesota, conducted his doctoral research on the prairie in 1949 working with J. T. Curtis. He mapped the vegetation on the

Fig. 3 Arthur S. Hawkins (left) and the writer moving small white lady slippers on the Crawfish prairie May 12, 1941. (Aldo Leopold photo)

Faville prairie preserve at that time and again, in 1976, mapped and recorded plants on the same site. He states in a letter to me (Aug. 1976) "And where are most of the white lady's slippers? In the NW corner just where you planted them in 1941."

At the time these orchids were being moved, a rough census of native lady's slippers (small white) was made on the tract; the total was 251 transplanted and 135 native on the new site.

On the day of our first transplant effort we talked of the rarer white fringed orchis or prairie fringed orchid (*Habenaria leucophaea*) that was also jeopardized by the proposed grazing. They bloom late and so could not be recognized for moving at that time. The cattle grazed them before a salvage attempt could be made.

The small white lady's slipper was the main object of concern at that time, but the rarer fringed species was given center stage in

Leopold's essay *Exit Orchis* (1940) that called attention to the plight of all wildflowers competing with cattle for a place in the sun or in the shade. It was this essay, which we discussed several times prior to release, that made me acutely aware that Aldo Leopold was a man of literature as well as a man of ecology. I began at that time to collect his longhand writings that would otherwise have been relegated to the wastepaper basket. These manuscripts collected over the last eight years of his life are now prized possessions, and a copy of the original *Exit Orchis* page 1 is shown here (Fig. 4). This, however, was not the only writing by Aldo Leopold on the culmination of a long, hard battle for prairie and posterity. There was a slight barb in the news release dated March 20, 1941; it reads as follows:

Faville Prairie Preserve

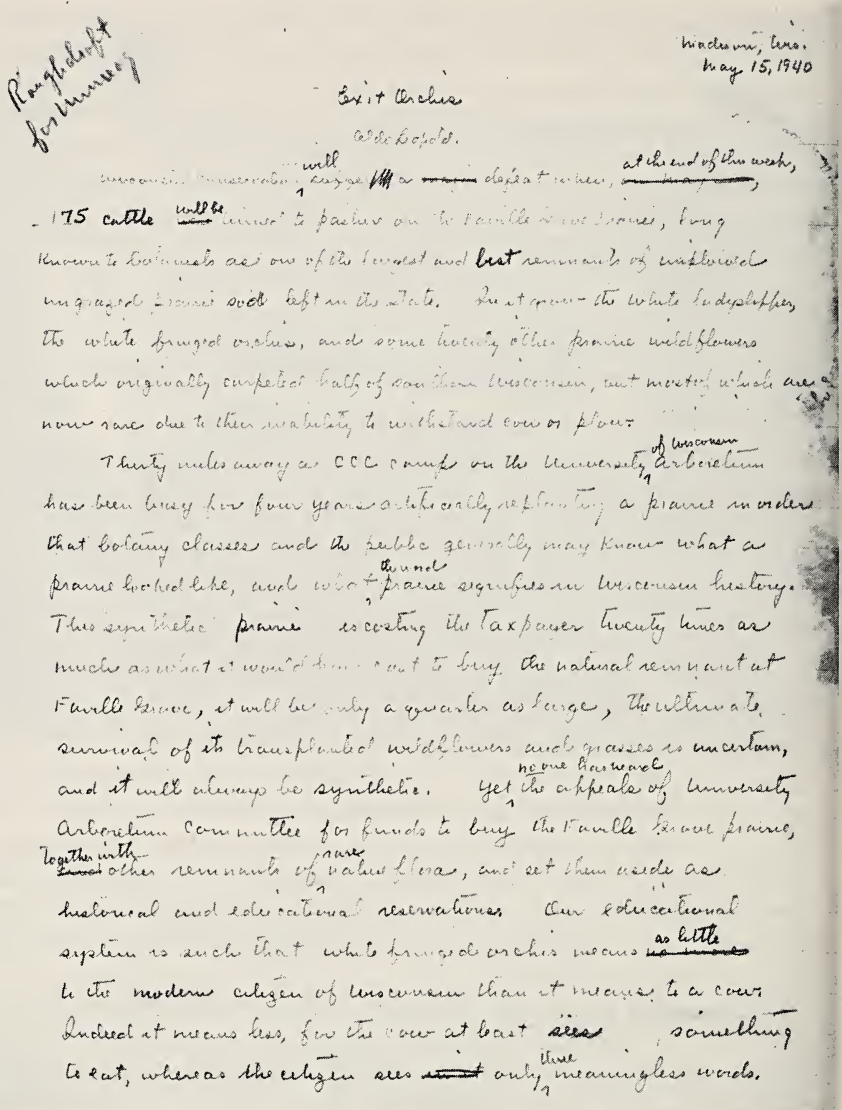
"On May 15, 1940, cattle were turned to pasture on the Faville prairie, long known to botanists as one of the largest and best remnants of unplowed, ungrazed prairie sod left in Wisconsin. In it grow the white ladyslipper, the white-fringed orchis, the prairie clover, prairie fringed gentian, Indian plantain, Turk's cap lily, compass plant, blazing star, prairie dock, and other prairie wildflowers which originally carpeted half of southern Wisconsin, but most of which are now rare due to their inability to withstand cow or plow.

"Thirty miles away a CCC camp on the University of Wisconsin Arboretum has been busy for four years artificially replanting a prairie in order that botany classes may know what a prairie looked like, and what the word "prairie" signifies in Wisconsin history.

"Within the tract converted to pasture last year, the cattle demolished the prairie vegetation within a single season; if any of it was left, it was underground. By September the grazed area looked like any other pasture.

"The loss of this tract, however, called public attention to the question of preserving prairie vegetation. An adjacent tract, containing 60 acres, and botanically almost as good as the lost pasture, has now been purchased by Mr. and Mrs. Philip E. Miles of Madison, for the express purpose of protecting its flora. Mr. and Mrs. Miles are retaining the title to the land, but will allow the University botanists to use it for research purposes.

"In preparation for this hoped-for floral preserve at Faville Grove, the Botany Department and the Department of Wildlife Management of the University have, during the last three years, mapped the location of the surviving colonies of rare flowers, and


Rough draft

Madison, Wis.
May 15, 1940

Exit Orchis

Aldo Leopold

Wisconsin conservation will suffer a defeat when, at the end of this week, 175 cattle will be turned to pasture on the Faville Grove prairies, long known to botanists as one of the largest and best remnants of unplowed ungrazed prairie still left in the state. In it grow the white ladyslipper, the white fringed orchis, and some twenty other prairie wildflowers which originally carpeted half of southern Wisconsin, but most of which are now rare due to their inability to withstand cow or plow.

Thirty miles away a CCC camp on the University of Wisconsin Arboretum has been busy for four years artificially replanting a prairie in order that botany classes and the public generally may know what a prairie looked like, and what the word prairie signifies in Wisconsin history. This synthetic prairie is costing the taxpayer twenty times as much as what it would have cost to buy the natural remnant at Faville Grove, it will be only a quarter as large, the ultimate survival of its transplanted wildflowers and grasses is uncertain, and it will always be synthetic. Yet no one has heard the appeals of University Arboretum Committee for funds to buy the Faville Grove prairie, together with other remnants of rare native floras, and set them aside as historical and educational reservations. Our educational system is such that white fringed orchis means as little to the modern citizen of Wisconsin than it means to a cow. Indeed it means less, for the cow at least sees something to eat, whereas the citizen sees only three meaningless words.

Fig. 4 The longhand manuscript of "Exit Orchis", page one. It was Leopold's reaction to a shameful defeat in conservation and one over which money, not reason or right, had control. (U. W. Photo Lab)

each spring have counted the blooms. It is now proposed to experiment, on a ten acre fraction of the 60 acre preserve, to see whether burning and mowing causes the colonies to expand or contract. It is already known that with the possible exception of ladies' tresses, all the rarer species succumb to pasturing. That is why they are rare. Few of them succumb to mowing, hence the past use of the Faville prairie as haymeadow has not greatly injured its flora.

"John Muir, who grew up amid the prairie flowers in Columbia County, foresaw their impending disappearance from the Wisconsin landscape. In about 1865 he offered to buy from his brother a small part of the meadow of the family homestead, to be fenced and set aside as a floral sanctuary. His offer was refused. This, insofar as I know, was the first attempt to establish a wildflower preserve in Wisconsin. The number of such preserves, either public or private, is still so small that many interesting species are in danger of disappearing for lack of a protected place to survive in.

"The first successful attempt to establish a wildflower preserve in Wisconsin was the Ridges Sanctuary near Bailey's Harbor in Door County. This area was purchased by a group of local landowners, and now offers safe habitat for several bog orchids, lake iris, and arctic primrose.

"The Faville Prairie is Wisconsin's second floral preserve. A system of fifty similar preserves, scattered over the entire state, would constitute adequate insurance that Wisconsin will suffer no more needless losses from her list of native plants."

I do not know if this piece was ever reduced to printer's ink.

About June 22, 1941, Mr. and Mrs. Aldo Leopold and Mr. and Mrs. Miles and I visited the prairie with Gordon MacQuarrie, reporter, and George Shershell, photographer, for the *Milwaukee Journal*. The resulting article appeared in the Sunday edition of the *Milwaukee Journal*, June 29, 1941 (Fig. 5). I think this was the first time the Miles's had seen the prairie and the tract they had just purchased. It was a beautiful day. The prairie responded with its best in blossoms for the month of June and the upland plovers' song was the crowning voice in a chorus of bird songs. It was a prairie "thank you" to the Miles.

The deed to the prairie tract was transferred to the University in 1945. The transfer was not a perfunctory gift of real estate; rather it established a preserve in honor of Stoughton W. Faville. Mr. and Mrs. Miles had planned well; part of the deed transfer (U. W. Archives) reads as follows:

"The lands herein conveyed shall until the grantee shall otherwise direct, be known as "Stoughton Faville Prairie Preserve."

Fig. 5 Stoughton Willis Faville (1852-1951) taken at the Faville Homestead farm 1941. (Milwaukee Journal photo)

"The grantee shall designate and preserve all the rest and remainder of the lands herein conveyed for the continuance and the propagation of native or indigenous prairie wild life, and shall make reasonable and proper efforts to eliminate or prevent the coming of intrusive or exotic vegetable growth." The primary aspect of the quit-claim deed was the dedication of the land to S. W. Faville. Although the term "prairie wildlife" is repeated several times, it is meant to convey both plants and animals.

For Mr. Faville it was an honor he accepted in his shy and humble way and, although he was not a demonstrative man, I know that he was immensely pleased. He and I visited the prairie several times during that first spring and summer and also in years afterward. On one such occasion I took his picture, a copy of which was sent to his granddaughter, Elizabeth T. Hawkins. Part of her letter (U. W. Archives) in reply follows:

"Dear Mack,

"We are so glad to have the picture of Grandpa on the prairie. I know just how that was for him. I can see how pleased he was to have you take him, and I can hear you laughing.

"Imagine how many happy prairie memories he must have had! When he was a boy he heard his father and brothers tell about that wonderful, tall prairie grass that helped decide them about settling there. On clear spring mornings with no traffic in the distance they could hear the prairie chickens from their booming grounds. And later in the summer he could go out there to see the lady's slippers, other orchids, turks caps, star grass, compass plant and prairie clover, golden rod, shooting stars. I bet he never forgot how sweet it smelled, but he never mentioned things like that much. As far back as I can remember Papa used to come back from a day planting corn ("up on the river") to announce that the plovers were back. We all looked for that news, and after Art came when we became date-conscious, we expected to see them on my birthday (April 14). Back in 1935 or '36 when Art and Bandy [Hilbert R. Siegler-student] built a blind on the booming ground we were all so excited and after all those years actually got out there to watch them. We'd leave before sun-up (sometimes Mother would come) and get home for a late breakfast.

"Sometimes late in the afternoon we'd watch the short eared owls from a hay stack. We used to squeak them in and they'd make pass after pass, turning their anxious faces back and forth, this way and that, gazing down at us til they gave up and went hunting elsewhere. It was fun to watch their wing clapping in the spring, and hear the jack snipe winnowing . . . Your picture shows the end of that era. I'm glad we had a chance to live in it. Grandpa's death just before his 99th birthday marked the end."

It did indeed mark the end of that era and I, too, am glad to have lived in it. Living with the Tillotson family and Grandpa Faville during my field assignment as a graduate student was and is a cherished experience even now. The memories are indelible and the educational aspects unforgettable. Perhaps the acme of my sense of belonging to this time and place and with these wonderful people occurred when I, too, was "allowed" to call Mr. Faville "Grandpa". I'm proud to say we liked each other from the first meeting. S. W. Faville was a man whom it would be extremely difficult not to like. He was, by his admission, of God-fearing Yankee stock.

The Faville family came from Herkimer County, New York. S. W. Faville's father Alpheus came to the 120-acre homestead north of Lake Mills in 1844. It was here that Stoughton was born on February 12, 1852. He attended both district school and Lawrence College, and returned to the farm where, in 1882, he purchased the first herd of purebred Holstein-Friesian cattle in Jefferson County and increased his land holdings to 400 acres. He devoted his active life as a farmer to the development of his herd and promoting the virtues of this fine breed of dairy cattle. Conservation practices came naturally to this man. His woodlot was not pastured nor his wetlands drained. Collecting Indian relics was one of his hobbies. He told me of experiences with Indians traveling on foot from Hubbelton to Lake Mills where they had to pass his home en route. All aspects of the out-of-doors interested him.

Plants of all kinds challenged his curiosity, but wildflowers were his favorites. We tend to think of John Muir as the champion of the wildflower conservation movement, and he was, but on a local level S. W. Faville was of equal stature. Neighbors, friends, naturalists and University botanists came to see his small wildflower garden and to explore his woodlot for wildflowers. So keen were his observations that he discovered a hybrid orchid that was a cross between the large yellow lady's slipper and the small white lady's slipper *(Cypripedium candidum* x *Cypripedium pubescens)*. It was described botanically by John T. Curtis and named *Cypripedium Favillianum*, Faville's lady's slipper; It is now recognized as a valid hybrid. The type specimen grew in his garden for many years. It was transplanted into the University Arboretum at Madison about 1944. If he had accepted all the offers of wildflowers for his wildflower garden, his yard and garden would have been filled to overflowing. He always wanted to add the butterfly weed *(Asclepias tuberosa)*, to his collection. I brought him healthy plants on two occasions but both efforts to establish the plant were unsuccessful. We both knew the site and soil were ecologically wrong, so failure came as no shock.

This Lincolnesque man, born on February 12, was the community patriarch whose advice and counsel were always available on matters where he held knowledge or expertise. Grandpa was a man of temperance and moderation and possessed all, or almost all, the endearing human virtues.

In 1927 the College of Agriculture saw fit to present him with a citation as one of Wisconsin's outstanding farmers. The citation (U. W. College of Agricultural and Life Sciences) reads in part:

"S. W. Faville

"Has helped to lead his neighborhood along the lines of better farming specializing in improving dairy stock.

"As a community builder especially in social and religious circles, his influence has always been on the side of vigorous advancement.

"Rarely does one meet a more sympathetic attitude for the finer things in nature than is to be found in Mr. Faville." By 1939, when I first met Mr. Faville these words were already understatements of his relationship with farming, dairy husbandry and the social community in which he lived.

All the players in this historical drama in wildflower conservation, from the leading roles to bit players like myself, felt satisfied and warmly rewarded to know that at least a part of the unspoiled Crawfish Prairie would be preserved and that it was named in honor of so worthy a person.

Stoughton Willis Faville enhanced the lives of those he touched; for me it was a 'laying on' of hands.

* * * *

The story could well have ended here, but for the fact that Lynn Faville was ready in 1942 to sell his 60-acre holding south of and adjacent to the Miles parcel, about a year after the initial sale was completed. Several persons from the Lake Mills area were interested in purchasing it. Again Aldo Leopold attempted to interest Mr. Miles in extending his recently-acquired tract. Mr. Miles asked what had been done to begin wildflower research suggested in previous plans and news releases (U. W. Archives). In reply it was noted that U. W. botanists were inclined to defer activity until the land became University property as it was still in Mr. and Mrs. Miles' name. While this impasse was being reconciled, two men from Lake Mills bought the second prairie piece with its oak opening above a flowing artesian well. They ditched the lower end to create a duck marsh and planted the upper half to corn, thus destroying the prairie tract.

One may wonder whether ducks in the bag or corn in the crib have held a higher social or democratic value than does a remnant of virgin prairie. The economic benefits doubtless favor the developers. Our laws, courts, history and traditions allow the owners of land to deny integrity to the soil, plants and animals which are part of the owning. We even fail to imply or demand custodial responsibility for those privileged to own a part of our country. It is little wonder then that today with increased knowledge and technical sophistication we allow even small remnants of unspoiled natural areas to slip from the public grasp in futile attempts to pit esthetic, educational and other social benefits against individual monetary gain.

There was yet another chance to increase the land area held by the University of Wisconsin as the Stoughton Faville Prairie Preserve, but it did not occur until almost 20 years later. S. W. Faville's grandson, David Tillotson, a teacher and conservationist, purchased his sisters' share in the farm and now lives with his family at the Faville Homestead. About 1958 he, with a group from the Milwaukee Audubon Society, solicited funds from many individuals throughout Wisconsin to purchase land adjacent to the Stoughton Faville Prairie Preserve.

It was not an easy chore but the funds were raised and land on the west and north sides of the preserve plus a pie-shaped piece along the Crawfish River increased the preserve by 35 acres.

In September 1976 this parcel was offered to the University by the Audubon Wild Land Foundation of Milwaukee. It was accepted by the Board of Regents on September 17, 1976 and is now part of the 92 acre Stoughton Faville Prairie Preserve (Fig. 6). Administration and maintenance rest with the University Arboretum committee and staff.

The past record of the University in managing the Stoughton Faville Prairie Preserve has not been exemplary. At the time when the Miles transferred their property to the University, Aldo Leopold composed the following letter for Philip Miles' signature.

"I recently purchased a 60 acre remnant of virgin prairie near Faville Grove, Lake Mills, Jefferson County, for the purpose of ensuring the preservation of its prairie flora. Your botanists have been studying the tract, and have found on it some dozens of species of prairie wildflowers, grasses, and shrubs, some of which are becoming rare. Among these are the small white ladyslipper and the white-fringed orchis.

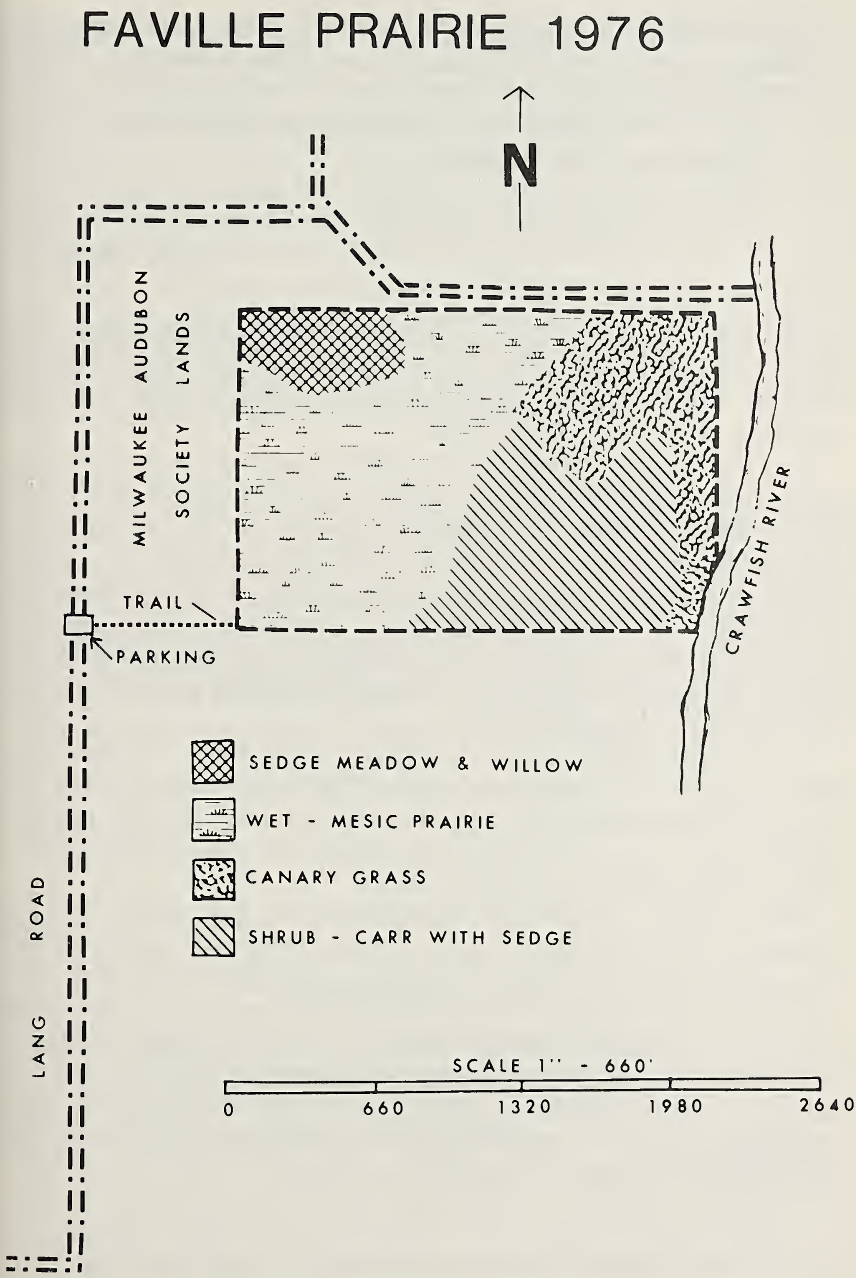


Fig. 6 The Stoughton Faville Prairie Preserve 1976.

"In my opinion the University Arboretum is the proper custodian for floral reservations of this kind. I am willing to deed this tract to the University, should you wish it, with the understanding that:

(1) It will be preserved as a wildflower refuge, preferably as a substation of the Arboretum.

(2) It will not be used as a tourist attraction, or for any other purpose which might endanger the preservation of its flora.

"Yours sincerely,"

The note on this letter in Leopold's handwriting reads—"not sent". I do not know why it was not sent. There is no record to indicate what was requested of the University apart from the wording in the quit-claim deed.

The University Aboretum committee was given custodial charge. In the years between 1945 and 1976 the care necessary to maintain this prairie remnant was sporadic at best, due in part to lack of interest but primarily to heavy demands on the Arboretum crew in Madison. Part of the wording in the quit-claim deed delineating the University's responsibility reads: " . . . and shall make reasonable and proper efforts to eliminate or prevent the coming of intrusive or exotic vegetable growth." The intrusive vegetable growth was (and is) composed of woody plants.

A. S. Hawkins (pers. comm.) writes that he was " . . . shocked by the invasion of woody plants which if left unchecked, threatens to eliminate this remnant of a prairie." He adds "It's rather tragic to realize that it was saved from its enemies only to be destroyed by its friends, through lack of proper care."

The current Arboretum administration has taken renewed interest in the Stoughton Faville Prairie Preserve, but it will take time and financial support to rectify past neglect. The University Arboretum has always functioned on a minimal, if not inadequate budget; nonetheless, remedial efforts are required legally through a reversion clause in the quit-claim deed. The program of restoration begun in 1976 will be continued until the "intrusive or exotic vegetable growth" is eliminated (R. S. Ellarson, Chairman, UW Arboretum Committee, pers. comm. 1977).

* * * *

In his excellent wildlife history of Faville Grove, Hawkins (Trans. Wis. Acad. Sciences, Arts and Letters, 1940, 32:29-65), states that prairie (low) "has receded much less, under clean farming than have oak openings." The main use of the prairie by its farmer owners was for marsh hay in years when tame hay was limited by . . . dry conditions. Wet years rendered the prairie unsuited even for haying. Hawkins' conclusion was . . . "Result: a sizable remnant of the low prairie still exists". Nowhere is the spectre of prairie drainage mentioned but drainage came in the press for farm production during World War II. In the prewar period of the great depression it was not financially feasible to drain or the agricultural gamble on drainage was too great. Wartime economy intervened. The handy work of drainage rigs siphoned the life blood of low prairies and wetlands to render them fit for the plow. Today only 85 of the original 1800 acres of the Crawfish Prairie remain intact in a matrix of corn, grain, tame hay, and pasture.

* * * *

Written on the wind that ripples its way across this botanical relic is this: that we, as the people, fail either to look back or to look forward in our responsibility as custodians of our land; that the tortuous effort to preserve this original prairie kindled the prairie preservation concept, certainly for Wisconsin, and perhaps the Midwest; and lastly that this piece of prairie and the meaning it conveys to our heritage is properly dedicated to a man who looked back and saw the future. Stoughton W. Faville.

ACKNOWLEDGMENTS

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LATE PLEISTOCENE (WISCONSINAN) CARIBOU FROM SOUTHEASTERN WISCONSIN

Robert M. West
Milwaukee Public Museum

ABSTRACT

Two specimens of caribou (*Rangifer tarandus*) antlers extend the late Pleistocene range of that species to southeastern Wisconsin.

* * * * * *

Specimens of caribou, *Rangifer tarandus*, have been reported from the late Pleistocene of Michigan (Dorr and Eschman, 1970), Illinois (Bader and Techter, 1959), Iowa (Frankforter, 1971), and Minnesota (Hay, 1923a), as well as numerous other localities in the eastern United States (Guilday, Hamilton and Parmalee, 1975). The only reported Wisconsin occurrences are from fire clays near Menomonie in Dunn County, presumed by Hay (1923b) to be of late Illinoian Age. Antler specimens from two previously unrecorded localities now confirm the expected presence of this species in the late Pleistocene of southeastern Wisconsin. Both specimens are in the vertebrate paleontology collection of the Department of Geology, Milwaukee Public Museum.

The best diagnostic material, MPM VP 858 (Fig. 1), is composed of three unconnected fragments of at least two right antlers. They are slender in comparison with antlers of the modern barren ground caribou, the more gracile of the living North American subspecies. The beams are oval in cross-section. Both brow and bez tines are well developed, and the brow tine is noticeably palmate. All three fragments are intensively water-worn, and the broken surfaces are also abraded, suggesting considerable pre-burial transportation.

Figure 1. MPM VP 858, fragmentary right antlers. The longest fragment is 79 cm in length.

The second eastern Wisconsin caribou (MPM VP 902) is a fragmentary left antler of a much larger animal than those represented by MPM VP 858. The brow tine is missing, lost prior to burial; the broken surface is large, suggesting that it was well developed. The antler, which has an oval cross-section, is comparable in size with the larger barren ground caribou specimens in the collection of the Department of Vertebrate Zoology at the Milwaukee Public Museum.

The specimens comprising MPM VP 858 were found in June, 1943, in a peat deposit near Wauwatosa in the Menomonee River valley a few miles west of Milwaukee. When the specimens were recently found in the collection precise locality data were not with them. Probably the area of the occurrence was the NW¼ of T7N, R21E, Milwaukee County, Wisconsin. By the time the writer examined the specimens all adhering matrix had been removed. However, surficial sediments in the probable area of occurrence were late Wisconsinan in age (Hough, 1958), and compatible in age with other, much better documented, *Rangifer tarandus* finds. The isolated specimen, MPM VP 902, was eroded from a bluff along the shore of Lake Michigan east of Oostburg (approximately sec. 4, T13E, R23E, Sheboygan County, Wisconsin) during the summer of 1963. The precise circumstances of this discovery are also unclear; the bluff is composed of lacustrine sediments equated to the late Wisconsinan late Glenwood Stage of Lake Chicago, and to till of the upper Wedron Formation (12,500-13,000 years BP: late Woodfordian) (Evanson *et al*, 1976), and to the peat from which MPM VP 858 was collected.

Four living subspecies of North American caribou presently are recognized (Banfield, 1974). The most southerly is the woodland caribou *(R. t. caribou)*, which now ranges south to the north side of Lake Superior, and which occurred with some frequency in northern Minnesota, Wisconsin and Michigan in historic times (Cory, 1912; Burt, 1946; Bergerud, 1974). There is no historic record of its occurrence south of about 45° north. Three barren ground subspecies *(R. t. groenlandirus, R. t. pearyi,* and *R. t. granti* range far to the north into the Arctic tundra, and are physically smaller than *R. t. caribou.*

Subspecific distinctions based only on antlers are difficult (Bubenik, 1975). Barren ground caribou antlers tend to be smaller, less palmate, and more oval to round in cross-section than those of woodland caribou, but there is extensive overlap. Clearly, the MPM specimens belong to *R. tarandus.* On the basis of the rounded cross-section of the beams, they are tentatively assigned to *R. t. groenlandicus,* despite the relatively large size of MPM VP 902.

ACKNOWLEDGMENTS

Mr. Walter Bubbert of Wauwatosa, Wisconsin, recovered and donated MPM VP 858, and Ms. Julie Te Ronde of Oostburg, Wisconsin, recovered and donated MPM VP 902. The illustration was prepared by the Photography Department, Milwaukee Public Museum. Dr. Holmes A. Semken, University of Iowa, offered comments which greatly improved the manuscript.

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AN ORDINATION OF TERRICOLOUS AND SAXICOLOUS BRYOPHYTES AT CACTUS ROCK, WAUPACA COUNTY, WISCONSIN

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ABSTRACT

A three-dimensional ordination of 100 stands of terricolous bryophytes found on Cactus Rock, Waupaca County, Wisconsin, is established. The sampling procedure was based on a point-quadrat method; the analysis, on percent cover and index of similarity. Several environmental parameters were quantitatively measured at each stand and were then related to the ordination. *Polytrichum juniperinum* was dominant in stands which had thinner soil cover, less acidic soil, and higher light intensity than those stands in which *P. commune* was dominant. *Thuidium delicatulum* was found in shady stands with very thin soil cover; *Ceratodon purpureus*, on gentle rock slopes receiving intermediate levels of sunlight; *Hedwigia ciliata*, on shady rock slopes; and *Grimmia apocarpa*, on sunny rock slopes.

INTRODUCTION

Cactus Rock is a granitic outcropping surrounded on all sides by alluvial sand. It is located in Waupaca County, 1.61 km south of New London. The Rock extends approximately 500 m northwest of Bean City Road and rises 30 m above the pavement. Several prominent glacial features characterize it, including striae, polish, chatter marks, and pronounced truncations in several locations on the top of the outcrop. The south slope has many large, separated boulders resulting from the plucking action of the overriding ice sheets. The north slope has few such boulders. As a result, the south slope has more crevices where humus can accumulate and foster a greater diversity of habitats, but such soil accumulation is otherwise generally distributed.

The vascular vegetation at Cactus Rock varies from aspen on the north to pine-oak on the rock and mixed oak-hickory on the south. The base of the north slope is dominated by *Populus tremuloides, P. grandidentata,* and *Acer rubrum,* but the overstory also includes *Tilia americana, Quercus velutina, Q. alba, Carya ovata,* and *Prunus serotina.* Scattered patches of *Diervilla lonicera, Vaccinium angustifolium, Toxicodendron radicans, Amelanchier laevis, Aralia nudicaulis, Polygonatum biflorum, P. canaliculatum, Maianthemum canadense, Geranium maculatum, Mitchella repens, Osmorhiza claytoni, Anemone quinquefolia, Carex pennsylvanica,* and *Galium triflorum* constitute the ground cover. This community ascends about 7.75 m up the slope and extends westward from the road about 250 m. On the upper slope and on the rock *Juniperus virginiana, Pinus banksiana P. strobus* and *Quercus velutina* predominate. The substory is occupied by *Zanthoxylum americanum, Juniperus communis, Prunus serotina, Vaccinium angustifolium,* and *Rhus typhina,* and the herbaceous layer includes *Viola sagittata, V. pedata, Heuchera richardsonii, Amorpha canescens, Aristida basiramea, Agrostis hyemalis, Panicum implicatum, P. capillare, Scleria verticillata, Carex bicknellii, C. pennsylvanica, Ranunculus fascicularis, Talinum rugospermum, Veronica peregrina, Potentilla arguta,* and *Senecio aureus.* Many of these species frequent the entire crest of the rock where *Andropogon gerardi, A. scoparius, Melampyrum lineare, Opuntia fragilis, Corydalis sempervirens, Hypoxis hirsuta, Aquilegia canadensis, Cheilanthes tomentosa* and *Selaginella rupestris* also appear. The western end of the rock is occupied by a small *Pinus strobus* stand and associated scattered colonies of *Michella repens, Maianthemum canadense, Trientalis borealis,* and *Vaccinium angustifolium.* The soil at the base of the southern slope is sandy, with considerable humus accumulation near the rock. This area receives considerable runoff and radiation and supports a dense vegetation. The lower slope and the base of the rock are dominated by *Quercus velutina, Q. alba, Acer rubrum* and *Carya ovata.* Patches of *Corylus cornuta, Rubus sp. Rosa sp.* and *Rhus typina* are common. *Carex pennsylvanica* and *Agropyrum repens* dominate the ground layer, but associated are many of the herbaceous species previously mentioned as well as ruderals such as *Verbascum thapsus, Achillea millefolium* and *Rumex acetosella.* White tail deer *(Odocoileus* *virginianus)* are present as indicated by numerous browsed twigs; other mamalian species frequenting and inhabiting the area include *Marmota monox, Peromyscus maniculatus, Microtus pennsylvanicus, Tamias striatus, Citellus tridecemlineatus, Procyon lotor, Didelphis marsupialis, Erethizon dorsatum, Vulpes fulva,* and *Sylvilagus floridanus.*

Lichens and bryophytes were present throughout, but were especially important where exposure, inclination, and rock texture inhibited the development of vascular communities. The vitality and diversity of these cryptogamic communities subtly reflected the interaction of the prevailing environmental factors and suggested that ordination might provide fruitful insights into their ecological relationships.

Beals (1965) employed ordination to analyze the corticulous cryptogamic communities in south-central Wisconsin. Foote (1966) used this technique on bryophytes associated with limestone outcrops in Southwestern Wisconsin, and related the vegetational continuum to a moisture gradient. Lechowicz and Adams (1974) prepared a similar study of the lichen-moss ground-layer communities in Ontario and Wisconsin to assess the comparative autecology of *Cladonia.* Our study utilizes a three-dimensional ordination of terricolous bryophytes at Cactus Rock to examine autecological relationships.

PROCEDURE

A point-quadrat method was used in sampling the stands. Stand size and the number of points to be used for each stand were determined by a species-area curve and a species-point curve, respectively. Use of the species-area curve permits reasonably objective determination of the smallest (minimal) area on which community species composition may be adequately represented (Mueller-Dombois, 1974).

Twenty stands chosen in a stratified random fashion were used to determine the species-area curve. We attempted to include in the assortment, stands which would represent the general types present within the study site. In each stand, a series of eleven concentric squares was laid out and the species present in each square were tabulated. The first square was 2 x 2 cm (4 cm^2) and the bryophyte species present in this area were counted. Next, the species present in a 3 x 3 cm (9 cm^2) square were counted, and the square size was increased to 4 x 4 cm (16 cm^2). In this way, the plot size was approximately doubled ten times, resulting finally in a 61 x 61 cm (3721 cm^2) square. As the square size increased, the number of new species encountered within the square decreased. The average number of species found at each of the twenty locations was calculated for each of the square sizes. A species-area curve was then constructed by plotting these eleven average species numbers against the eleven area sizes. The area to be chosen for the stand sampling was required to include 95% of the average number of species present in the largest square. The 95%-inclusion point on our species-area curve had an abscissa of 2700 cm^2. At this point, the curve was still approaching an asymptote, so to better ensure the presence of at least 95% of the species, a sample area of 3025 cm^2 (55 x 55 cm) was chosen.

To determine the species-point curve, twenty stands (3025 cm^2) were again chosen randomly. At each stand, 25 points were plotted in a designated order. A wooden frame with cross strings intersecting at the 25 points was used. The first point was located in the center of the 55 x 55 cm square. The second, third, fourth, and fifth points were located in the four distant corners of the square. The sixth, seventh, eighth, and ninth points were located at the mid-point of the center of the square (point 1) and each of the four corners. The remaining points were similarly located approximately equidistant from each other. The same pattern of points was consistently used from stand to stand. After placement of each point, the presence or absence of a new species was noted. The average number of new species encountered at each of the 20 stands was calculated for the first point and for each succeeding group of four points.

The average number of new species encountered was plotted against the point number (1-25) to establish the species-point curve. The species-point curve approached zero through the use of only 25 points. Thus, any number of points greater than 25 should increase sampling accuracy. One hundred points were finally used to provide a more than adequate number of points and yet not to be so large a number as to hinder the sampling process.

The appartus used in the point-analysis of the 100 stands was designed with the above stand-size and point-number criteria in mind. It consisted of a wooden frame with strings tied across in both directions such that the intersections of the strings designated 100 points equally spaced over a 55 x 55 cm area. The columns of the grid were labelled "A" through "J" and the rows were labelled "1" through "10" such that the point in the upper left corner was "A1" and the point in the lower right was "J10."

One hundred stands were selected employing the following criteria:

1) Stands must include terricolous bryophytes.
2) Stands should be in relatively homogeneous environments.

To sample a stand, the wooden frame was placed on the ground and the presence of a species or the substrate (where no species occurred) was recorded for each of the 100 points. Percent cover for each species in a stand was then tabulated by counting the number of points at which the particular species had been encountered.

The angle of inclination was determined by handing a string from a levelled meter stick (one end touching the uphill, uppermost string row of the frame, the other end jutting into space) to the row string farthest downhill. A right triangle was formed, and, since the length of the hypotenuse (distance from A to J; 55 cm) and the length of the leg opposite the angle of inclination were both known, the angle could be calculated as $\sin A = a/h$.

Light measurements were made at each stand with a light meter. Readings were made on three different days. The first readings were made between 9:00 and 11:10 A.M. on an overcast day. The second, between 11:50 A.M. and 1:20 P.M. on a clear day. The third, between 3:05 and 4:35 P.M. on a clear day. The three light readings for each stand were totaled to provide a relative representation of sunlight received during the course of the day.

The direction of inclination was found with a compass. The soil depth was approximated at each stand by inserting a 15 cm probe into the soil in several places, measuring the depth, and recording an apparent minimum and maximum depth. If the probe became completely submerged in the soil, a reading of over 15 cm was recorded. Soil moisture was determined by drying soil samples for 65 hr at 115 C. The ratio of the dry weight of the soil to the wet weight of the soil was calculated, multiplied by 100, and subtracted from 100 percent. Soil pH was determined on previously dried soil samples wetted with 4 parts distilled water.

After determining the percent cover of each species for each stand (Table 1), index of similarity (IS) values were calculated. The IS values were based on $2w/a + b$, an index previously used by Culberson (1955a) on lichen communities. The IS values ranged from complete similarity between two stands (1.00) to complete dissimilarity (0.00).

A three-dimensional ordination was constructed. Two dissimilar stands were selected as endpoints, or reference stands, for the axis. All reference stands were required to have at least twelve similarity indices greater than fifty percent (0.50) following a modification of a criterion used by Swan and Dix (1966) and Newsome and Dix (1968). Of those stands meeting the above criterion, stand 24 had the lowest sum of similarity indices and was thus most dissimilar to the other stands. The second reference stand should be that stand most dissimilar to stand 24, but 44 stands showed complete dissimilarity with 24 (37 of these met the above criterion), so 24 was discarded as an impractical candidate. Similar difficulties also resulted in discarding four other candidates. Stand 7, an eligible stand having the sixth lowest sum of similarity indices, was finally chosen as the first reference stand (A) for the x axis. The stand most dissimilar to 7 (and still meeting the above criterion) was 68 (B). The index of similarity of 7 and 68 was 0.06; the dissimilarity of these two stands 100 — 0.06 = 0.94, was the length (L) of the axis. The stands were then located between these two endpoints according to Beals' formula, $x = (L^2 + (dA)^2 - (dB)^2)/2L$, where dA is the dissimilarity from stand B, L is the length of the axis, and x is the location of the given stand on the x axis.

Construction of the second dimension, or y axis, required a reference stand (A′) which was poorly fitted to the x axis. This fit was determined by "e" and was calculated $e^2 = (dA)^2 - x^2$. The stand (must meet previous criterion) with the highest e^2 value was 32. Newsome and Dix (1968) required stand A′ to lie within the mid-50% range of the first axis. Stand 32 satisfied this criterion. The second reference stand should be most dissimilar to 32, but should lie near 32 on the x axis to approximate a perpendicular y axis (limit used was within 10% of x axis length). Four stands became candidates and 94, the one most dissimilar to 32, became the second reference stand (B′). The y axis length was 0.84, the dissimilarity between 32 and 94. Locations on the y axis were found similarly to those on the x axis, according to $y = ((L')^2 + (dA')^2 - (dB')^2)/2L'$.

Expansion into a third dimension, a z axis, required a reference stand most poorly fitted to both previously constructed axes. The highest sum of $e_x{}^2 + e_y{}^2$ indicated the poorest fit. The first reference stand, A″, should also lie within the mid-50% range of both the x and y axes. The only two candidate stands were 46 and 73.

Stand 46 was chosen as the first reference stand (A″) since it had a higher $e_x{}^2 + e_y{}^2$ sum. The second reference stand (B″) should be the stand most dissimilar to 46. Sixteen stands had complete dissimilarity with 46, but only one of these (24) met the criterion of having at least 12 IS values greater than 0.50. Stand 24 was thus chosen as reference stand B″, and the z axis length was 1.00. Location of the stands again followed Beals' formula, $z = ((L'')^2 + (dA'')^2 - (dB'')^2)/2L''$.

Ordination values were plotted to present a three-dimensional description of the similarity of the stands and their respective environmental characteristics.

RESULTS AND DISCUSSION

The ordination has been represented by the xy and xz planes, respectively. It established distribution patterns and simplified interpretation of those patterns. The species composition data identified stands on the basis of species dominance and presence. Dominance, as used here, refers to the species which displayed the highest percent-cover value in the stand, and does not imply further ecological relationships. A species was considered to be present in a stand if it appeared on at least one point in that stand (Table 1). Frequency refers to the percentage of the total 100 stands in which the species was present.

The xy and xz planes of the ordination are shown with the stands labeled according to the dominant species in each. (Fig. 1) Five moss species (*Polytrichum juniperinum, P. commune, Ceratodon purpureus, Grimmia apocarpa,* and *Hedwigia ciliata*) formed clusters.

By comparing presence figures, it was evident that the clusters of the major species often overlapped. For example, *Polytrichum juniperinum* occurred in some of the same stands in which *Ceratodon, Thuidium,* and *Hedwigia* were found. The overlapping of the presence clusters indicated additional pair associations such as *P. commune* and *Thuidium, Grimmia* and *Hedwigia, Grimmia* and *Ceratodon, Hedwigia* and *Ceratodon,* and *Hedwigia* and *Thuidium.*

Table 1. Percent cover, overall frequency, and relative frequency by soil type and aspect for representative species at Cactus Rock

Species	Mean % Cover	Overall Frequency (%)	Frequency (%) by Soil Depth			Frequency (%) by Aspect	
			Rock	Medium	Deep	S & W	N & E
Amphidium lapponicum	6.8	4	0	11.1	0	0	8
Brachythecium rutabulum	31.7	9	2	19.4	6.3	6	12
Ceratodon purpureus	22.5	23	4	22.2	12.6	38	8
Dicranum scoparium	7.2	13	8	22.2	6.3	2	24
Funaria hygrometrica	4	1	0	2.7	0	2	0
Grimmia apocarpa	26.2	25	2	0	0	48	2
Hedwigia ciliata	32.6	44	38	8.3	0	44	44
Hylocomium phyrenaicum	36.0	2	0	0	6.3	2	2
Isopterygium pulchellum	5.2	9	12	5.6	6.3	2	16
Leptodictyum brevipes	3.0	1	0	2.7	0	2	0
Leucobryum glaucum	25.3	6	0	8.3	12.6	2	10
Mnium cuspidatum	1.0	1	2	0	0	0	2
Polytrichum commune	75.6	14	0	5.6	75.0	18	10
Polytrichum juniperinum	48.3	25	0	63.9	12.6	14	36
Polytrichum piliferum	20.6	8	0	13.9	6.3	10	6
Thuidium delicatulum	41.7	11	2	19.4	18.8	6	16
Barbilophozia barbata	9.1	7	14	0	0	0	14
Lophozia ventricosa	8	1	0	2.7	0	0	2

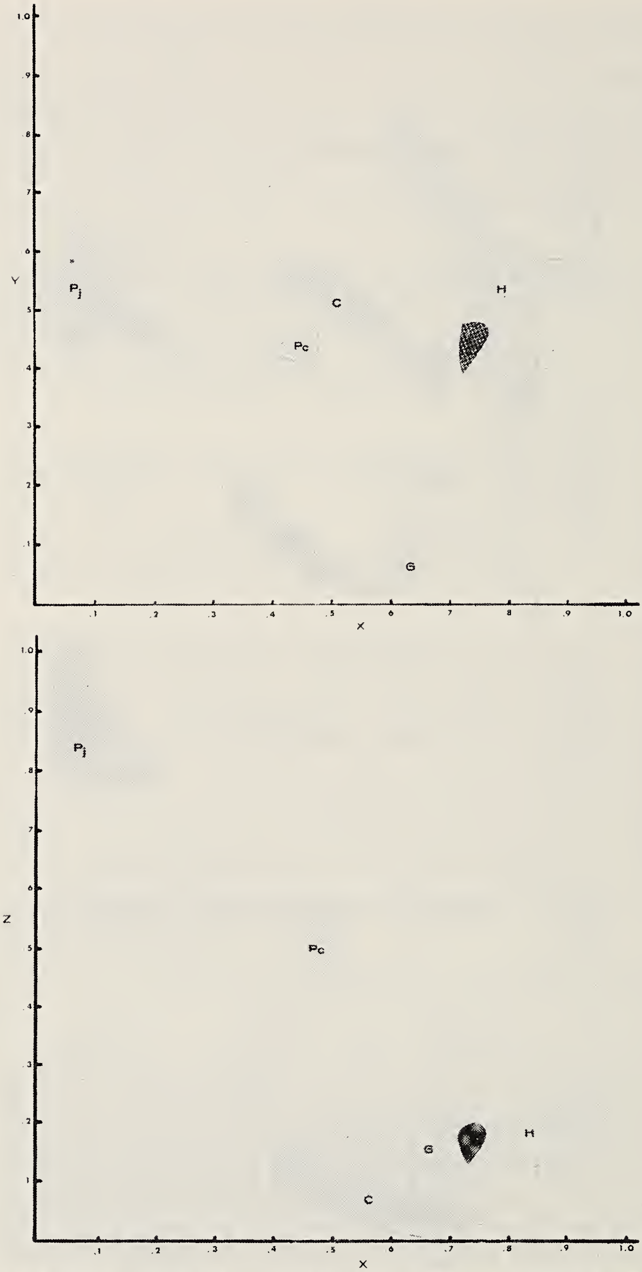

Figure 1. Ordination of the bryophyte stands at Cactus Rock. Letters indicate dominant moss species (C: *Ceratodon;* G: *Grimmia;* H: *Hedwigia;* Pc: *Polytrichum commune;* Pj: *Polytrichum juniperinum*) (a). XY plane. (b) XZ plane.

Substrate parameters established two major stand groupings. The soil stands appear to the left (xy ordination) and to the upper left (xz ordination) of the rock stands (Fig. 2). These clusters suggest that the species composition of the soil stands was particularly different from that of the rock stands. Furthermore, the soil stands were more similar to other soil stands than they were to rock stands, and the rock stands were more similar to other rock stands than to soil stands.

Only six stands had soil depths of 2.5 cm or less; four of these stands appeared near the rock-soil interface of the ordination. The next deepest soil depth (2.6 to 6.5 cm) included about one half of the soil stands. Most of these stands had x axis values less than 0.30 and conversely most of the stands with x axis values of less than 0.30 had soil depths within this range. Stands with the greatest soil depths generally appeared in the center of the ordination (x values of 0.40-0.50).

When stands were grouped by four levels of soil moisture the two intermediate moisture grades (30-40%, 40-50%) were usually associated with those stands which had the intermediate soil depths (2.5-6.5 cm, 6.5-12.5 cm), and were found in most of the stands having x values less than 0.25 and z values greater than 0.55. The wettest stands were found primarily at x axis values of 0.30-0.45 and at z values less than 0.60. Excluding the rock stands, soil moisture and soil depth generally increased with increasing x values and decreasing z values. Those stands having the thinnest soil and those which were driest did not fit this model.

Soil pH values paralleled the patterns described above. Except for the stands with the lowest pH values (pH 3.2-3.6), soil pH increased with increasing x values and decreasing z values.

Stands of low light intensity were situated primarily to the right on the xy graph and to the lower right on the xz graph. Several stands of low light intensity also occurred at the center of both planes. Higher intensity levels ($3.7\text{-}5.3 \times 10^3$ 1x, $5.3\text{-}7.5 \times 10^3$ 1x) appeared mainly in stands to the left and lower center of the xy graph, and to the upper left and lower center of the xz graph.

A comparison of aspect (direction of inclination) and light intensity data revealed that the stands receiving lower light intensities were north-facing, and that the stands receiving higher light intensities were south-facing. Thus, light intensity was a function of aspect.

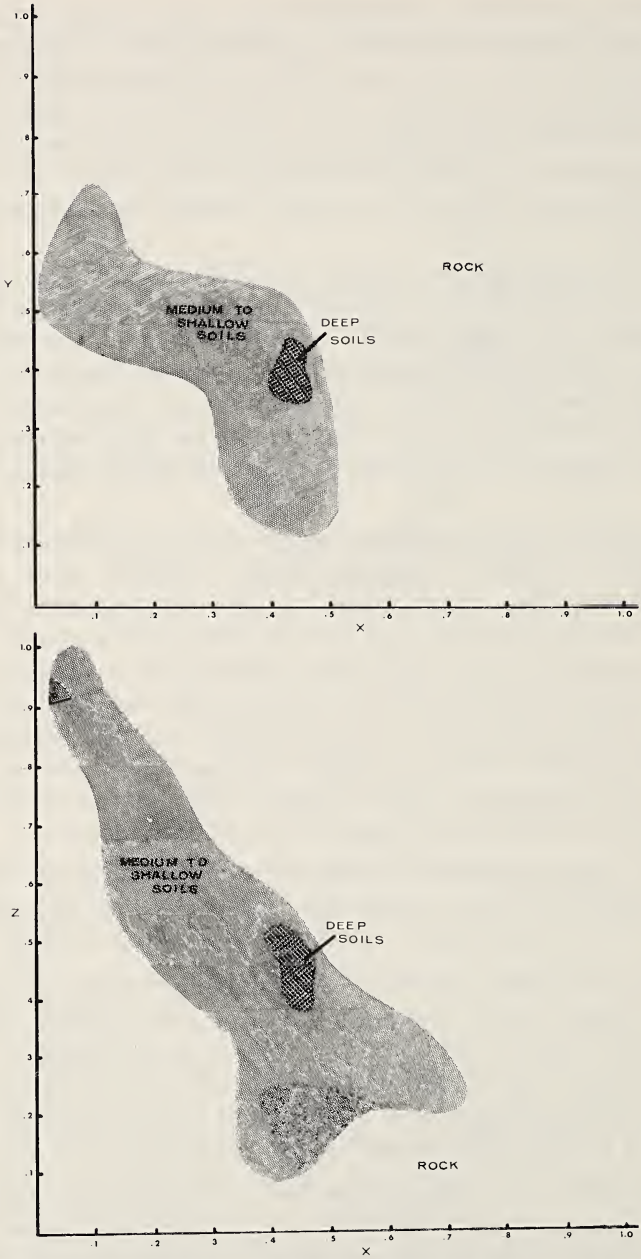

Figure 2. Grouping of the study-stands at Cactus Rock as a function of their maximum soil depths.
(a) XY plane. (b) XZ plane.

All of the soil stands had slopes of less than 27°. In the rock stands, the angle of inclination increased with increasing x values.

Stands having the lowest x values were stands in which *Polytrichum juniperinum* was dominant. These stands were further characterized by maximum soil depths of 2.5-6.5 cm, mesic to wet mesic conditions, acidic soil (pH 3.7-4.2), and relatively high levels of sunlight.

A cluster of stands in the center of the ordination (x and y values of 0.40-0.50) was dominated by *Polytrichum commune.* These stands were generally on deep soil, were mesic to wet mesic, and had slightly more acidic soil (pH 3.2-4.2) than *P. juniperinum* stands. *Polytrichum commune* stands were found in the open as well in the shade of trees.

Polytrichum commune was often found in pure stands in the field, and when present occurred as a large percentage of the stand. A strong competitive advantage, created either by a physiological (allelopathic) or morphological adaptation, may be responsible but such speculation requires further investigation.

Thuidium was present in eleven stands, one of which was classified as a rock stand. The rock stand contained small areas where thin soil pockets had accumulated. *Thuidium* grew in the other stands where the soil was shallow; all depths were less than 6.5 cm. Soil moisture of those stands ranged widely, but the pH was primarily in the intermediate range of 3.7-4.2. The stands were relatively level, mostly north-facing, and received very low levels of light (generally between 0.39-1.9 x 10^3 1x). The rock stand where *Thuidium* occurred was dominated by *Hedwigia* and *Thuidium* represented only 4% cover. The substrate was primarily rock, and *Hedwigia* was easily the stronger competitor. *Thuidium* was also found in association with both *Polytrichum* species and with minor species such as *Brachythecium* and *Leucobryum.*

Ceratodon purpureus stands formed a conspicuous grouping on the xz plane where the *Ceratodon* stands had the lowest z values. Light intensities in those stands were generally intermediate between those of the *Hedwigia* and *Grimmia* stands (see below). The *Ceratodon* stands were similar to *Grimmia* stands in that both were mainly south-facing. The distinctive feature of the *Ceratodon* stands was their gently sloping surface. *Ceratodon* was also found in soil stands in association with *Polytrichum juniperinum.* These stands had thin soil cover with occasional areas of open rock upon which *Ceratodon* was found.

Stands in which *Hedwigia* was dominant had the highest x values. These stands had rock substrates that varied greatly in aspect. The stands generally received little sunlight and most were north-facing.

Grimmia stands generally had the same z values as *Hedwigia* stands, and on the xz plane, groupings of *Hedwigia* and *Grimmia* were interlocked; these species are found together frequently. Therefore, one would expect to find differences which would favor the dominance of one species over the other.

The *Grimmia* stands were primarily south-facing, while the *Hedwigia* stands were north-facing. The *Grimmia* stands also were on more gradual slopes. However, the most important difference appears to be the higher light intensities in the *Grimmia* stands compared to those of the *Hedwigia* stands. Some of the stands in which *Grimmia* was present but sub-dominant to *Hedwigia* had light values higher than most of the *Hedwigia* stands. *Grimmia* was favored in bright light, while *Hedwigia* attained dominance under shadier conditions.

The analysis of the ordination concentrated upon the six species which dominated the greatest number of stands. Five other species dominated only one to four stands, and characterization of stand environments, based upon so few stands, would be unduly speculative. Since those five species displayed dominance in very few stands and since several species encountered never displayed dominance one could conclude that conditions were not favorable for those species. However, the role of the less numerous species cannot be overlooked. At the time of the study the minor species may have been in the process of becoming more—or less—established within the dynamic interactions of succession. Work on the major moss species and their environments presents an ecological perspective of the Cactus Rock bryophyte populations at the time of this study.

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THE HISTORIC ROLE OF CONSTITUTIONAL LIBERALISM IN THE QUEST FOR SOCIAL JUSTICE[1]

Wayne Morse

In 1969, the family of Morris Fromkin (1892-1969)[2] by a gift to the University of Wisconsin-Milwaukee Library provided for the establishment of a collection of materials on the history of social justice in the United States between 1865 and the end of the New Deal. On November 22, 1970, the Fromkin Memorial Collection was officially opened with a day of activities which included a symposium on "Third Forces in American Politics" and the first annual Fromkin Lecture, "The Historic Role of Constitutional Liberalism in the Quest for Social Justice," by the Honorable Wayne Morse (1900-1974), a distinguished lawyer, teacher, labor mediator, public administrator, Senator from Oregon from 1945 to 1969, and champion of countless liberal causes. Senator Morse began with a discussion of the role of constitutional liberalism in the labor movement.

Morris Fromkin was on the side of liberal advocates of political and economic reform because he recognized it was essential to obtain social justice for all the people rather than special privileges for the selected few. The exploitation of labor under corporate industrialization, with its mass production and repressive labor policies, brought forth the militant organized labor movement of the 1880s and 1890s and on through to the 1930s and 1940s. The right of workers to organize into unions; the right to bargain collectively for agreements governing hours, wages, and conditions of employment; and the right to withhold their services by means of a strike, first against an individual employer and later against a group of employers in the same business on a regional or industry-wide basis, were eventually won by organized labor. These rights of social and economic justice were won over the bitter opposition of organized employer groups, opposition which led to much economic suffering for workers and their families and—all too frequently—physical injuries and bloodshed inflicted by employer goons and politically directed, overzealous police. During this long struggle for the rights of groups of workers to organize into unions and to withhold their services until a collective bargaining agreement could be consummated, the representatives of labor had to oppose vigorously not only strong anti-union employer opposition, often joined in by employer-sponsored non-union employees and company police, but also anti-labor political administrations, city and state. Even judges, both state and federal, dishonored their robes by issuing *ex parte* anti-labor injunctions breaking strikes and boycotts.

"Government by injunction" became the protest battle cry of organized labor and of political liberals throughout the progressive period from the 1880s to the 1940s. Public confidence in the impartiality of the courts was damaged by disclosures of anti-labor bias, the exercise of arbitrary and capricious discretion by too many former corporation lawyers and hack politicians who had been elevated to judgeships.

The very foundation of our constitutional guarantees of democratic self-government is our judicial system, which is charged with the obligation of dispensing evenhanded justice to all litigants, without discrimination as to equality of procedural rights in the administration of justice.

I am satisfied that throughout our history most judges have been dedicated, honest dispensers of equal justice in accordance with the law as they have found it to be applicable to the operative facts of each case coming before them. Nevertheless, in the social, economic, and political turbulence of the progressive period, with its many conflicts over social-justice legislation, it became evident that, in too many instances, the donning of judicial robes did not cover the conflicts of interest, the biases against organized labor, and the partisan political prejudices against long overdue legislative reforms. Public criticism of many decisions involving social justice spread throughout the land. Although it was not limited to labor-law jurisprudence, it was in this area that some of the strongest political attacks against the courts were made.

Under our constitutional system of government, with its three coordinate and co-equal branches of government, whenever public opinion starts losing confidence in the impartiality of judges, our national stability becomes seriously threatened. Such a trend of loss of confidence in members of the bench developed in the early years of this century, and renewed itself in the 1930s . . . .

Whenever the people in large numbers come to believe that legal procedures for the administration of justice limit or infringe upon their substantive legal rights, the courts are certain to come under justifiable attack. That happened in the progressive period. It is beginning to happen again today. The people must be shown, if they do not already know, that one of the characteristics of a police state is judicial tyranny. They must be made aware that their right to social justice can never be any better than their procedural rights for obtaining it, whether through the courts, through legislation, or through executive order . . . .

Granted that today we must have more judges, police, deputy prosecutors, administrative personnel, and law enforcement facilities, but these alone will not bring about public confidence in the men and women in charge of our procedures for administering justice. We should never forget that whenever public officials, including judges, are removed from the direct check of the general public . . . public confidence in their procedures and rulings is lessened. This happened in the progressive period, and we should learn the lessons of that era before it becomes too late in our time to avoid a constitutional crisis.

The federal judiciary came under widespread criticism in that period for its alleged anti-union bias and exercise of arbitrary discretion in adjudicating labor dispute cases. Anti-union employers found it not difficult to obtain injunctive relief from many federal judges well practiced in enjoining unions from picketing, from organizing employees against employer opposition, and from engaging in other standard union practices. Many of the injunctions were obtained by employers in *ex parte* hearings based upon employer charges of alleged violence or threats of violence or coercion of one type or another. "Union busting by anti-union judges" became a political charge of organized labor. Liberal political leaders in Wisconsin and other states . . . decided that the courts in fact were abusing their powers and supported labor's demand for legislation to curb the power of the courts in labor dispute cases.

The widespread public dissatisfaction with "government by injunction" . . . produced legislation in Congress and in several state legislatures designed to restrict the jurisdiction of courts in such cases. The Norris-La Guardia anti-injunction act of 1932 was an attempt by Congress to check the courts in their abuse of the injunction power. The National Labor Relations Board legislation, known as the Wagner Act of July, 1935, was another part of the answer to public criticism of the courts. Some state legislatures adopted similar state laws applicable to state cases not subject to federal jurisdiction.

For many years, the organizational picket line, stretched in front of an employer's plant or place of business as an economic inducement for him to recognize the union and proceed to bargain collectively with the union, was enjoined by many courts on one legal theory or another or one technicality or another. It was thought by labor leaders and their lawyers that after the passage of the Norris-La Guardia Act organizational picket lines had been placed out of the reach of court injunctions.

It was in a celebrated Wisconsin labor case which reached the United States Supreme Court in 1938, *Lauf* v. *Shinner & Co.*,[3] that Morris Fromkin and his colleague, A. W. Richter, successfully argued that a labor union, none of whose members worked for a given employer, could not be enjoined from picketing that employer in an attempt to force him to permit the union to organize his plant. The case editor of the *Michigan Law Review*, commenting on the signficance of the case, wrote, "A freedom from the impediments of the federal equity injunction greater than at any time since the rise of the labor movement now seems assured.". . . [4]

Thus ended many years of bitter controversy over the right of labor to stretch organizational picket lines, finally authorized by the Norris-La Guardia anti-injunction act and sustained by the United States Supreme Court in *Lauf* v. *Shinner & Co.*[5] The thoroughly researched brief prepared by Morris Fromkin and his colleague was responsible for labor's historic victory in this case. It was a great advance for social justice in the labor movement . . . .

> *Perceiving the labor movement as but one aspect of the quest for social justice in the United States in which constitutional liberalism played an important role, Senator Morse moved to recent political issues in which, in his opinion, the role of constitutional liberalism has been to provide a necessary safeguard to constitutional guarantees of self government.*

Our colonial forefathers revolted against a monarchy of government by kings and subservient parliaments exercising arbitrary, capricious, discretionary power over a subjugated colonial populace. They sought to set up a constitutional system of government by law which would guarantee protection to the people from government by executive supremacy and secrecy. Thus, they provided for three coordinate and co-equal branches of government with each exercising prescribed constitutional checks upon the other two. They recognized an ever present human factor, frequently overlooked or ignored throughout the history of our nation and even today: that our constitutional system, which was designed to give us a government by law, is nevertheless bound to be administered by mere men, with all their human frailties. Among these frailties is the temptation to usurp power and arbitrarily deny legal rights and social justice and to justify capricious discretion with intellectually dishonest rationalizations. Thus, too frequently men in office succumb to corruptive influences and desecrate their offices and bring government into disrepute.

From Lincoln to Franklin Roosevelt, liberal leaders and their many supporters . . . sought to obtain for all the people through the guarantees of the Constitution the liberties, civil rights, and political and economic freedoms for the individual which were envisioned by the people and their leaders when the Constitution was adopted. This, to my mind, is the definition of constitutional liberalism.

These constitutional guarantees involve the basic abstract principles of self-government whence come our rights as free men and women. The denial of these rights in varying degrees to too many people was the motivating cause of dissent which grew until it produced the liberal reform movements fighting for social justice throughout the Lincoln-to-Roosevelt period in our history . . . .

I firmly believe that the self-government guarantees of the Constitution, with its checks-and-balances safeguards against government by mere men rather than by law, if faithfully administered, will assure social justice to the American people. The provisions for amending the Constitution, the delegating of duties, and the restricting of authority granted to the people's officials in the three branches of government, if faithfully carried out, offer our people their best hope of retaining self-government through law, and of obtaining a full measure of social justice for all.

The alternative? Obviously, a form of police state under which social justice disappears along with personal liberties.

Throughout the Lincoln-to-Roosevelt era, populist movements and their leaders, regardless of their political party labels, opposed powerful, reactionary political forces that sought to deny social justice by seeking to reverse the political tenet that public officials are to serve the people, not master them.

The populist crusaders fought under the banner "constant vigilance is the price of liberty." Underlying Lincoln's faith in self-government by the people was his dedication to the commitments set forth in the Preamble to the Constitution: "We the people of the United States, in Order to form a more perfect Union, establish Justice, insure domestic Tranquility, provide for the common defense, promote the general Welfare, and secure the Blessings of Liberty to ourselves and our Posterity, do ordain and establish this Constitution for the United States of America."

Lincoln recognized that if those statements of the purposes of the Constitution ever should be allowed to become empty rhetoric, self-government in the United States would cease to exist . . . .

It is not trite to quote that famous Lincoln statement of governmental obligation to the people which has become a major premise used by liberals ever since in their advocacy of government controls, regulation, and (if necessary for the protection of the public interest) ownership and operation of facilities and projects essential to promoting the general welfare. I refer to the well known Lincoln teaching, "The legitimate object of government is to do for a community of people whatever they need to have done but cannot do at all, or cannot do so well, for themselves in their separate and individual capacities."

I submit that from the time of Lincoln, throughout the progressive period, right up to the present, the leading spokesmen for liberal and insurgent political movements, who have fought for social justice while advocating continued self-government, have been constitutional liberals in the sense that I have used the term . . . .

It is my judgment that of all the liberal movements in the country after Lincoln to the time of Franklin Roosevelt none accomplished so much in the quest for social justice as the populist movement in Wisconsin from 1890 to 1938. It would take a one-semester seminar course to cover, even in a cursory manner, the major contributions of Victor Berger, Daniel Hoan, Robert M. La Follette, Sr., Robert La Follette, Jr., and his brother Philip, plus all their liberal associates in and out of office during that period of time. The liberal legislative program of the La Follette era . . . became the pacesetter for state after state, as well as for the White House and

Congress. How well I remember the several conversations I had with Franklin Roosevelt about Senator Robert M. La Follette, Sr., and the legislative policies he fought for.

President Roosevelt told me he had been a close follower of what he called "Bob La Follette's phenomenal liberal political record both in Wisconsin as governor and in the Senate." As a member of the War Labor Board, in addition to participation in the adjudication of cases, I was assigned the responsibility of serving as compliance officer of the Board.[6] Those duties brought me into conference with President Roosevelt two or three times a month, because all major enforcement decisions of the Board against unions or management, as in seizure cases, required his personal approval. It was a great privilege to meet with him, and frequently after we had finished our discussion of a given compliance case he would seem to enjoy relaxing into a discussion of political issues. It was on several of these occasions, knowing my early Wisconsin background,[7] that he seemed to enjoy talking about La Follette's legislative record. He did not hesitate to tell me that the La Follette Wisconsin legislative program laid the groundwork for many of his own legislative proposals both when he was Governor of New York and when he and his advisors promulgated the New Deal legislative program . . . .

In the field of foreign policy, constitutional liberals have a duty to oppose Presidential requests for authority which exceed constitutional Presidential powers. Unfortunately, many liberals, under the pressure of political expediency, have voted for resolutions requested by Presidents authorizing the use of American military forces in combat on foreign soil without a declaration of war. One of these requests was made by President Wilson in April, 1914, when he asked Congress for approval to "use the armed forces of the United States [in Mexico] in such ways and to such an extent as may be necessary to obtain from Gen. Huerta and his adherents the fullest recognition of the rights and dignity of the United States. . . ."[8] It was a forerunner by many years of the Formosa, Middle East, and Gulf of Tonkin resolutions of the Eisenhower and Johnson administrations.

While the resolution was pending before Congress, President Wilson ordered Admiral Fletcher to seize Vera Cruz. During this action four American Marines were killed and twenty wounded; 126 Mexicans were killed and 195 wounded. . . .

On March 10, 1916, in a speech in the Senate, La Follette . . . said, "I believe it to be vital to the safety and perpetuity of this government that Congress should assert and manintain its right to a voice in declaring and prescribing the foreign policy of the United States. . . . Democratic control of foreign policies is a basic principle of all organized effort looking for the future establishment of permanent world peace. . . . Shall we in this crisis of the world's history fail to assert our constitutional rights and by our negligence and default permit the establishment in this country of that exclusive Executive control over foreign affairs that the people of Europe are now repenting amid the agonies of war? . . . There never was a time in history when it was more fundamentally important that we preserve intact the essential principle of democracy on which our Government is founded—that the will of the people is the law of the land." . . .[9]

The advice-and-consent clause does not mean that the advice and consent of the Congress should be sought by the President after the fact. It means that he should seek it before the fact. Constitutional liberals should recognize that Presidents have no constitutional right to make war without a declaration of war . . . .

Presidents have no legal right to make war in the name of acting as commander-in-chief of the armed forces. They have the duty to respond to the self-defense of the republic if our nation is suddenly attacked, as the Japanese attacked us at Pearl Harbor. In that crisis, Franklin Roosevelt, as commander-in-chief, went to the immediate self-defense of our nation, but he also went to his desk and wrote his great war message calling for a declaration of war . . . .

I have mentioned the issue of the fast growing trend in our country toward government by executive supremacy and secrecy because it is the major issue that the liberal movements since the Civil War have made the least progress in checking and solving in the interest of the people. It threatens to create a constitutional crisis. More than 44,000 American soldiers have died and more than 275,000 have been wounded in Asia because Congress has not checked Presidents from conducting an illegal, immoral, and unjustifiable war in Asia.

I would suggest that in the last decade there have developed so many changes in the life patterns of our people that mythology has come to characterize much of our American way of life. Some aspects of it are no longer relevant, or, I prefer to say, serviceable, in the solving of the crises that confront our nation. To determine what is still valid in this electronic world of computers and all the rest and to discard the other without losing our individual liberty is the most serious problem facing us today . . . .

NOTATIONS

[1]Stanley Mallach, Bibliographer of the Fromkin Memorial Collection, adapted and edited this paper from a tape recording and rough text of Senator Morse's lecture, supplying notes where necessary, and inserting ellipses where conversational asides and extensive quotations have been omitted from the present text.

[2]Of Morris Fromkin, Senator Morse said:

> I came to know Morris Fromkin through our mutual interests and activities in the field of labor relations. When I was on the National War Labor Board, I met him first, as I recall, in Milwaukee through Joseph Padway [the legal counsel for the American Federation of Labor] . . . . He possessed a brilliant mind and a social conscience that directed him into crusades seeking social justice for individuals and groups to whom justice was being denied.
>
> Morris Fromkin was a learned lawyer who developed a flourishing law practice in Milwaukee from 1920 to 1946. He then moved to New York City where he continued to be a very successful leader of the Bar until his death, April 24, 1969. His office practice rested on a broad base of labor law, corporation law, and a general practice serving the legal and social justice needs of the rich and the poor, as well as clients of average means.
>
> He was born in Russia. After the death of his mother, when he was a young boy, his father migrated to the United States, bringing Morris and his brothers and sisters with him, and settled on the Lower East Side of New York City. Young Morris went to work with his father in a factory. It was there that he learned that urban industralization, crowded conditions in substandard housing, low wages for long hours of work, high prices, and limited educational opportunities contributed to the denial of social justice to many immigrants and other underprivileged workers.
>
> Economic and social ruts can become deep and confining in any congested urban industrial area, even though the streets may be of asphalt and stone. Morris Fromkin came

from a family that would not be rutted. The family helped each other, and Morris worked hard for his education. With scholarships and outside jobs he worked his way through Creighton University in Omaha, Nebraska, attaining his B.A. degree in 1918. He then went to Marquette University Law School in Milwaukee, where he obtained his LL.B. degree in 1920. During the First World War Morris Fromkin served in the United States Field Artillery and saw active duty in France, notably in the St-Mihiel salient.

From this background, it is understandable that in his law practice he provided much free legal service to many immigrants and indigents who otherwise would have been denied justice. He was a liberal lawyer in the sense that he recognized that if social justice and legal rights are denied to the economically disadvantaged because they cannot meet the price tag, then government by law—the foundation of political self-government—will disintegrate.

He was a liberal lawyer also in the sense that he recognized that a decent standard of living for all those willing and able to work is essential to the survival of our system of economic and political self-government. Thus, he took an active interest in many struggling social justice movements: collective bargaining for labor unions, programs of the Grange and other farmer groups, and, most particularly, the political reform proposals of liberal leaders of all political persuasions—Governor Altgeld, a Democrat of Illinois; Senator La Follette, a progressive Republican of Wisconsin; Senator Norris, a liberal Republican of Nebraska; Victor Berger and Daniel Hoan, Socialists of Wisconsin; and many leaders of the Farmer-Labor Party in Minnesota, the Nonpartisan League of North Dakota, as well as liberal leaders and organizations in other states.

[3]Lauf *v.* Shinner & Co., 303 U.S. 323 (1938). The case involved "stranger picketing," a situation in which the picket line around a struck firm was manned by people who were not and usually never had been employees of the firm. Neither the Norris-La Guardia Act nor the Wisconsin Labor Code specifically included stranger picketing in its definition of a labor dispute. The question the United States Supreme Court confronted was whether the stranger picket in Lauf did indeed constitute a labor dispute under the provisions of the Norris-La Guardia Act and was therefore

protected from being enjoined. The larger question the Court spoke on in its decision was the power of Congress to limit the injunctive power of courts in labor disputes.

The case concerned a firm that operated five meat markets in Milwaukee and a labor union to which none of the firm's employees belonged. The union came to the firm and demanded that it require its employees to join the union as a condition of employment. The firm told its employees they were free to join the union, but none did. The union then began picketing the firm's markets to force the employer to require his employees to join the union as a condition of employment or to drive the firm out of Milwaukee. In picketing Shinner's meat markets the union resorted to some unseemly tactics, such as physically intimidating prospective customers. Taking no notice of these tactics, but dealing with the question of the legality of the picket itself, a Federal District Court enjoined the picket on the ground that no labor dispute existed between the firm and the union. The Circuit Court of Appeals affirmed the decision. The Supreme Court reversed the lower court decisions by finding that a labor dispute did exist under the provisions of the Norris-La Guardia Act and the Wisconsin Labor Code and that therefore the picket could not be enjoined. On stranger picketing, see also American Federation of Labor *v.* Swing, 312 U.S. 321 (1941).

[4]Erwin B. Ellmann, "When a 'Labor Dispute' Exists Within the Meaning of the Norris-La Guardia Act," *Michigan Law Review*, 36 (May, 1938), 1147. In his comment Ellmann was writing not only about Lauf *v.* Shinner, but also about New Negro Alliance *v.* Sanitary Grocery Co., which likewise involved stranger picketing.

[5]Senator Morse slightly exaggerates the importance of the Norris-La Guardia Act and Lauf *v.* Shinner & Co. in making picketing immune from judicial attacks. Other laws and cases were equally important. Among these were the Wagner Act, which created the National Labor Relations Board to regulate labor relations in the United States; N.L.R.B. *v.* Jones & Laughlin Steel Corp., 301 U.S. 1 (1937), and other cases which upheld the constitutionality of the Wagner Act; and Thornhill *v.* Alabama, 310 U. S. 88 (1940), in which the Supreme Court brought picketing under the protection of the First Amendment as an exercise of free speech. After the Thornhill decision, however, the Court modified its implicit position that picketing was absolutely protected as a form of communication and put the legality of pickets and injunctions against pickets on a case-by-case basis in Milk Wagon

Drivers' Union *v.* Meadowmoor Dairies, 312 U. S. 287 (1941), and Carpenters and Joiners Union *v.* Ritter's Cafe, 312 U. S. 722 (1942).

[6]Morse served as a public representative on the Board from 1942 to 1944.

[7]Morse was born in Madison and educated at the University of Wisconsin. He taught there in 1924, after which he went to Minnesota to continue his education.

[8]Quoted in Belle C. and Fola La Follette, *Robert M. La Follette*, 2 vols. (New York: Macmillan Company, 1953), I, p. 496.

[9]Quoted in *ibid.*, p. 560.

THE REPRODUCTIVE CYCLE AND FECUNDITY OF THE ALEWIFE IN LAKE MICHIGAN[1]

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ABSTRACT

The alewife population in southern Lake Michigan exhibited a spawning season extending from mid-June to early August, with a peak in July, as indicated by gonosomal indices and confirmed from histological sections of the ovaries and testes. During the height of spawning, gonads comprised 5 to 6% of body weight in males and 8 to 12% in females, values approximately nine times as great as in the quiescent season. The relationship between fecundity and total length was expressed as Y = 292X — 29,719. The correlation coefficient was .44. Fecundity versus ovarian weight was Y=4,819X - 1,262, with a correlation coefficient of .90. Fecundity was related to the gonosomal index by Y = 2,352X - 3,801, with a correlation coefficient of .71. Gonosomal indices of dying fish revealed various states of sexual development.

INTRODUCTION

The alewife, *Alosa pseudoharengus* (Wilson) was first noted in Lake Michigan in 1949 (Miller, 1957), and its subsequent population explosion has had detrimental ramifications, particularly because it occupies several niches during its life history and competes with many of the more desirable fishes (Smith, 1968). Since the alewife has been multiplying at a rapid rate in the lake, a study of its reproductive cycle is warranted as an aid in estimating its biotic potential.

Spawning in landlocked alewives has been reported from April to early August in Lake Ontario, with a peak from mid-June to July (Pritchard, 1929; Graham, 1956); in late June in both Lake Erie (C.F.R., 1961) and Lake Michigan (Edsall, 1964); and from late May

[1] Contribution No. 178, Center for Great Lakes Studies, The University of Wisconsin-Milwaukee, Milwaukee, Wisconsin 53201.

to late August in the Finger Lakes of New York State (Odell, 1934; Galligan, 1962).

Concerning fecundity, Odell (1934) reported an average of 10,000 to 12,000 mature ova in freshwater alewives from Seneca Lake, New York, while Norden (1967) indicated a range of 11,000 to 22,000 in Lake Michigan alewives. These are far below counts for the marine form: 60,000 to 100,000 (Bean, 1902 in Breder and Rosen, 1966; Havey, 1950), and 102,800 (Brice, 1898; Hildebrand and Schroeder, 1928; Smith, 1907).

This research was undertaken to describe the natural changes which accompany the development and maturation of the reproductive organs of the alewife in Lake Michigan.

METHODS AND MATERIALS

Several hundred alewives were collected by dip-net, seining, and commercial trawling from various points in Lake Michigan from 1968 to 1971. Dying fish were collected from the Milwaukee Harbor on several occasions during July, 1969. Only fish dying of apparent natural causes were examined.

Gross morphological gonadal changes were expressed as variations in the percentage of total body weight comprised by the gonads (Gonosomal index = g/bw x 100), also referred to as maturity index (Vladykov, 1956).

Fecundity of 35 gravid females collected July 26, 1969 at Milwaukee Harbor was determined. The gonosomal index of each specimen was first calculated, then each ovary was divided into: anterior, middle, and posterior parts. A small subsample of each part was weighed and the total number of mature eggs counted. The fecundity in thousands of mature eggs per female was then correlated with total length, gonosomal index, and ovarian weight.

Histological differentiation was determined by sectioning gonads of fish collected throughout the year. Testes and ovaries were sectioned at 6 and 10 micra respectively, and stained with Heidenhain's hematoxylin and eosin.

RESULTS

Reproductive Cycle

The spawning cycle of the alewife can be rather accurately determined from the gonosomal index. During the course of the year, both sexes underwent an approximate nine-fold increase in gonad/body weight relationship from the quiescent to sexually

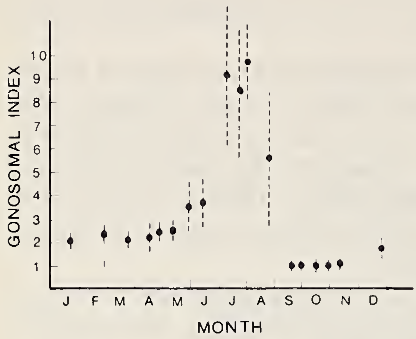

Fig. 1. Seasonal changes in the gonosomal index of the female alewife in Lake Michigan [dashed line indicates 1 standard deviation].

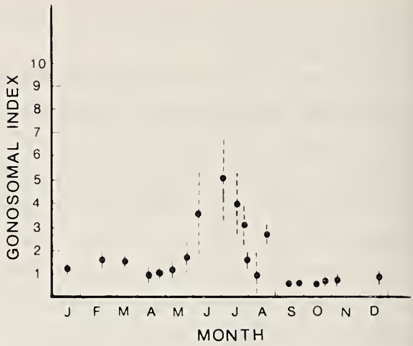

Fig. 2. Seasonal changes in the gonosomal index of the male alewife in Lake Michigan [dashed line indicates 1 standard deviation].

mature condition (Figs. 1 and 2). Ovaries developed from about 1% of body weight in September and October with low variability, to over 9% in July with great variability. Some individuals reached 15%. These changes were reflected in the size and gross anatomy of the gonads. The testes increased slowly from mid-September to early May, and variability among individuals was low. A rapid acceleration and increased variability were observed from late May to early July. A sharp decrease in the gonosomal index occurred in both sexes from late August to September, and variability tended to be lower. The absence of a well defined peak and the increased variability indicates that the alewife population in Lake Michigan has an extended spawning season, with individuals maturing asynchronously.

The relative state of reproductive maturity can be estimated from the gonosomal index. A value of less than one percent in males and one to one and one half percent in females places them in the post-spawned or quiescent phase. Values from one to two percent in males and two to three percent in females indicates the start of gonadal development for next season. Males of three to four percent and females of four to five percent are maturing, with the gonads beginning to enlarge noticeably. Ripe individuals are characterized by gonosomal indices of five to six percent for males, and eight to twelve percent for females. Since there was a larger variability as maturation neared, these values are only approximations and not absolute natural divisions.

Fecundity

This study revealed an average of 19,460 mature ova per female. The number of mature ova per fish was compared with total length. The least squares equation was Y = 292X - 29,719, with a correlation coefficient of .44. (Fig. 3)

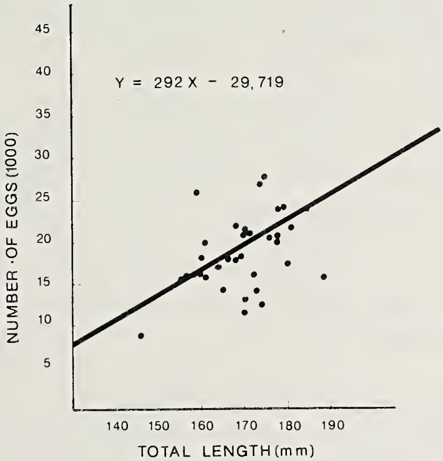

Fig. 3. Linear relationship between total length and fecundity of the alewife in Lake Michigan.

The regression of ovarian weight on fecundity was Y = 4,819X - 1,262 (Fig. 4). The high correlation coefficient of .90 indicates fecundity can be fairly well estimated from ovarian weight.

The relationship for gonosomal index versus fecundity is expressed as Y = 2,352X - 3,801, with a correlation coefficient of .71 (Fig. 5). All three correlations were significant (p. 0.01, 33 d.f.).

OOGENESIS

The ovaries of the alewife are paired structures surrounded by an epithelium and suspended from the mesovarium. They are ellipsoid in general shape, tapering from anterior to posterior; in cross section they may be round or triangular. As in most teleosts, the ovary is of the cystovarian type with ovigerous lamellae protruding into a central lumen to increase the surface area of the organ. The overall color is white to cream in the quiescent stage; the gravid ovary is a bright yellow-orange.

The alewife ovary exhibits a seasonal cycle. In January, large

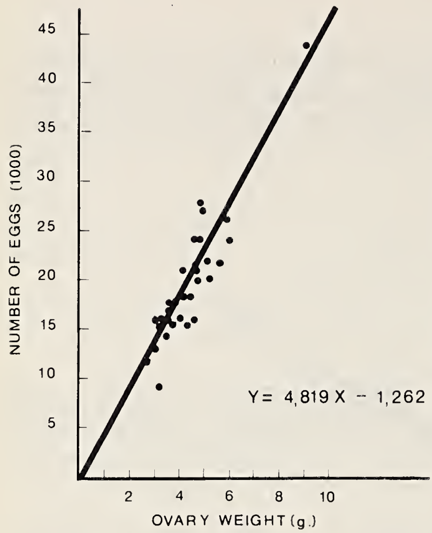

Fig. 4. Linear relationship between ovarian weight and fecundity of the alewife in Lake Michigan.

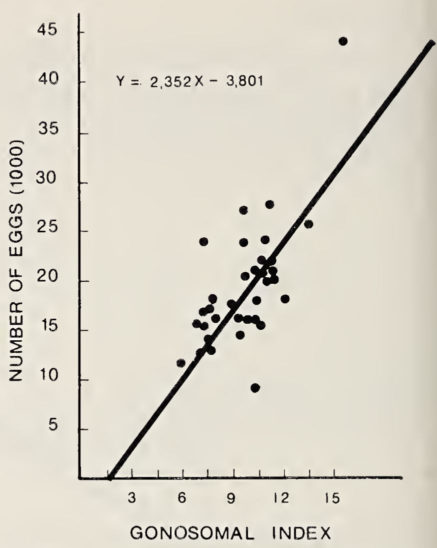

Fig. 5. Linear relationship between gonosomal index and fecundity of the alewife in Lake Michigan.

numbers of primary and secondary oocytes predominate. Most ova are less than 200 micra in diameter, although some are larger. A follicle, chorion, and vitelline membrane are beginning to be formed. The larger ova are characterized by a vacuolated peripheral layer of cytoplasm as oil droplets begin to form. Ova of all sizes are intermingled within the ovary, and little crowding is noted (Fig. 6). Sex can be fairly easily determined by the gross anatomy of the gonad, although its color is usually whitish at this stage. During this period, the ova grow slowly with no abrupt changes.

During April, the majority of eggs are still less than 220 micra in diameter with some of the ova developing prominent follicular and vitelline membranes. Peripheral vacuolization is present in ova measuring 230-250 micra, while the central ooplasm remains fairly homogeneous. The ovigerous lamellae become more crowded and the ovarian wall has become thicker and more vascular. Prominent strands of supporting connective tissue migrate into the ovarian cavity, dividing it into compartments. Grossly, the ovary is yellower than during the fall and winter.

By May, the larger ova are approaching 320 micra in diameter, and vacuolization is prominent in the peripheral ooplasm. The smaller oocytes are usually under the epithelium of the ovigerous lamellae, but the ova are not very crowded. A central lumen is still present (Fig. 7). The ova are yellower and ovarian vascularization is increased. Sex can be easily determined from the gross anatomy of the gonad at this stage. The ova are pale yellow and blood vessels are apparent.

During the first part of June the follicle is obvious, and the chorion reaches a maximum thickness of 9 - 11 micra. The larger ova (400 micra) are most conspicuous, although immature ones are still present. By mid-June, the ova are approaching 600 micra in diameter, and are yolk laden. Yolk granules have increased from 4 - 5 micra to 9 or 10 micra. Eggs are quite crowded and some are pushed together so that they appear flat sided. The follicular epihelium and vitelline membrane are well developed (Fig. 8).

During the peak spawning month of July, the ova are crowded, and some resorption is noted. The anterior tip of the ovary is often medianly reflected because the organ is so extensive.

Although alewives spawn in Lake Michigan during late June and July, a wide range of ova sizes including primary and secondary oocytes can be found in the ovary at this time. Some atresia was noted in August and a large number of vacuolated ova was seen. Ovaries of spawned - out fish are thin and flaccid and appear almost translucent.

In the fall, early stages of oogenesis are evident in the ovary, with ova less than 125 micra in diameter. Grossly, the gonads can be determined as female by their relatively "granular" texture. If the organ is broken in half, the ovary will "open up" and a central cavity will be evident. At this season the gonads are in a very undeveloped condition.

During November, most ova are less than 150 micra, but a few of the larger ones show a fairly apparent vitelline layer, which is quite thin. Most eggs are developing a follicle layer, the ova are not extremely crowded, and a central lumen is more obvious. The ovarian wall is thinner and less vascularized.

In December, a few of the larger ova are about 200 micra in diameter, with considerable peripheral vacuolization, but the majority of the eggs has not grown appreciably since late fall. The follicle is more developed and the chorion is becoming more apparent.

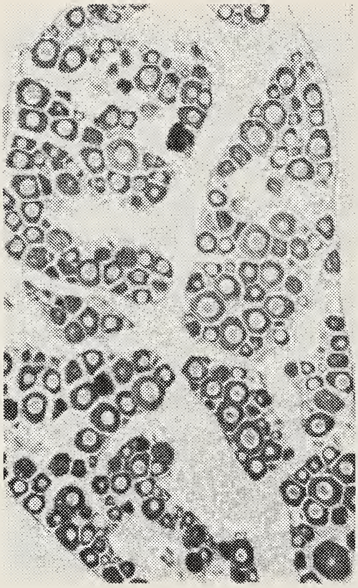

Fig. 6. Section of an immature alewife ovary showing typical cystovarian configuration, with ovigerous lamellae containing primary and secondary oocytes protruding into the central lumen. TL 130 mm. Wt. 19 grams (40x)

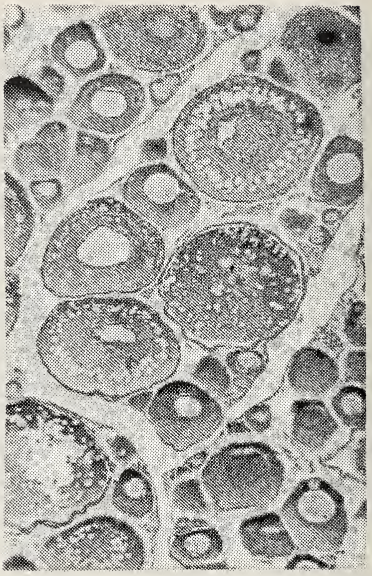

Fig. 7. Section of a maturing alewife ovary showing peripheral vacuolization of the ova. TL 183 mm. Wt. 53 gr. (100x).

Fig. 8. Section of a ripe ovary showing a mature ovum in the follicle. TL 188 mm. Wt. 48 gr. (100x).

Spermatogenesis

In the fall of the year, the alewife testes is a narrow strand of whitish, blade-shaped tissue, slightly wider anteriorly and dorsally. Determination of sex by gross anatomy is somewhat difficult, but is possible because the organ's texture is more homogeneous than that of the ovary, and it does not have a central lumen.

Histologically, the immature testes is divided into numerous crypts or lobules, which are separated by connective tissue. Within each lobule are numerous spermatogonia, each of which will progress and mature as an independent unit. All the cells within a crypt are at the same stage of spermatogenesis at any one time. During the fall these cells do not show much variation. The testes develops slowly throughout the winter months and does not increase in size to the extent the ovary does in the female.

By May, the testes shows some variability among the stages of spermatocyte development. Some of the crypts contain mostly spermatogonia, while others are in the primary spermatocyte stage.

By July, the testes is greatly enlarged. The color is creamy white, and the anterior is often folded back upon itself. Male alewives in this condition are ripe or nearly so. Histologically, the gonads show crypts filled with spermatids. The gametes in the ripe male gonad do not exhibit as much variability as those in the ripe ovary, the vast majority all being in the same stage of development.

Dying Fish

Fifty-one females had a mean gonosomal index of 4.2%, with a range from 1 to 14%. Thirty males had a mean index of .83%, and range of .30 to 2.9%.

DISCUSSION

The ovary was used in this study as the major indicator of gonadal changes, as environmental influences on the sex cycle are reflected with greater dependability in the ovary than in the testes (Harrington, 1959). The gonosomal index is a valid measure because the gonad/body weight ratio tends to be constant at any one season for all sizes of the same sex and state of maturity (LeCren, 1951).

The spawning season of the alewife in Lake Michigan is characterized as extended and asynchronous, a situation which reduces the likelihood that an entire year class would be lost by a sudden transient detrimental change in the environment, once spawning has commenced. This mechanism may help explain the success of this species in lakes of the temperate region which are annually subjected to far greater extremes than the marine form in the relatively stable ocean.

The equations developed for the determination of fecundity from length, ovary weight, and gonosomal index can be used to gain estimates of egg counts on the basis of simple measurements.

The histological description of the reproductive cycle has been reported for several species of fish, but the present work is the first to our knowledge on the freshwater alewife. The spawning cycle as determined from the gonosomal index agrees well with the histological development of the reproductive organs.

Specimens of dying fish examined during the spawning period indicate that mortality does not necessarily occur after the completion of spawning, because several fish had relatively high gonosomal indices. It is conceivable that a reproductive stress is related to mortality. Morsell and Norden (1968) showed that there was a marked reduction or possible cessation of feeding at this time, and the reserve energy supply of adipose tissue was at a seasonal low. This suggests the alewife is susceptible to environmental stress during the reproductive season.

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THE PARASITOIDS OF THE EUROPEAN PINE SAWFLY NEODIPRION SERTIFER (GEOFFROY) (HYMENOPTERA: DIPRIONIDAE), IN WISCONSIN, WITH KEYS TO ADULTS AND LARVAL REMAINS

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ABSTRACT

Thirteen species of hymenopterous parasitoids have been reared from *Neodiprion sertifer* (Geoffroy) in Wisconsin. *Pleolophus basizonus* Grav. was reared for the first time in Wisconsin. Two illustrated keys based on the adults and remains left in the host cocoon have been prepared to aid in the separation of these parasitoids. Brief notes on the biology of each species are also presented.

INTRODUCTION

The European pine sawfly, *Neodiprion sertifer* (Geoffroy) has been in North America since at least 1925, spreading from New Jersey to southwest Ontario and west to Iowa and Missouri. It was first reported in Wisconsin, near Lake Geneva, in 1972 (Mertins and Coppel 1974).

The hosts of the sawfly include most species of two-needled pines. The favored hosts in the Lake States region are Scotch pine, *Pinus sylvestris* L.; red pine, *Pinus resinosa* Ait.; and jackpine, *Pinus banksiana* Lamb. (Wilson 1966). Trees of all ages are defoliated but those in exposed locations are most severely attacked. Tree mortality is rare as feeding is confined to previous year foliage and there is only one sawfly generation per year (Wilson 1971). However, growth loss and deformation, especially of Christmas tree stock makes this pest a serious threat to Wisconsin pine forests and plantations.

This paper, deals with the known parasitoids of *N. sertifer*. Keys are presented for the separation of the adult parasitoids and of the remains left in the host cocoon after parasitoid emergence. Descriptions of the adults, final larval instar cephalic structures and spiracles are given, with notes on the biology of the parasitoids.

METHODS

The parasitoid material upon which the keys were based consisted of adults preserved in alcohol and parasitoid remains from cocoons positively associated with the parasitoids emerging from them. The key to parasitoid remains is based on the absence or presence, and appearance of the parasitoid cocoon, and the cast of the last instar larval skin. Cocoons from which parasitoids had emerged were sliced open near the end closest to the emergence hole, to observe the location and appearance of the contents. The last larval skins were removed from the host cocoon, softened in warm 10% KOH for 10-30 minutes and rinsed in distilled water. The skins were spread during rinsing and mounted in a non-resinous mounting medium.

Illustrations of the larval head capsules and spiracles were made with the aid of a [Reichert] binocular compound microscope. Measurements were made with a [Reichert] ocular micrometer calibrated with a stage micrometer. Illustrations of adults and gross characters of larval remains were made with the aid of a [Bausch and Lomb] binocular dissecting microscope. Terminology used for the parts of the cephalic structures and spiracles of final instar parasitoid larvae follows Finlayson (1960).

Parasitoids Obtained

The following 13 species of Hymenoptera were reared from *Neodiprion sertifer* cocoons originating at four sites in southeastern Wisconsin, in Walworth, Kenosha, and Racine Counties:

Ichneumonidae: *Exenterus amictorius* (Panzer), *Exenterus nigrifrons rohwer*, *Pleolophus basizonus* Gravenhorst, *Pleolophus indistincta* (Provancher), *Endasys subclavatus* (Say), *Mastrus aciculatus* (Provancher), *Agrothereutes lophyri* (Norton), *Delomerista japonica diprionis* Cushman

Eulophidae: *Dahlbominus fuscipennis* (Zetterstedt)

Eupelmidae: *Eupelmella vesicularis* (Retzius)

Pteromalidae: *Dibrachys cavus* (Walker)

Habrocytus thyridopterigis Howard

Eurytomidae: *Eurytoma pini* Bugbee

KEY TO ADULT PARASITOIDS OF *N. SERTIFER*

1. Antennae geniculate (Chalcidoidea) 2
   Antennae filiform (Ichneumonidae) 6

2. (1) Antennae with 10 segments, last 3 fused (Figs. 36, 38) .... *Eurytoma pini*
Antennae with 8 or 13 segments 3
3. (2) Tarsi 4 segmented; antennae with 8 segments (Figs. 25, 26) .... *Dahlbominus fusipennis*
Tarsi 5 segmented; antennae with 13 segments, the last three of which may be fused 4
4. (3) Wings micropterous (Fig. 28) .... *Eupelmella vesicularis*
Wings well developed 5
5. (4) Antennal sockets about 2/3 way up between upper and lower eye margins (Fig. 33) .... *Habrocytus thyridopterigis*
Antennal sockets about even with lower margins of eye (Fig. 29) ..... *Dibrachys cavus*
6. (5) Wings micropterous (Fig. 11) .... *Pleolophus indistincta*
Wings well developed 7
7. (6) Yellow stripes on abdomen; yellow patches on thorax; ovipositor short and inconspicuous 8

No yellow stripes or patches; ovipositor extends beyond tip of the abdomen and at least one-third as long 9

8. (7) A large yellow patch on either side of propodeum; all yellow margins of abdominal tergites less than one-third the length of the tergites ...... *Exenterus nigrifrons*

No yellow patch on sides of propodeum; yellow margins of tergites I and II at least 1/3 length of the tergite................*Exenterus amictorius*

9. (8) Clypeus with a median apical notch (Fig. 21) .... *Delomerista japonica diprionis*

Clypeus round or angular apically, never with a median notch 10

10. (9) White band around proximal metatibia; white abdominal tip, meso and pro coxa; proximal 4 segments of antennal flagellum at least three times as long as wide (Fig. 19)......................*Agrothereutes lophyri*

Not having all of above 11

11. (10) Meso and pro coxa black .... *Pleolophus basizonus*
Meso and pro coxa brown 12

12. (11) Apical truncation of scape strongly oblique, 50-70 degrees from transverse; female hirsute; male with light-brown clypeus (Fig. 16) .... *Mastrus aciculatus*

Apical truncation of scape weakly oblique or almost transverse, 5-30 degrees from the transverse; female not hirsute; male with black clypeus (Fig. 13) .... *Endasys subclavatus*

KEY TO THE PARASITOID OF *N. sertifer* BASED ON PARASITOID REMAINS

1. Host cocoon containing parasitoid cocoon 2
   Host cocoon not containing parasitoid cocoon 9

2. (1) Blade of mandible with two rows of teeth, epistomal arch incomplete; labral sclerite apparent 3

   Blade of mandible without teeth, epistomal arch complete; labral sclerite not visible 8

3. (2) Labial sclerite closed dorsally; mandibles with a large posterio-medial tooth (Fig. 46) .... *Delomerista japonica diprionis*

   Labial sclerite open dorsally; mandibles lack a posterio-medial tooth 4

4. (3) Antennae as wide as long or wider (Fig. 43) ..... *Endasys subclavatus*

   Antennae longer than wide 5

5. (4) Teeth of mandibles of even length and less than 3 μm long; antennae 3-4 times as long as basal width (Fig. 44) .... *Mastrus aciculatus*

   Teeth of mandibles of uneven length and up to 6 μm long; antennae less than three times as long as basal width 6

6. (5) Arms of labral sclerite broad to base (Fig. 41) .... *Pleolophus basizonus*

   Arms of labral sclerite broad only on ends 7

7. (6) Antennae less than twice as long as wide; closing apparatus of spiracle about one-half its total length (Figs. 45, 58) .... *Agrothereutes lophyri*

   Antennae at least twice as long as wide; closing apparatus of spiracle about one-third its total length (Figs. 42, 55) .... *Pleolophus indistincta*

8. (2) Height of epistomal arch above blades of mandibles about one-half its width at widest point; atrium of spiracle almost as deep as wide and tapering to stalk (Figs. 39, 52) .... *Exenterus amictorius*

   Height of epistomal arch above blades of mandibles about one-third its width at widest point; atrium of spiracle wider than deep and not tapering to stalk (Figs. 40, 53) .... *Exenterus nigrifrons*

9. (1) Cast skin of last larval instar sparsely covered with long setae 10

   Cast skin of last larval instar not covered with long setae 11

10. (9) Mandibles each with a large tooth (Fig. 51) .... *Eurytoma pini*

Mandibles each without a large tooth (Fig. 48) .... *Eupelmella vesicularis*

11. (9) Atrium of spiracle with at least 10 chambers; antennae domelike (Figs. 47, 60) .... *Dahlbominus fuscipennis*

Atrium of spiracle with 4-8; chambers; antennae conelike 12

12. (11) Cephalic structure of last larval instar with mandibles, epistoma, pleurostoma, hypostoma, superior and inferior mandibular processes (Fig. 49) .... *Dibrachys cavus*

Cephalic structure of last larval instar with only mandibles and sometimes visible a slightly sclerotized articulation (Fig. 50) .... *Habrocytus thyridopterigis*

Description

Exenterus amictorius (Panzer)
Figs. 1, 2, 3, 39, 52, 65

This European species was an abundant parasitoid of *N. sertifer* only at the Burlington collection site. No specimens were reared from Bassett, the only other site from which a large ground collection of cocoons was made. *E. amictorius* is a larval parasitoid and thus would not be found at Lake Geneva and Genoa City where lab reared cocoons, placed in field cages to prevent mammal predation, were the only source of parasitized cocoons. It is a solitary, primary parasitoid and emerges from the host cocoon. Adults are black with yellow markings and in life the eyes have a greenish sheen. The sex ratio was about 1:1. Females have a single hypopygial plate whereas males have two, the anterior of which is bordered by a thin yellow stripe.

The emergence hole is slightly to the side of the end of the host cocoon, round, irregularly cut, and 2.0-2.5 mm in diameter (Fig. 65). The parasitoid cocoon nearly conforms to the size and shape of the host cocoon and is thin, shiny, slightly fuzzy, and white to light pink. The host remains are outside the parasitoid cocoon, against the lateral wall. Several brown pellets of larval meconium, the shrivelled yellow last instar larval skin, the transparent white pupal skin and a mass of white adult meconium are found loose inside the parasitoid cocoon, at the end opposite the exit hole.

Two species of *Exenterus* are recorded from *N. sertifer* in Wisconsin. A perfect mount is necessary to separate the larvae, and even then there may be some doubt. The cast skin of the final instar larva is covered with minute sharp spicules and a few short setae. The epistoma of the cephalic structure (Fig. 39) is complete but never well sclerotized. The stipital sclerites are large and extend toward the hypostoma. The blade of the mandible is long, slender and lacks teeth. The atrium of the spiracle tapers toward the stalk and is about as deep as it is wide (Fig. 52).

Exenterus nigrifrons Rohwer

Figs. 4, 5, 6, 40, 53, 66

This native parasitoid was found in moderate abundance at Burlington, especially from cocoons spun on the trees. It is a solitary, primary parasitoid and emerges from the host cocoon. The adults appear similar to *E. amictorius*, but may be easily distinguished by a large yellow spot on either side of the propodeum, and by the uniform width of the yellow margins of the abdominal tergites. The sex ratio was 3 females: 2 males. The emergence hole (Fig. 66) and parasitoid remains are similar to *E. amictorius*, except that the cocoon is never pink. The cephalic structure of the last larval instar has a lower epistomal arch and shorter lacinial sclerites than *E. amictorius* (Fig. 40). The shape of the spiracles varies considerably within the two *Exenterus* species; however, generally *Exenterus nigrifrons* may be distinguished by the atrium, which is wider than deep (Fig. 53).

Pleolophus basizonus Gravenhorst

Figs. 7, 8, 9, 41, 54, 67

This European species was recorded for the first time in Wisconsin. It was the most abundant and most common parasitoid, being reared from all four collection sites. It is a solitary, primary parasitoid of the cocooned host larvae, the adults emerging from the host cocoon. The adults are black and brown with a white spot on the tip of the abdomen and a white band around the proximal metathoracic tibia. Females are distinguished by a white band on the antenna. The sex ratio of reared specimens was 3 females: 2 males.

The emergence hole is to the side of the end of the host cocoon, round, with a slightly lobed but even margin, and 1.7-2.0 mm in diameter (Fig. 67). The parasitoid cocoon is nearly the same size and shape as the host cocoon, white, thick, fuzzy on the outside and smooth on the inside. The shrivelled host remains are outside the parasitoid cocoon and usully at the end of the host cocoon, opposite the exit hole. At the closed end of the parasitoid cocoon is a mass of tan to brown larval meconium. The final instar larval skin and yellow cast pupal case are usually embedded in the larval meconium. Light tan adult meconium may be present on top of the larval meconium.

The larval skin is rough, with scattered small setae. The atrium of the spiracle is wider than deep (Fig. 54). The cephalic structure (Fig. 41) lacks a complete epistomal arch. The labial sclerite is broadened dorsally, where it has numerous vacuoles. The arms of the labial sclerites are broad. The blade of each mandible is swollen at the base and has two rows of large irregular teeth.

Pleolophus indistincta (Provancher)
Figs. 10, 11, 42, 55, 68

This native parasitoid was found in very low abundance, but at all four sites. It is a solitary, primary, cocoon parasitoid. Adults appear similar to *P. basizonus* except that the former have micropterous wings. All reared specimens were female. The emergence hole is similar to *P. basizonus* but smaller, 1.5-1.7 mm in diameter (Fig. 68). The parasitoid cocoon is nearly the same size and shape as the host cocoon, white to grey, and composed of several layers. The outer layer is slightly fuzzy, the inner smooth, and the area between filled with loosely spun silk. The host and parasitoid remains are similar to *P. basizonus* except for the dark brown larval meconium.

The last larval skin is similar to *P. basizonus* except for the spiracles (Fig. 55) which have a slightly tapered atrium, about as deep as wide, and the cephalic structures (Fig. 42). The labial sclerite is not widened dorsally and does not have vacuoles. The arms of the labial sclerite are widened only at the ends. The blades of the mandibles are not swollen at their bases.

Endasys subclavatus (Say)
Figs. 12, 13, 14, 43, 56, 69

Endasys subclavatus was found in low numbers at all four collection sites. It is a solitary, primary parasitoid which attacks and emerges from the host cocoon. Adults are black with brown coxae and abdomens. The apical truncation of the scape is strongly oblique. Females are hirsute. Males of *Mastrus aciculatus* appear very similar but may be distinguished by careful examination of the apical truncation of the scape which is almost transverse. The sex ratio of *Endasys subclavatus* from reared specimens was 4 females: 3 males.

The emergence hole (Fig. 69) is usually oval, 1.6 x 1.9 mm in diameter, but sometimes round, and located near the tip of the host cocoon. The shrivelled host remains are opposite the exit hole and outside the parasitoid cocoon. This cocoon is nearly the same size and shape as the host cocoon, smoky to black, and layered, the outside smooth, the inside slightly fuzzy. At the closed end is a mass of dark red-brown to black pellets of larval meconium. The larval skin and light yellow pupal case are free inside the cocoon. Chunks of white, chalky adult meconium may also be present.

The delicate larval skin is smooth except for minute papillae and scarce small setae. The spiracular stalk has a short neck and large closing apparatus (Fig. 56). The cephalic structure has an incomplete epistoma, lacks lacinial sclerites, has a labial sclerite with widened dorsal arms and a labral sclerite which extends over the mandibles. The labial and maxillary palpi each have one large and one small sensorium. The antennae are as wide at the base as long (Fig. 43).

Mastrus aciculatus (Provancher)
Figs. 15, 16, 17, 44, 57, 70

Mastrus aciculatus was reared in low numbers but was found at all collection sites. It is a solitary, primary parasitoid of the cocooned larvae. Adults appear similar to *E. subclavatus* and may be distinguished by the weakly oblique or almost transverse apical truncations of the scape. Females are not hirsute. The sex ratio of reared specimens was 4 females: 3 males.

The emergence hole is round, slightly irregular, 1.5-1.9 mm in diameter and located the farthest from the end of the host cocoon of all ichneumonid parasitoids reared (Fig. 70). The parasitoid cocoon is nearly the same length as the host cocoon but flattened on one side near the host remains. The cocoon is white and composed of several layers. The outer layer varies from loose silk to fuzzy and the inner layer is shiny and smooth. A light brown mass of larval meconium pellets is at the closed end of the parasitoid cocoon. The final larval instar skin and light yellow pupal case are free in the parasitoid cocoon. A mass of light tan, grainy, adult meconium may also be present.

The larval skin is covered with minute papillae and scattered setae. The atrium of the spiracle (Fig. 57) is goblet-shaped and the stalk is long. The cephalic structure (Fig. 44) has an incomplete epistoma and labral sclerite which is slightly arched down over the mandibles. The antennae are long and narrow.

Agrothereutes lophyri (Norton)
Figs. 18, 19, 20, 45, 58, 71

Agrothereutes lophyri was reared in low numbers from Bassett and Burlington. It is a solitary, primary cocoon parasitoid. Adults have white tibiae and each has a wide red-brown to orange band around the abdomen. Females are distinguished by a white band around the antennae. The sex ratio of reared specimens was 2 females: 1 male.

The emergence hole is near the tip of the host cocoon, irregularly round, and 1.6-2.0 mm in diameter (Fig. 71). The host remains are in the end of the host cocoon opposite the exit hole. The parasitoid cocoon is white, thin, brittle, and nearly the size and shape of the host cocoon. The outside is rough and the inside smooth and shiny. A mass of brown to dark red-brown larval meconium fills the end of the parasitoid cocoon opposite the emergence hole. The last instar larval skin, transparent white pupal skin, and white brittle chunks of adult meconium are loose inside the parasitoid cocoon.

The last instar larval skin is covered with minute conical spines and scattered setae. The spiracular atrium tapers to a short stalk. The closing apparatus is large and transversed by reticulations (Fig. 58). The head capsule is brown and the cephalic structure includes a sclerotized prelabium, long stipital sclerites extending close to the hypostomal arms and mandibles each with two rows of large teeth (Fig. 45).

Delomerista japonica diprionis Cushman
Figs. 21, 22, 23, 46, 59, 72

Delomerista japonica diprionis was reared only from cocoons on Burlington trees. Here, the parasitoid was of moderate importance. It is a solitary, primary, cocoon parasitoid. Adults are black with brown legs. The abdomen is about twice the length of the thorax. Males are easily distinguished by their white faces. The sex ratio of reared specimens was 7 females: 6 males.

The emergence hole is close to the tip of the host cocoon, irregularly cut, and round, 1.9-2.5 mm in diameter (Fig. 72). A brown, leathery parasitoid cocoon walls off the host remains, on the side, and is usually complete and closely appressed to the host cocoon. The parasitoid remains are loose inside and consist of dark red-brown pellets of larval meconium, light yellow pupal case, yellow-brown final instar larval skin, and white chalky chunks of adult meconium.

The larval skin is covered with small conical papillae and numerous setae. The spiracles are funnel-shaped and have thick walls (Fig. 59). The head capsule is brown and heavily sclerotized. The epistoma of the cephalic structure is incomplete. The bow-shaped labral sclerite, epistoma, and pleurostoma are lightly sclerotized. The labial sclerite is closed dorsally (Fig. 46).

Dahlbominus fuscipennis (Zetterstedt)
Figs. 24, 25, 26, 47, 60, 73

Dahlbominus fuscipennis is a common and sometimes abundant parasitoid. It is gregarious (ave. 31, max. 59) and usually primary. In one case it was hyperparasitic (6 adults) on *P. basizonus*. The adults are easily recognized by the centrally infumate forewings. Males are distinguished by the shape of the antennae. The first three segments of the flagellum have long appendages.

The emergence hole is irregular, round, and 0.6-0.8 mm in diameter (Fig. 73). There may be two or three holes, usually on the side near an end. There is no parasitoid cocoon. Inside the host cocoon are the shrivelled host remains, surrounded by the parasitoid remains, small masses of brown larval meconia, broken yellow pupal skins and small, white, threadlike larval skins.

The larval skin is smooth. The spiracles (Fig. 60) are funnel-shaped, each with a long stalk. The cephalic structure (Fig. 47) includes only dome-shaped antennae and mandibles each with a long, straight, toothless blade.

Eupelmella vesicularis (Retzius)
Figs. 27, 28, 48, 61, 74

Eupelmella vesicularis is a rare parasitoid of *N. sertifer* in Wisconsin. Only four specimens were reared. This solitary cocoon parasitoid was primary on *N. sertifer* in two cases and hyperparasitic through *D. fuscipennis* and *Habrocytus thyridopterigis* Howard the other two instances. Adults have reduced wings and enlarged metathoracic legs. All reared specimens were females.

The exit hole (Fig. 74) is near the tip of the host cocoon, evenly cut, and oblong, 0.8 x 1.0 mm. Although there is no parasitoid cocoon, a small white mat is attached to the inside of the host cocoon. Clausen (1940) believed that these mats protect the young larvae from the primary parasitoids upon which they will feed. Also present in the host cocoon are a dark red-brown mass of larval meconium pellets, a yellow final instar larval skin, and a golden-yellow pupal case.

The larval skin is smooth except for a few long setae. The spiracles (Fig. 61) are funnel-shaped with a least 14 chambers. The cephalic structure (Fig. 48) consists of a prominent 8-toothed clypeus, mandibles and two short, lightly sclerotized bars to which the mandibles have an inferior articulation.

Dibrachys cavus (Walker)
Figs. 29, 30, 31, 49, 62, 75

Dibrachys cavus was reared only from cocoons collected on the trees at Burlington. Despite its limited distribution, it ranked fourth in abundance among all parasitoids collected. It is a gregarious (ave. 23.7, max. 51) cocoon parasitoid and is usually associated with another parasitoid. It is often (1 in 5) hyperparasitic on *E. amictorius*, *E. subclavatus*, or *M. aciculatus*. The number of adults produced in hyperparasitic attacks, 23.2, is similar to primary attack. Successful multiparasitism with *H. thyridopterigis* occurred in one-third of all *D. cavus* rearings. The average number of adult *D. cavus* was 7.2 per cocoon. Adults are dark green. Males are easily distinguished, each with a light yellow band around the abdomen. The sex ratio favored females 3.6:1.0.

The emergence hole (Fig. 75) is round, 0.7-0.9 mm in diameter, and on the side or near the end of the host cocoon. Two emergence holes may be present. There is no parasitoid cocoon. Loose inside the host cocoon are small masses of brown to black larval meconium, broken golden-yellow pupal cases, and small white thread-like final instar larval skins.

The larval skin is smooth and featureless except for the 4-5 chambered spiracles (Fig. 62) and the cephalic structure (Fig. 49). The mandibles each have a toothless blade and articulate with inferior and superior mandibular processes. The epistoma is incomplete and the hypostoma short. The conical antennae are not set in obvious sockets.

Habrocytus thyridopterigis Howard

Figs. 32, 33, 34, 50, 63, 76

Habrocytus thyridopterigis was found, like *D. cavus*, only in cocoons collected on Burlington trees. It is a gregarious cocoon parasitoid. It may function as a primary parasitoid (ave. 8.5 per cocoon, max. 13) but usually is associated with *D. cavus* and occasionally *D. fuscipennis* in successful multiparasitism (ave. 2.9, max. 7).

It is occasionally found as a hyperparasitoid (ave. 4.0, max. 4) on *E. subclavatus* and *M. aciculatus*. The adults are metallic green and slightly larger than *D. cavus*. Males each have a creamy white band around the abdomen. The sex ratio favored females 3.2:1.0.

The emergence hole is round, 0.8-1.1 mm in diameter, and usually on the side of the host cocoon, near an end (Fig. 76). No parasitoid cocoons are present. The parasitoid remains are similar to those of *D. cavus* but are slightly larger and their pupal skins are brownish-yellow. The final instar larval skin is smooth except for spiracles and the cephalic structure. The spiracles taper to the closing apparatus, the 6-8 chambers often appearing subdivided (Fig. 63). The cephalic structure includes antennae set in large antennal sockets and mandibles each with a row of fine teeth. The mandible has one visible articulation point with the small lateral sclerite (Fig. 50).

Eurytoma pini Bugbee
Figs. 35, 36, 37, 38, 51, 64, 77

Only one specimen of *Eurytoma pini* was reared. It was a solitary, primary parasitoid. The adult, a female, was shiny black with 10-segmented antennae. The round, smoothly cut exit hole was on the side of the host cocoon, near the middle and was 1.1 mm in diameter (Fig. 77). No parasitoid cocoon was spun. The parasitoid remains were loose in the host cocoon and consisted of a mass of brown larval meconium pellets, a yellow final instar larval skin, and a golden-yellow pupal case.

The larval skin has a sparse covering of long setae, each about 0.2 mm long. The spiracles are large and funnel-shaped (Fig. 64). The cephalic structure (Fig. 51) includes an incomplete epistoma, long inferior mandibular processes, long narrow hypostomal arms, mandibles each with a long curved blade and a conspicuous large medial tooth, and well sclerotized antennae.

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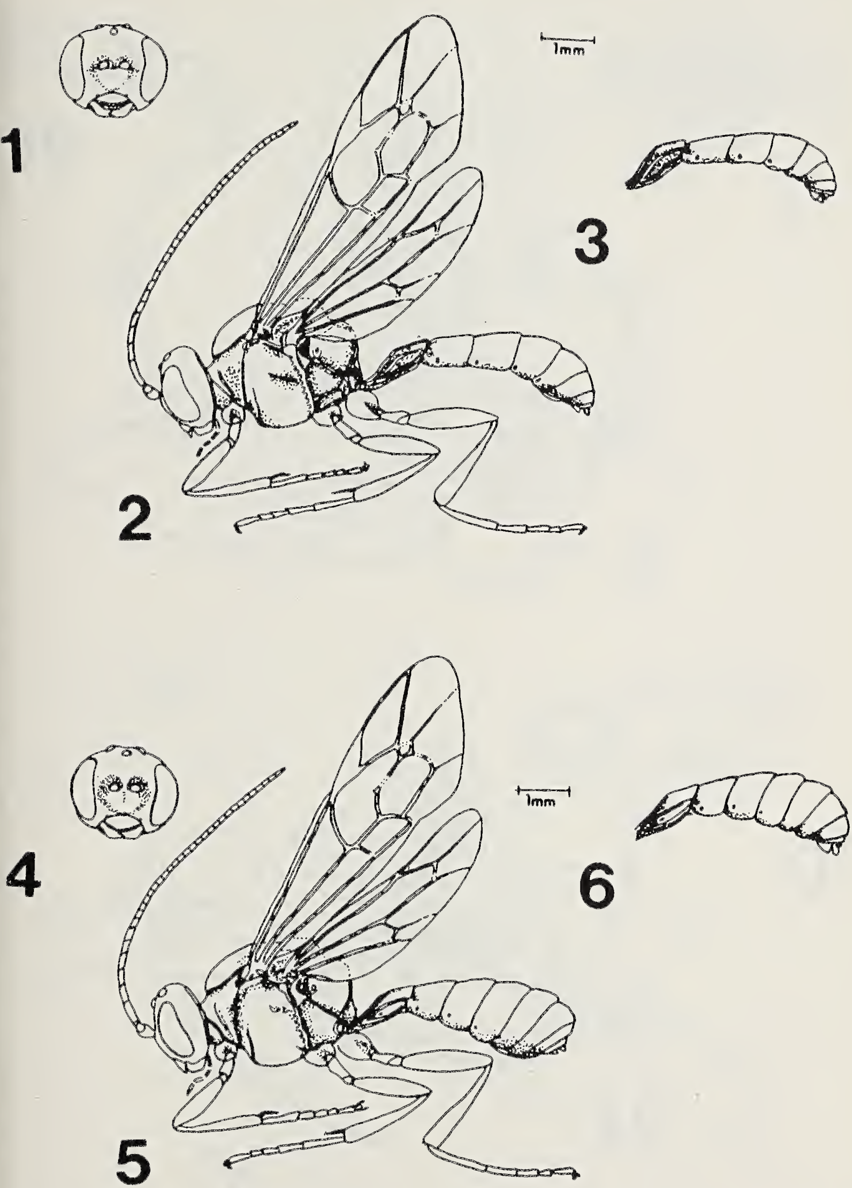
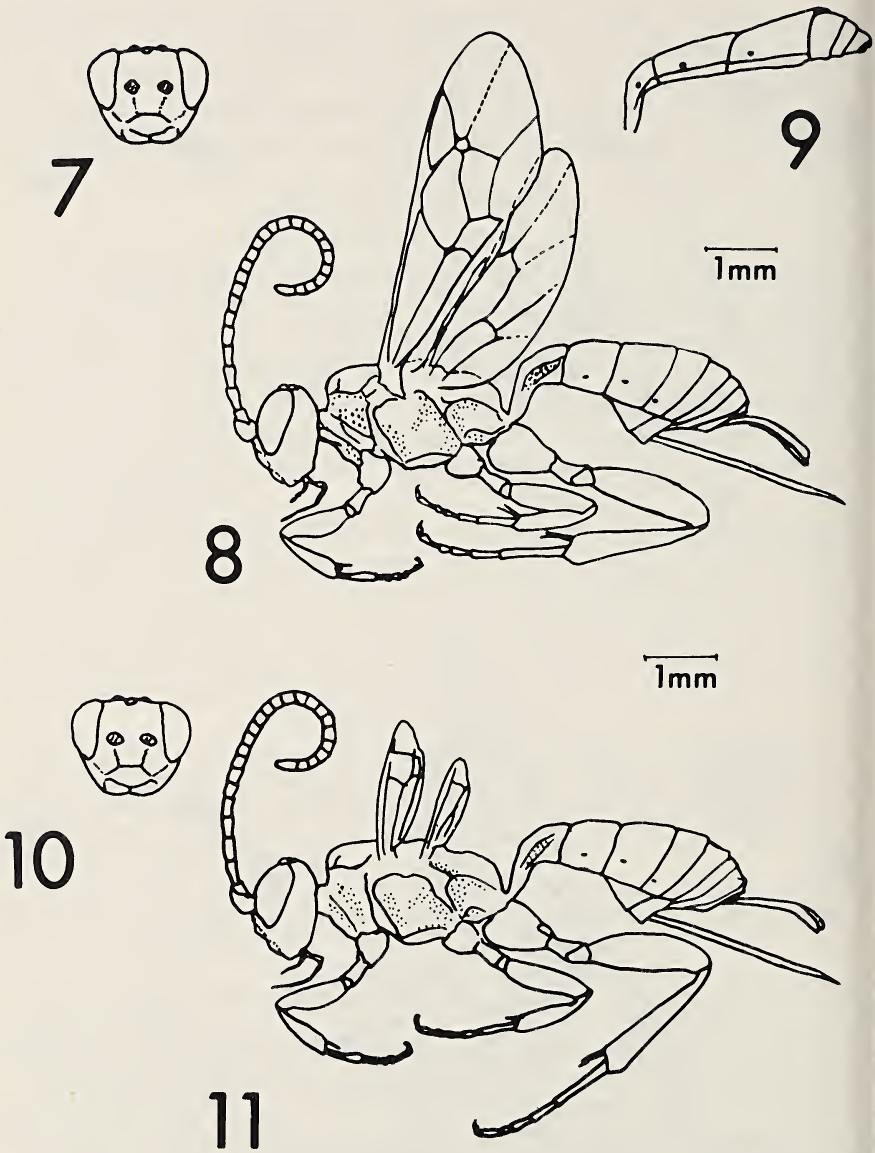
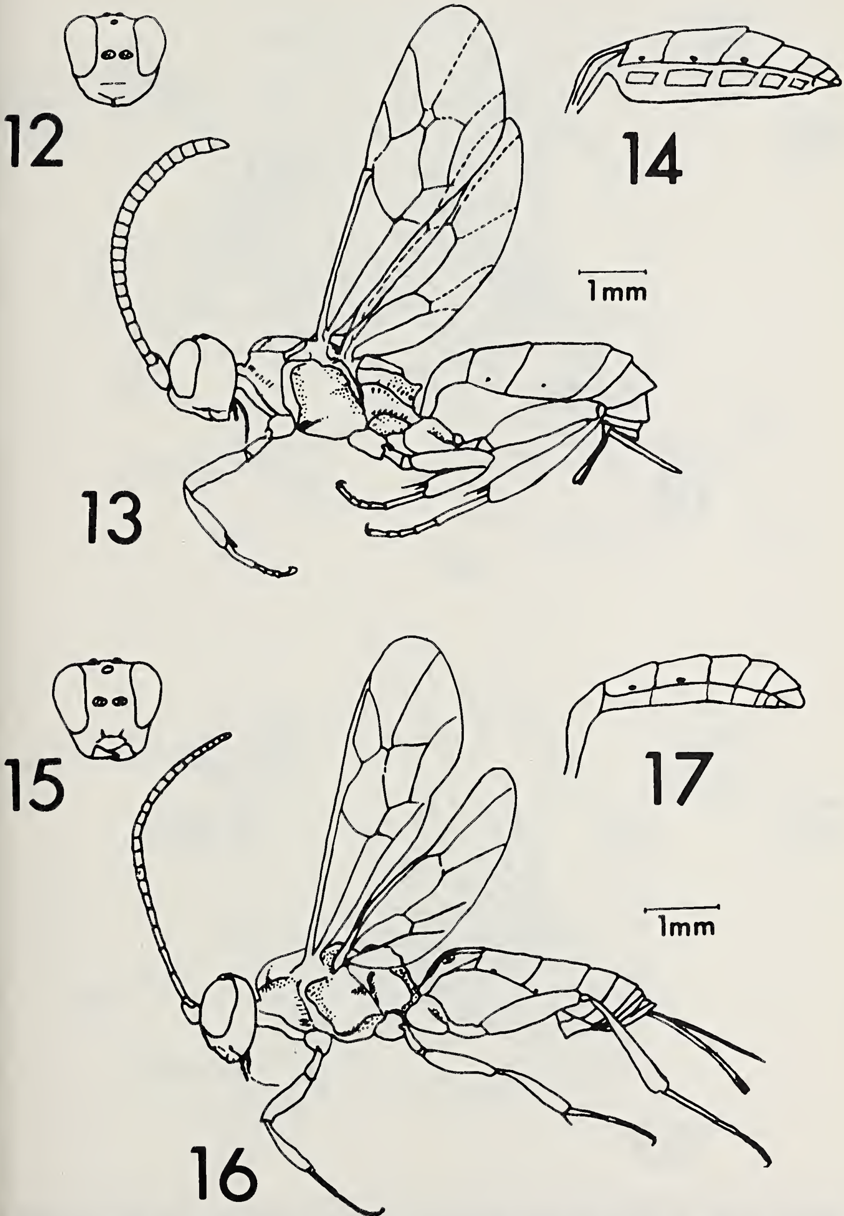


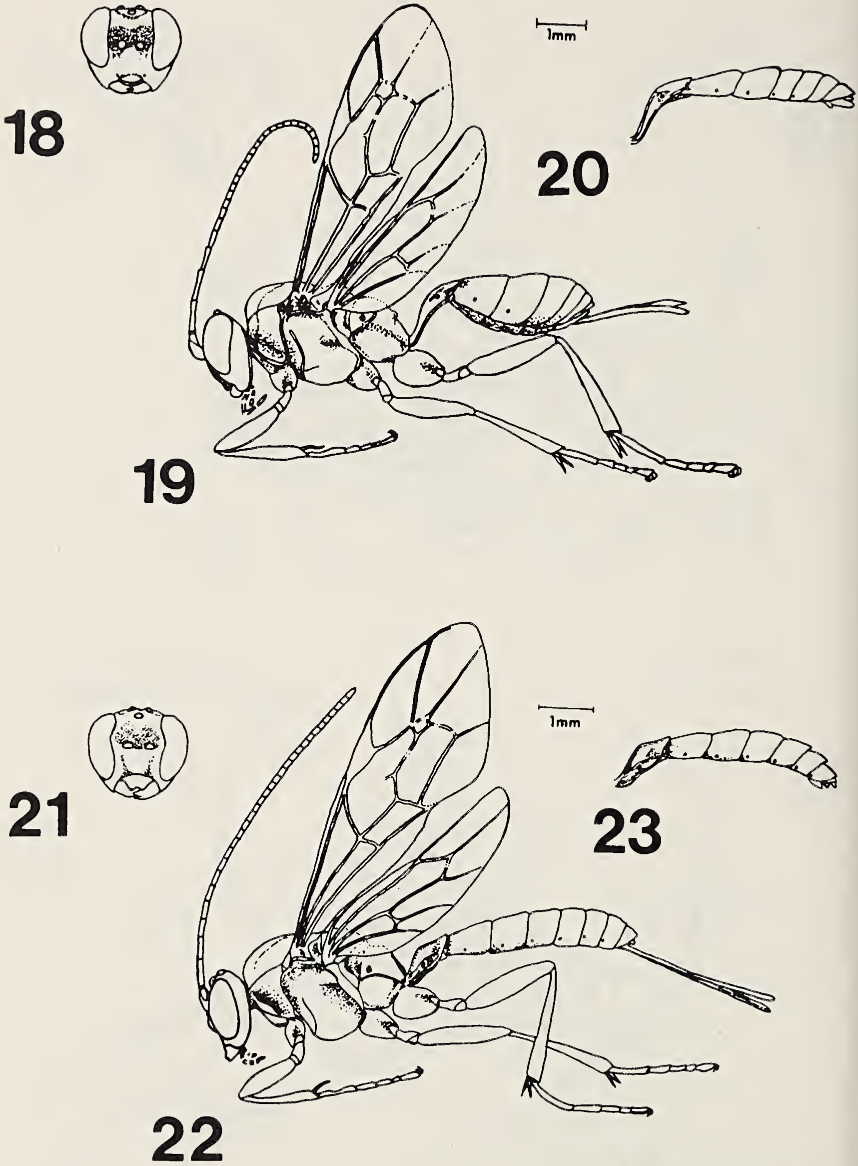
Figures 1-6. Adult hymenopterous parasitoids of *N. sertifer.* 1-3, *Exenterus amictorius;* 1, head capsule, frontal view; 2, female, lateral view; 3, male abdomen, lateral view. 4-6, *Exenterus nigrifrons;* 4, head capsule, frontal view; 5, female, lateral view; 6, male abdomen, lateral view. Courtesy of J.W. Mertins, U. W.-Madison.



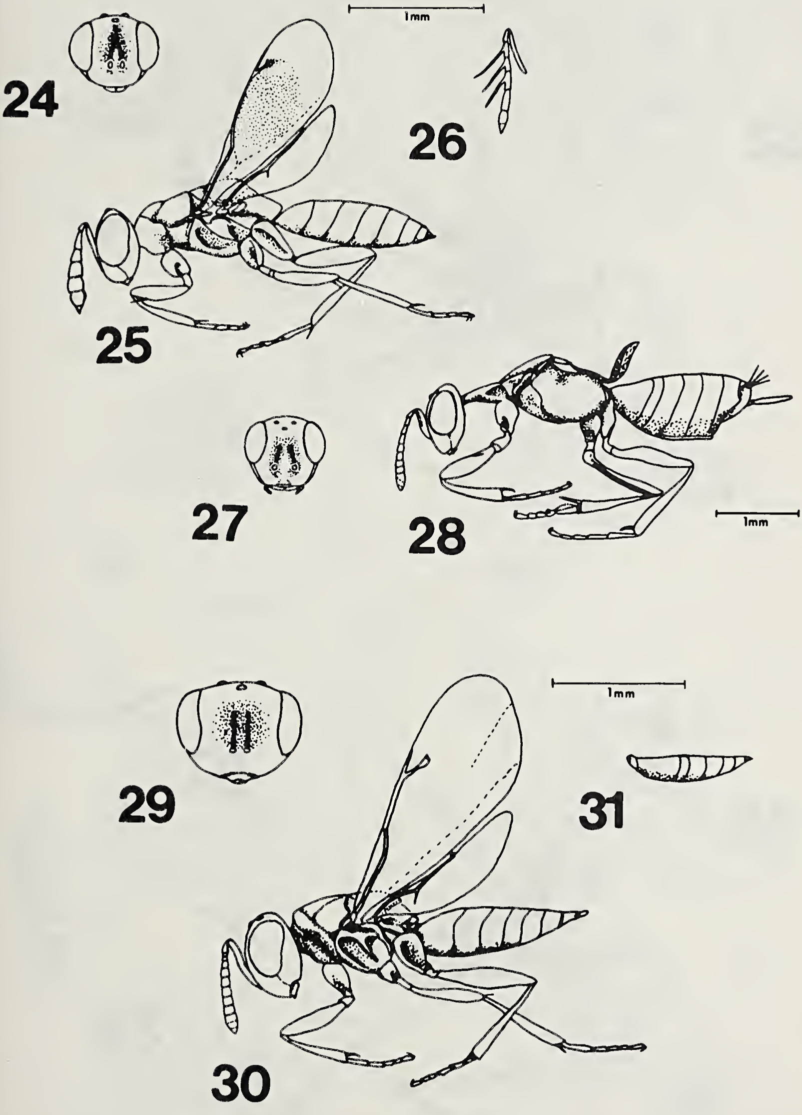
Figures 7-11. Adult hymenopterous parasitoids of *N. sertifer.* 7-9, *Pleolophus basizonus;* 7, head capsule, frontal view; 8, female, lateral view; 9, male abdomen, lateral view. 10, 11, *Pleolophus indistincta;* 10, head capsule, frontal view; 11, female, lateral view. Redrawn from Townes (1969).



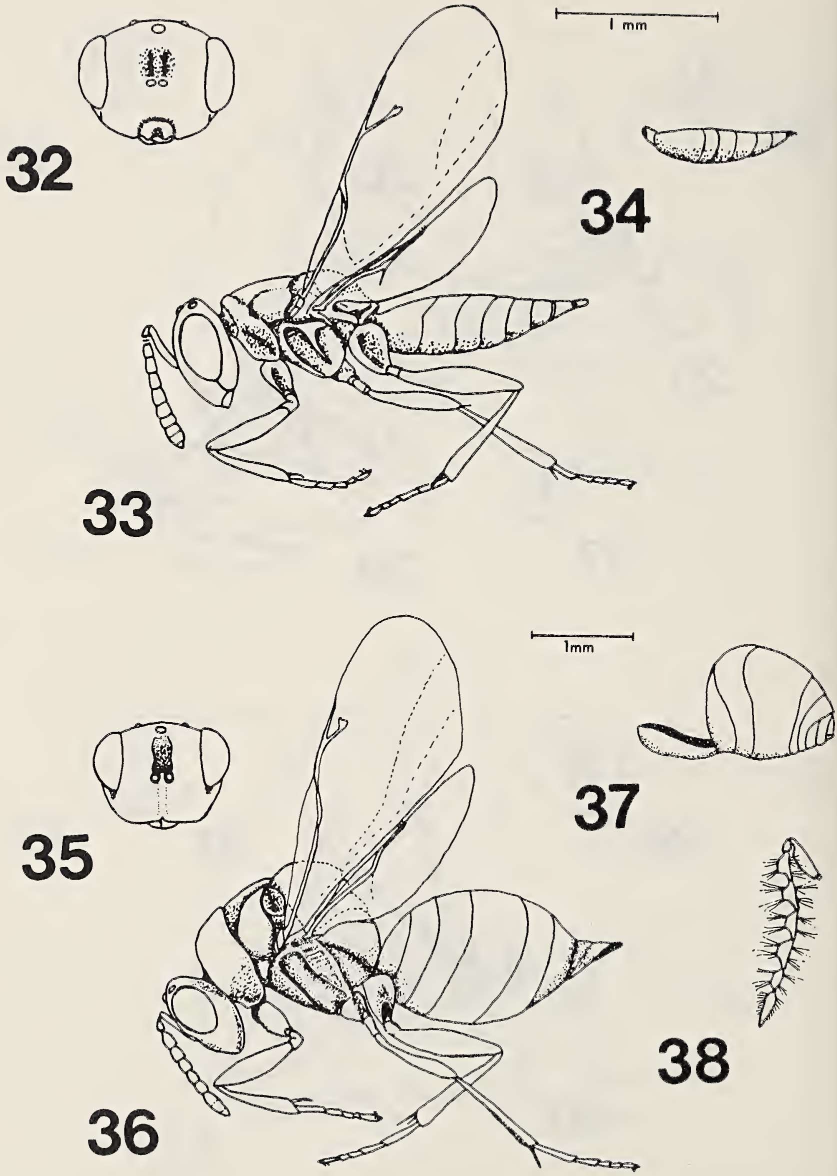
Figures 12-17. Adult hymenopterous parasitoids of *N. sertifer*. 12-14, *Endasys subclavatus;* 12, head capsule, frontal view; 13, female lateral view, 14, male abdomen, lateral view. 15-17, *Mastrus aciculatus;* 15, head capsule, frontal view; 16, female, lateral view; 17, male abdomen, lateral view. Redrawn from Townes (1969).



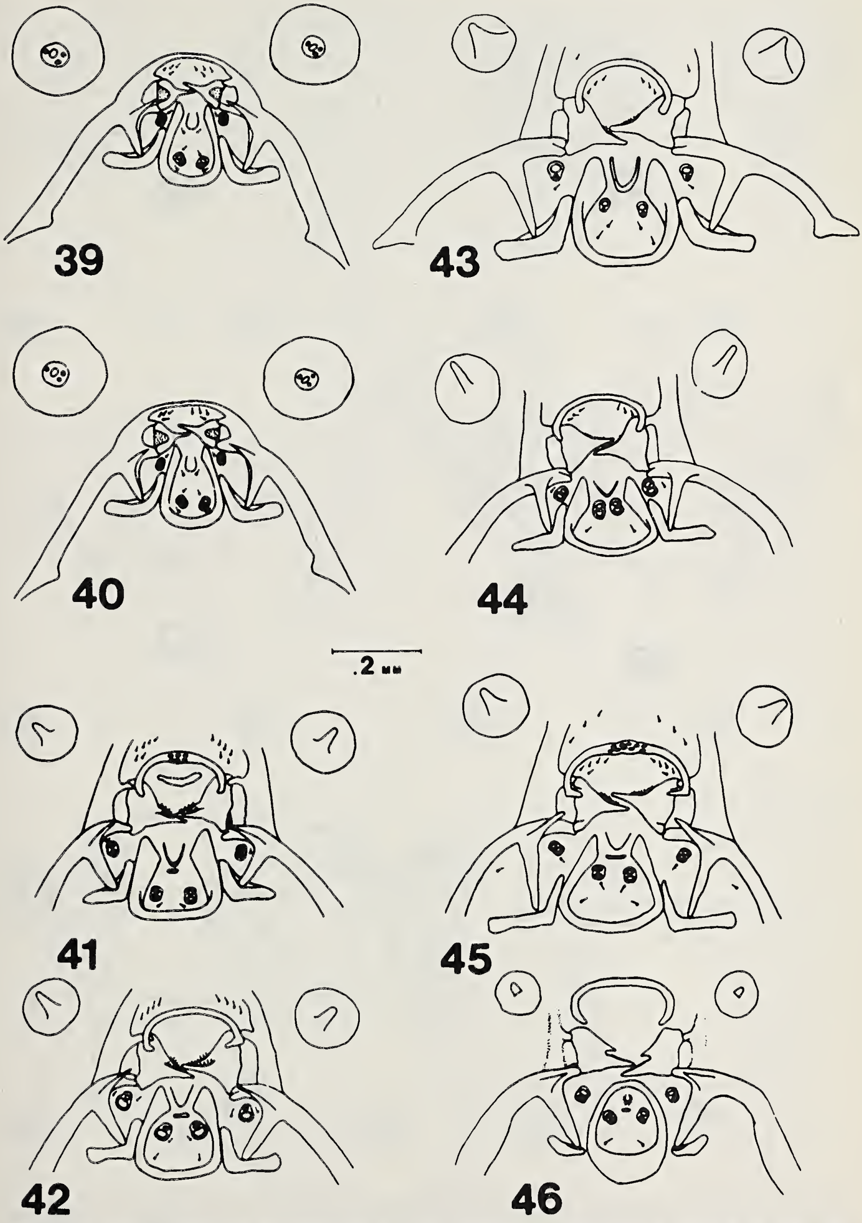
Figures 18-23. Adult hymenopterous parasitoids of *N. sertifer.* 18-20, *Agrothereutes lophyri;* 18, head capsule, frontal view; 19, female, lateral view; 20 male abdomen, lateral view. 21-23, *Delomerista japonica diprionis;* 21, head capsule, frontal view; 22, female, lateral view; 23 male abdomen, lateral view. Courtesy of J. W. Mertins, U.W.-Madison.



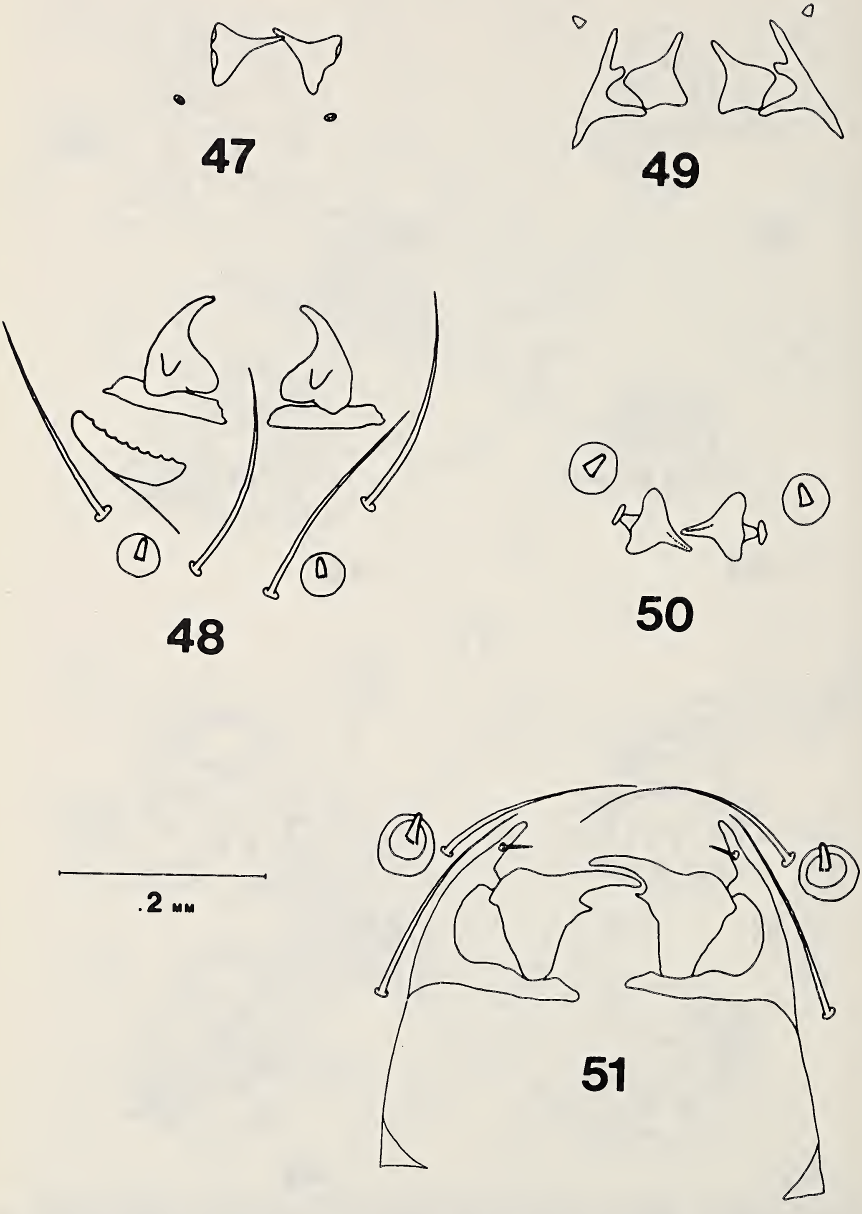
Figures 24-31. Adult hymenopterous parasitoids of *N. sertifer*. 24-26, *Dahlbominus fuscipennis;* 24, head capsule, frontal view; 25, female, lateral view; 26, male antenna, lateral view. 27-28, *Eupelmella vesicularis;* 27, head capsule, frontal view; 28, female, lateral view. 29-31, *Dibrachys cavus;* 29, head capsule, frontal view; 30, female, lateral view; 31, male abdomen, lateral view. Courtesy of J.W. Mertins, U.W.-Madison.



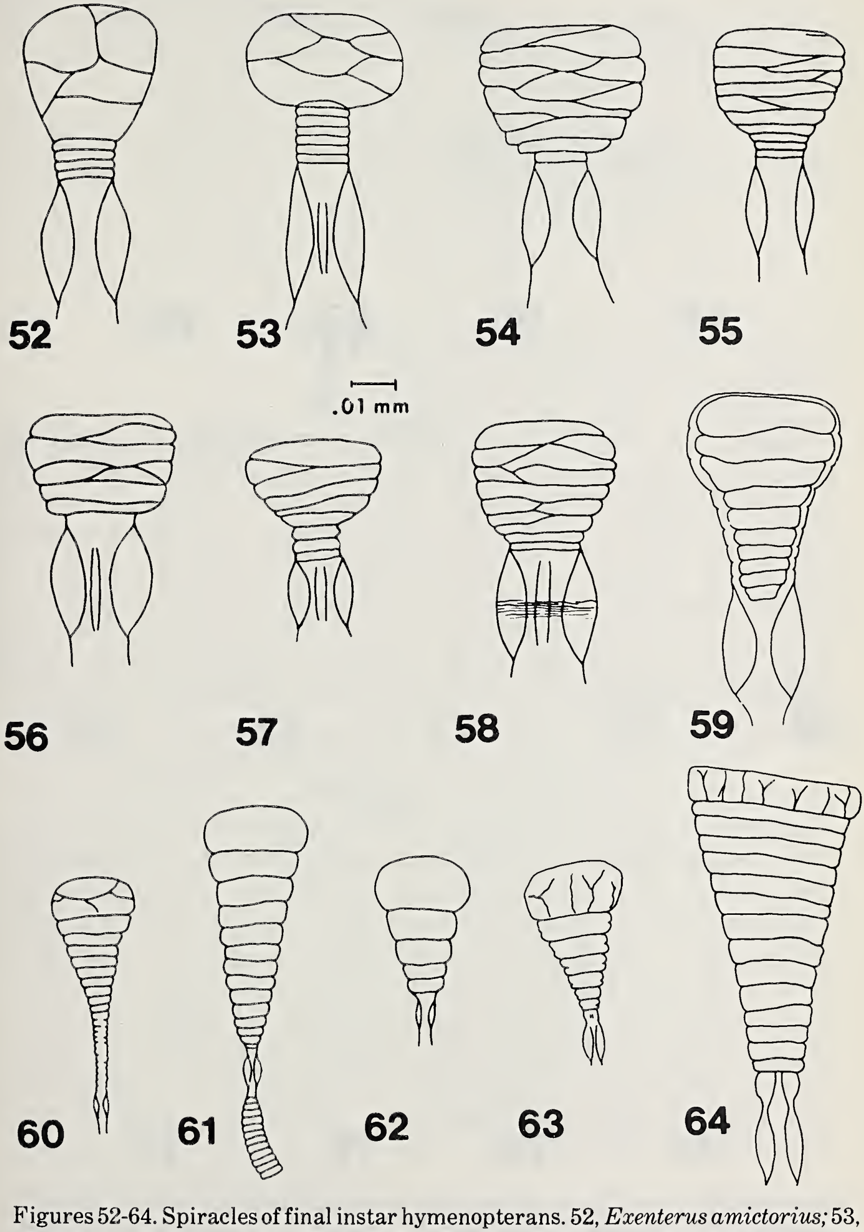
Figures 32-38. Adult hymenopterous parasitoids of *N. sertifer*. 32-34, *Habrocytus thyridopterigis;* 32, head capsule, frontal view; 33, female, lateral view; 34, male abdomen, lateral view. 35-38, *Eurytoma pini;* 35, head capsule, frontal view; 36, female, lateral view; 37, male abdomen, lateral view; 38, male antenna, lateral view. Courtesy of J. W. Mertins, U.W.-Mádison.



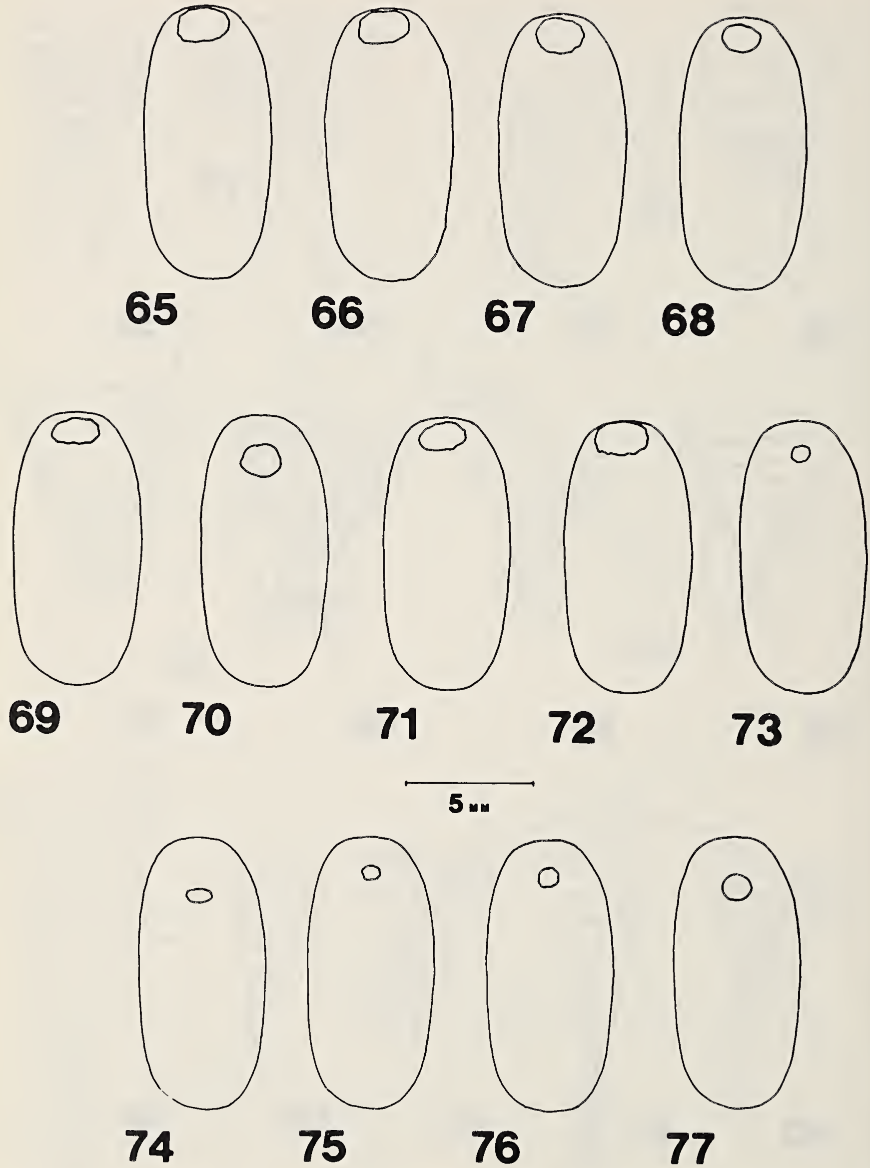
Figures 39-46. Cephalic structures of final instar ichneumonids; frontal views. 39, *Exenterus amictorius;* 40, *Exenterus nigrifrons;* 41, *Pleolophus basizonus;* 42, *Pleolophus indistincta;* 43, *Endasys subclavatus;* 44, *Mastrus aciculatus;* 45, *Agrothereutes lophyri;* 46, *Delomerista japonica diprionis.*



Figures 47-51. Cephalic structures of final instar chalcidoids; frontal views. 47, *Dahlbominus fuscipennis;* 48, *Eupelmella vesicularis;* 49, *Dibrachys cavus;* 50, *Habrocytus thyridopterigis;* 51, *Eurytoma pini.*



Figures 52-64. Spiracles of final instar hymenopterans. 52, *Exenterus amictorius;* 53, *Exenterus nigrifrons;* 54, *Pleolophus basizonus;* 55, *Pleolophus indistincta;* 56, *Endasys subclavatus;* 57, *Mastrus aciculatus;* 58, *Agrothereutes lophyri;* 59, *Delomerista japonica diprionis;* 60, *Dahlbominus fuscipennis;* 61, *Eupelmella vesicularis;* 62, *Dibrachys cavus;* 63, *Habrocytus thyridopterigis;* 64, *Eurytoma pini.*



Figures 65-77. *N. sertifer cocoons* showing parasitoid emergence holes. 65, *Exenterus amictorius;* 66, *Exenterus nigrifrons;* 67, *Pleolophus basizonus;* 68, *Pleophus indistincta;* 69, *Endasys subclavatus* 70, *Mastrus aciculatus;* 71, *Agrothereutes lophyri;* 72, *Delomerista japonica diprionis;* 73, *Dahlbominus fuscipennis;* 74, *Eupelmella vesicularis;* 75, *Dibrachys cavus;* 76, *Habrocytus thyridopterigis;* 77, *Eurytoma pini.*

THE ETHNIC IMPACT OF WILSON'S WAR: THE GERMAN-AMERICAN IN MARATHON COUNTY, 1912-1916

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This paper explores the impact of ethnic background on the political attitudes and voter behavior of Marathon County's German-Americans during the early years of World War I. Long before the outbreak of the European conflict, the German presence in the county had been well-established as German-Americans became the dominant local ethnic group. Marathon County was settled largely by peasants from the agricultural districts of northeast Germany. The heart of this settlement was to be found in the townships of Hamburg, Berlin, Maine, Stettin, Cassel, Marathon, Wien, Wausau, and Rib Falls. For example two of the most heavily German townships in the state of Wisconsin, Hamburg and Berlin, were over 90 per cent German and overwhelmingly Democratic in political preferences.[1]

It is impossible to overestimate the significance of ethnicity in explaining voter behavior in Wisconsin at the turn of the century. While recent studies note that native-born Americans enjoyed great influence and the lion's share of participatory roles in local and regional politics, it is also clear that voter preferences were strongly influenced by religious and nationality background. In Marathon County, this meant that the strongest Democratic areas were those in which a majority of family heads or their parents had been born in Germany, Poland, or Bohemia. This trend replicated statewide voting patterns: "the basis of voting support for the Democratic Party in all sections of the state came from both Catholic and Protestant Germans and from other predominantly Catholic and often 'new' immigrant groups."[2]

Consistent with this pattern, German-American strongholds in Marathon County continued to reward an essentially conservative Wisconsin Democratic Party with their votes during the early La

Follette years. The remarkable fact was not shrinking Democratic margins, but rather the stubborn dissent of a robust minority in the face of the statewide Progressive tide. Thus, German-American reservations over Progressive reform, particularly on the explosive "social issues," prevented the creation of a strong and permanent Progressive organization that might have replaced the dominant Stalwart Republicans in Marathon County. And the resurgence of the Democratic Party after 1910 was a predictable and significant political development.

The Roosevelt revolt of 1912 and the attendant disruption of the national Republican Party gave the Democrats their golden opportunity in the Presidential election of that year. Due to the chaos on the Republican side, Wisconsin Democrats viewed the prospects for both state and national offices optimistically. Progressive Democrats rallied behind the candidacy of the New Jersey insurgent, Woodrow Wilson; but true to form, Marathon County preferred the more conservative candidate, Champ Clark of Missouri. While Wilson won the Wisconsin primary handily, Marathon County, chose Clark by a 250 vote margin.[3] However, in the general election the county cast its lot with the victorious Wilson, although the tally documents Republican disunity as much as Democratic recovery. The swing to Wilson also reflected his generally positive image in the German-American press, which reminded readers that the Democratic candidate opposed prohibition and favored humane treatment of immigrants, positions which counted heavily in Marathon County. Of equal significance was a little-noted footnote to the 1912 campaign that held serious implications for future voter trends in the county. Brushed aside were the 600 votes cast for Socialist Eugene Debs, whose strong showing in Wausau's heavily German Eighth Ward was a harbinger of things to come.[4]

The link between ethnic background and protest voting was destined to become a prominent characteristic of Wisconsin voters, as wartime pressure on German-Americans escalated. Prejudice against the war ran deep, and the eventual American involvement was greeted with bitter opposition. Many Marathon County citizens resented "the suspicion with which they were often regarded, their enforced registration as alien enemies, and the hatred suddenly poured upon their most harmless and cherished institutions."[5]

The German-American revulsion at the thought of hostilities with the fatherland weighed heavy on the mind of the Secretary of State

William Jennings Bryan when he stumped for the Democratic ticket in Wausau during the campaign of 1914. Doubtless aware of the German vote in the county, the "Great Commoner" dwelt upon Wilson's commitment to a policy of strict neutrality, which would allow the United States eventually to act as mediator. He linked a vote for Democrats Paul Husting, A. C. Schmidt, and John C. Karel with loyalty to the President and all he stood for, including peace.[6]

Fortunately for Husting, the campaign of 1914 coincided with heavy Progressive infighting, which ended in the elevation of the conservative Republican Emanuel Philipp, to the governorship. In the senatorial contest, the La Follette organization refused to support rival Progressive Francis McGovern in November, Enjoying the tacit cooperation of "Fighting Bob," the Democratic aspirant earned a ticket to Washington and an opportunity to vindicate his president. In Marathon County Husting easily outdistanced the divided opposition in another good year for local Democrats. The victor was blissfully unaware of the complex problems he would soon face as Woodrow Wilson's supporter, when the administration's foreign policy came under attack from the county's substantial German community.[7]

And influential it was. As the European horror deepened, the militant German-American Alliance swung into action with a vigorous campaign opposing the extension of loans by local banks to foreign governments. After the Wilson Administration's decision to allow American loans to the belligerents, the Marathon County Bankers' Association declared its determination to avoid such transactions. The bankers, doubtless aware of the Wausau Alliance's open threat of a boycott against institutions participating in foreign loans, committed themselves to a policy of expending investment capital on home business and agriculture. On the very day that a New York banking group completed negotiations for the first major American loan to the allies, the Alliance warmly commended the county's banks for their vision in taking a stand "in accordance with [its] principles" and graciously described them as "entitled to public confidence and support."[8]

Evidence of the organization's influence surfaced in December, 1915, when Wausau played host to C. J. Hexamer, president of the national Alliance. At a meeting of his countrymen which filled the Opera House to capacity, Dr. Hexamer condemned "disgraceful truckling to Great Britain" in American economic and foreign policy. Denouncing as "incredible" the pro-British press that "dare

[d] to question the loyalty of the German-American," he exhorted his enthusiastic audience to stand for its ideals. Democratic leaders John Ringle and Judge Louis Marchetti participated in the program, the latter promoting the German Relief Fund already raising monies in the county. The Judge's comments clearly indicated the generosity of Marathon County citizens towards their homeland.[9]

So influential was the Alliance that Frank Leuschen, prominent Wilson supporter and editor of the *Marathon Times*, charged it with responsibility for the vituperative attacks on the administration in the German press. Especially vicious after the sinking of the Lusitania, these criticisms were traced to the insidious machinations of the German National Alliance in New York. To Leuschen, one thing was certain: his "German friends . . . most bitter in their denunciations and clamor against Wilson" were members of the organization.[10]

The escalation of German-American criticism came to public attention in May, 1915, after Senator Husting published an impassioned defense of the administration's foreign policy in the *Milwaukee Journal*. The popular Democrat's statement stressed strict adherence to America's rights under international law and Wilson's impartiality in dealing with violations of neutral rights. Seizing the initiative, he charged the critics with "base and cruel slander on the President," and castigated American citizens who promoted "foreign propaganda which [had] for its object and end the plunging of this country into war with one side or the other."[11]

The Senator's ideas did not go down well everywhere. Already a division of opinion on Wilson's policies was emerging in Marathon County, particularly in response to his insistence upon maximum economic freedom in the allied market. Reservations were expressed in early 1915, with a petition drive spearheaded by M. Gillmann of Marathon City in support of House Resolution 377, designed to halt the export of war supplies to the European belligerents. Treading a narrow line as a Democratic editor in a German community, Leuschen "cheerfully" complied with Gillmann's request that he publish the memorial in the *Times* though he personally saw little value in an embargo. Faced with a German readership, the Marathon journalist kept to a cautious course. While he stood firm with Wilson on neutral rights, he acknowledged that it was "foolish to talk about being neutral as far as our heart is concerned." All the same, as good American citizens his readers were obligated to control these national feelings" and resist the temptation "to say or do anything radical in this hour of trial." But after issuing instructions in moderation, Leuschen ignored his own advice and played to his audience. The editor now expressed his conviction that "as for Germany . . . rest assured that they will not be crushed in this struggle; for God will not permit this nation of thinkers and scientists, of art, culture and education to be annihilated."[12] Wilson supporters in German areas were clearly in a delicate position.

Leuschen's anxieties were temporarily relieved by Senator Husting's articulate expression of the administration's position, "an explanation of our Wilson neutrality" that the Marathon Democrat welcomed as "the best thing" he had read since the "damnable war began." He fervently hoped that all German-Americans would read it as antidote to some of the propaganda then circulating. This concern was political: the hostility of German-Americans was a threat to the future of the President's party in Marathon County, where "at Wausau and in every other village and town," the feeling against the administration was "something terrible."[13]

Sympathy for Senator Husting's stand also emerged in other county communities such as Athens, where J. I. Scott of the *Record* endorsed it as a "rebuke to our Wisconsin 'Copperhead' patriotism that has long been needed." Nonetheless, it was the cooperation of the *Marathon Times* that intrigued the junior senator from Wisconsin, who sensed that Leuschen was a valuable political ally. Husting's faith in the "good judgement of our American citizens" led him to encourage the widespread dissemination of Leuschen's views, and even to contemplate a campaign aimed at the suspicious German-American community. Regarding his Marathon correspondent as an expert in such matters, he appealed for counsel on an effort to get his message before the German voter. Convinced of its political value, the *Times* editor in turn urged further distribution of the article "to show our German friends the *other* side of the question." For his part, the local Democratic leader pledged to do "all in my power here in my little community to hold our Democratic friends in line," laughing off his Republican neighbors, who "hate me heartily for it, because I am too much for them."[14]

True to his word, Leuschen wasted little time in promoting the Democratic cause. Picturing Wilson as trapped between conflicting pressure groups, the *Times* extolled the President's virtues as a force for sanity in a world gone mad. Fresh from a Wilson appearance in Milwaukee, Leuschen attacked the Republican press for its "tirades against Wilson." Signaling the dawn of a political year, he also reminded Marathon voters that the administration had brought widespread prosperity while preserving an honorable peace.[15]

So meshed with foreign policy was German-American politics by 1916 that any stability in the Wisconsin German vote was shattered in the presidential election. Sympathy for Republican Charles Evans Hughes was connected with an unwillingness to forgive Wilson's belligerence simply because he had avoided war. When the votes were tallied in November, the effect of ethnicity was striking. While Wilson lost the Badger State by a margin of 42-49 per cent, Marathon County voters deserted the President in droves—a dramatic turnabout from his 1912 success. Hughes' edge of 57-36 per cent may be directly attributed to massive defections in Democratic wards and towns, most notably in German areas. While Wilson had carried nineteen of twenty-five German townships in 1912, twenty-two of those towns went Republican in 1916.[16]

Contrary to the voting pattern in German strongholds, another trend emerged in townships dominated by other customarily Democratic ethnic groups. Areas dominated by recent immigrant stock (particularly the Polish and Bohemians in Mosinee, Pike Lake, and to an extent, Cassel), held firm for Wilson in accordance with traditional voter preferences. And the Irish enclave in Emmet delivered a comfortable plurality for the beleaguered President, though his 1916 margin was more modest than that recorded in 1912. Thus, ethnicity was a two-edged sword in Wilson's re-election effort, and the foreign policy issue was a negligible factor in non-German areas.[17]

The widespread desertion of the Democratic presidential candidate suggests that German-American voters reversed their political loyalties as the United States inched its way closer to war with the fatherland. As this brief investigation has demonstrated, Marathon County Germans had come to believe that the President had abandoned the course of perfect neutrality in the period from 1914 to 1916. Hence, it was predictable that once America became an active belligerent in April, 1917, his former supporters would have little difficulty in perceiving the conflict as "Wilson's war."[18]

The attribution of this political revolution to ethnicity must be qualified, however, in the absence of a more scientific examination of the voter trends. A systematic model for the analysis of the data would require a consideration of such variables as income level, taxable property, recency of in-migration, and religious preferences. Such a sophisticated study offers a potentially fruitful area of inquiry for future investigations.

Despite this caveat, these tentative conclusions are supported by events in the wake of World War I. Not only would German-American voters express their hostility to an increasingly oppressive establishment in a wave of Socialist protest votes between 1918 and 1920, but the surprising conversion of many to the cause of La Follette Progressivism after 1920 would stand as evidence of lingering resentments harbored by Marathon County's most influential ethnic minority. The foreign policy crisis of the Wilson years cast a long shadow over the politics of the postwar era.

[1]Roger Wyman, "Voting Behavior in the Progressive Era: Wisconsin As a Test Case," (Ph. D. dissertation, Dept. of History, University of Wisconsin, 1970), p. 513; Harold E. Miner, et al., *History of Wausau* (Wausau: Centennial Project, 1939), p. 30. For full discussion of the source and nature of German immigration in Wisconsin, see Kate Everest Levi, "Geographical Origins of German Immigration to Wisconsin," in *Wisconsin Historical Collections*, Vol. XIV, and Albert Bernhart Faust, *The German Element in the United States*, Vol. I (Milwaukee, Steuben Society, 1927). The following table summarizes the national origins of the foreign born in Marathon County at various periods in the twentieth century.

Foreign-Born in Marathon County, 1870-1940

Source: *United States Census*, IX-XIX; 1870-1940.

	German	Polish	Norwegian	Bohemian	English	Native American
1870	2239	—	73	—	49	—
1880	4387	—	367	—	123	—
1900	8712	1064	420	369	93	—
1910	8807	—	471	—	70	26
1920	5794	1673	393	414	84	45
1930	4477	1555	302	403	54	37
1940	3017	1059	206	214	43	—

[2]Wyman, p. 386.

[3]*The Primary Election of 1910 and the Presidential Primary of 1912,* (Madison: Industrial Commission of Wisconsin, 1912), pp. 20, 152-153; see also Herbert Marguiles, *The Decline of the Progressive Movement in Wisconsin, 1890-1920* (Madison: State Historical Society of Wisconsin, 1968), pp. 126-128; Louis Marchetti, *History of Marathon County* (Chicago: Richmond-Arnold Co., 1913), p. 218. Primary returns clearly indicate that Clark owed his Marathon County victory to a 400 vote margin amassed in the city of Wausau, where he had appeared in a "non-political" capacity in 1911. *The Primary Election of 1910 and the Presidential Primary of 1912,* pp. 152-153; Wausau *Pilot,* March 14, 1911, p. 1; Wausau, *Record-Herald,* March 21, 1911, p. 1.

[4]The eighth ward was over 70 per cent German in 1912. Wyman, *op. cit.*, p. 571.

[5]Miner, p. 146; for full treatment of public opinion and war propaganda during the war, see Karen Falk, "Public Opinion in Wisconsin During World War I," *Wisconsin Magazine of History,* XXV (June, 1942), pp. 389-407; see also Falk, "War Propaganda in Wisconsin 1917-1918," (Master's Thesis, Dept. of History, University of Wisconsin, 1941).

[6]Over 3000 were in attendance while another 3000 were turned away from the Opera House event, which proved to be baldly partisan in character. *Pilot,* Nov. 3, 1914, p. 5.

[7]*Wisconsin Blue Book,* (Madison: 1915), p. 228; Marguiles, pp. 121-122. For discussion of the Progressive agony of 1914, see Robert Nesbit, *Wisconsin: A History* (Madison: University of Wisconsin Press, 1973), pp. 430-432.

[8]*Marathon Times,* Oct. 1, 1915, p. 1.

[9]By December, 1915 over $1300 had been raised by the Wausau Alliance and forwarded to the national relief fund for use in Germany, *Record-Herald,* Dec. 6, 1915, pp. 1, 4.

[10]Frank Leuschen to Paul Husting, May 29, 1915, Paul Husting Manuscripts, Madison, Wisconsin State Historical Society.

[11]*Milwaukee Journal,* May 16, 1915, pp. 1, 3.

[12]After this purple passage, Leuschen concluded that his readers should be "Americans first, and everything else afterwards." *Marathon Times,* Feb. 19, 1915, p. 1; Jan. 8, 1915, p. 1.

[13]Leuschen to Husting, May 24, 1915, Husting MSS.

[14]Leuschen complied with the Senator's request by publishing liberal excerpts from the *Milwaukee Journal* article. He also gave Husting detailed instructions on how to reach the local press and referred him to potentially sympathetic journalists, including E. B. Thayer of the Wausau *Pilot*, and A. Pankow of Marshfield. Leuschen to Husting, May 29, 1915; Husting to Leuschen, May 22, 1915; J. I. Scott to Husting, May 18, 1915; Husting to Leuschen, May 27, 1915, Husting MSS.

[15]*Marathon Times*, Feb. 8, 1916, p. 1; Jan. 21, 1916, p. 1.

[16]The following table illustrates the scope of defection in selected German localities:

VOTE PLURALITIES IN SELECTED GERMAN AREAS—PRESIDENTIAL ELECTIONS OF 1912 AND 1916

	1912	1916
Hamburg	Wilson-38	Hughes-118
Berlin	Wilson-91	Hughes-108
Maine	Wilson-86	Hughes-76
Stettin	Wilson-59	Hughes-43
Wausau	Wilson-14	Hughes-63
Rib Falls	Wilson-34	Hughes-99
Wausau		
Ward 6	Wilson-44	Hughes-43
Ward 7	Wilson-59	Hughes-123
Ward 8	Wilson-34	Hughes-103
Ward 9	Wilson-1	Hughes-81

Source—*Wisconsin Blue Book*, 1913, pp. 192-193; 1917, p. 216.

It should be noted that 1912 pluralities reflect the impact of the Roosevelt candidacy. However, in the townships cited, the Progressive garnered only 75 votes; while in the Wausau wards, his 265 votes were largely offset by 223 cast for Socialist Eugene Debs. Further comment on the ethnic factor in both Wilson elections may be found in Marguiles, p. 189, Wyman, 563; and Nesbit, pp. 444-445.

[17]*Ibid.*

[18]For full discussion of the permanent impact of the wartime experience on German-American political preferences, see Howard R. Klueter and James J. Lorence, *Woodlot and Ballot Box: Marathon County in the Twentieth Century* (Wausau: Marathon County Historical Society, 1977), Chapters VI, VII.

APPENDIX: German-American Voter Preferences In Marathon County, Wisconsin, 1912-1916 [a] [b]

Township	Plurality of Winner (1912)	Plurality of Winner (1916)	Wilson - Percent of Total Vote Cast (1912)	Winner's Percent of Total Vote Cast	c
Bern	W[d]—23	H—42	W—65%	H—78%	xx
Halsey	W—19	H—12	W—55.7%	H—67.9%	xx
Hamburg	W—38	H—118	W—56%	H—89.8%	xx
Berlin	W—91	H—108	W—75%	H—79%	xx
Maine	W—88	H—76	W—68.8%	H—67.9%	xx
Texas	W—2	H—86	W—34%	H—74%	xx
Hewitt	T—23	H—48	W—23%	H—86.8%	x
Harrison	W—2	W—2	W—38.8%	H—46.9%	x
Holton	T—10	H—122	W—34%	H—78%	xx
Johnson	W—13	H—56	W—44.5%	H—64%	x
Rib Falls	W—34	H—99	W—57.6%	H—75%	xx
Stettin	W—59	H—43	W—59%	H—61.7%	xx
Wausau	W—14	H—63	W—43.6%	H—65.9%	xx
Easton	W—24	H—63	W—45%	H—72.9%	x
Plover	T—13	H—30	W—18%	H—60.9%	x
Hull	W—62	H—1	W—62%	H—50%	x
Frankfort	W—7	H—61	W—43.9%	H—73%	xx
Wien	W—5	H—84	W—48%	H—78.6%	xx
Cassel	W—59	W—46	W—64%	W—62%	x
Marathon	W—36	W—17	W—59.8%	W—55.9%	xx
Rib Mountain	W—7	H—26	W—34.8%	H—61%	x
Weston	T—11	H—19	W—34%	H—45%	xx
Ringle	W—1	W—1	W—41.5%	W—43%	x
Norrie	W—17	H—45	W—39%	H—64.5%	x
Brighton	W—24	H—57	W—51.6%	H—73.7%	x
Rietbrock	T—16	H—18	W—42%	H—56.6%	—
Mosinee	T—28	Tie	W—30%	Tie	—
Elderson	R—4	H—54	W—33.5%	H—67.7%	—
Frazen	T—15	H—13	W—17.6%	H—58%	
Eau Pleine	T—9	H—28	W—41%	H—58%	xx
Cleveland	W—30	H—37	W—52%	H—61%	xx
Emmet	W—56	W—42	W—64.7%	W—63.5%	x
Pine Lake	W—11	W—159	W—41%	W—88.5%	—
Kronenwetter	T—6	H—17	W—39.8%	H—54%	x
Spencer	W—10	H—41	W—43%	H—68%	x
McMillan	W—22	H—27	W—52%	H—59.8%	xx
Day	W—42	H—8	W—61.8%	H—52%	xx
Green Valley	—	H—24	W—	H—72.5%	xx
Bergen	T—31	H—19	W—30%	H—58%	xx
Knowlton	T—40	H—10	W—21.8%	H—52%	x
County Total	Wilson 1010	Hughes 2161	Wilson 44%	Hughes 57%	

[a] The identification of townships as German-American was made on the basis of the findings reported by D. G. Marshall, Department of Rural Sociology, University of Wisconsin, whose exhaustive study of the "Cultural Background of Wisconsin People (Nationality Background)" is available at the Wisconsin State Historical Society, Archives, Madison, Wisconsin. Marshall defined ethnic dominance in terms of the percentage of family heads of foreign background residing in a particular township. His figures for 1905, based upon census records, classify townships as heavily-influenced by an ethnic group in those cases in which 40 per cent or more of family heads could be identified with that group. The figures for 1938, on the other hand, reflect more impressionistic estimates made on the basis of interviews with county residents.

[b] Source—*Wisconsin Blue Book*, 1913, 1917.

[c] Townships marked (x) were German-dominated in 1905 but not in 1938. Those marked (xx) were German-dominated in both 1905 and 1938.

[d] Abbreviations: W—Wilson, T—Taft, H—Hughes.

[e] Pluralities reflect total county votes including results from incorporated places not shown on chart.

STRUGGLE, HUSBANDRY, SEARCH: THREE HUMANISTIC VIEWS OF LIFE AND LAND

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An American novelist, an American scientist of French birth, and a French priest and philosopher look at the land. One considers it from a regional point of view, another from a global perspective. The third offers a cosmic vision. I am referring to Willa Cather's *Death Comes for the Archbishop*, Reno Dubos's *A God Within* and Teilhard de Chardin's *Rebuilding the Earth.* Each presents a unique humanistic attitude toward the land and yet a remarkably complementary one.

One of Willa Cather's fundamental attitudes toward the land is developed at the very beginning of her famous novel *Death Comes for the Archbishop* (1927). A group of cardinals gather in Rome to discuss the American southwest territory. Drinking fine old wines and looking out over the Eternal City, they epitomize the sophisticated, Old World temperament and Old World view. To them the southwest territory is a huge expanse of land containing Mexican Catholics, some Indians, and more Protestant Whites than Catholics. It is a land to be civilized. These men speak from the experience of a European civilization that had rounded the hills of Italy, made England into a manicured countryside, divided Ireland into patches of green plots, and covered French hillsides with vineyards. Europe was a land dominated by the human in a happy blend between human need and sound ecological balance. The young French priest appointed Bishop of the territory of Santa Fe brings with him the idea that he must civilize the land and convert the people. In a sense, the building of his Romanesque church late in the story symbolizes the imposing of a European way of life on the American scene. As the young Bishop travels by horseback over his new diocese, he sees the landscape at times as vast Gothic structures:

> In all his travels the Bishop had seen no country like this. From the flat red sea of sand rose great rock mesas, generally gothic in outline, resembling vast cathedrals.[1]

Wherever he goes the Bishop plants fruit trees and encourages gardens. There is an apricot tree outside his office that gives him visual pleasure, delightfully refreshing fruit, and eventually we can presume, a brandy or liqueur. The Bishop and Brother Joseph helped introduce the *espalier* technique of carefully pruning and guiding branches of fruit trees along a trellis or wall, providing convenience and beauty. In a region where water is not plentiful and trees are not numerous, the land is made to yield of its bounty. Cultivation and order become synonymous:

> Some subterranean stream found an outlet here, was released from darkness. The result was grass and trees and flowers and human life: household order and hearths from which the smoke of burning pinon logs rose like incense to heaven.[2]

In many of her books Willa Cather stresses the struggle between humans and the environment. Claude Wheeler, the central character of *One of Ours,* contends with the elements to farm his midwestern land and, like the Bishop, to impose order on it. When he reaches France in World War 1, he is amazed and pleased by the beauty of the cultivated landscape soon to contrast with the desolate mud holes of the trenches. After the passage of many years, Antonia, the Bohemian immigrant in *My Antonia,* discusses with the narrator her happy family, her farm, and especially her orchards. Again, in *O Pioneers* we have the theme of struggle to impose order on a hostile environment, an order that a rampaging nature can wreck in moments. Wherever we read in Cather, there is respect for the land, a fondness for the manicured European countryside, a portrayal of the struggle to impose order on the land. The Bishop reflects also Willa Cather's tolerance for the different. On one of his numerous visits throughout his vast diocese, he travels with a young Navajo guide. The young Indian carefully leaves each campsite as it was found—there is no trace of human passage. He leaves the land in order.

> When they left the rock or tree or sand dune that had sheltered them for the night, the Navajo was careful to obliterate every trace of their temporary occupation. He buried the embers of the fire and the remnant of food, unpiled any stones he had piled together, filled up the holes he had scooped in the sand. Since this was exactly Jacinto's procedure, Father Latour judged that just as it

> was the white man's way to assert himself in any landscape, to change it, make it over a little (at least to leave some mark of memorial of his sojourn), it was the Indian's way to pass and leave no trace, like fish through the water, or birds through the air.[3]

Rene Dubos describes Europe as a work of art. Centuries of careful husbandry have produced cities of unique characteristics, landscapes of surprising variety, and architecture reflecting climate and locale. Like Willa Cather, he sees the human imposing a sense of order on the land that we might describe as a "humanized landscape." An eminent microbiologist, experimental pathologist, author, and winner of the 1969 Pulitzer Prize for *So Human an Animal,* he writes in an engaging manner from a broad humanistic base.

One of his major themes is that there must be a close and harmonious relationship between humans and the land. Each geographic area has unique characteristics just as each human has a genetic heritage. The harmonious interaction of both creates a sensible ecosystem. This idea is best presented in his development of the Franciscan *love* of nature and the Benedictine *husbandry* of nature.

Saint Francis of Assisi loved birds and flowers and animals. He preached respect for nature and God's marvelous creation (perhaps he was our first genuine hippie!) He believed in the universal brotherhood of all living things. But love is not enough, Dubos insists. Rather it should be love united with action. His model is the Benedictines who believed one should pray and also work— *Laborate et orate.* The early followers of Saint Benedict built on the hillsides. Later orders, such as the Cistercians, built in the valleys. They cleared forests and drained the swamps and thereby eliminated malaria and established rich agricultural areas. By their direct intervention and systematic husbandry, Dubos feels:

> They have brought about profound transformations of soil, water, fauna, and flora, but in such a wise manner that their management of nature has proved compatible in most cases with the maintenance of environmental quality.[4]

Wherever this concern for nature, for the land, has been missing, great civilizations have floundered. In the Middle East, we can still visit the ruins of Assyria and Babylon or the barren slopes of Lebanon's mountains deprived of the famous cedars. Dubos points out that wildlife has been severely reduced in modern Japan, and that central and northern China are barren.[5] Dubos believes that humans today, although advanced in technology, are straying from their instinctive and physiological roots. We were meant to be a part of the natural world, and to run, hunt, play, and live in unison with the seasons. We were meant to retain a certain sense of awe and wonder of the natural world. While technology has certainly benefited the human condition, it has alienated us from our natural environment.[6] (We are back to Rousseau.) So Dubos makes some positive recommendations.

First and foremost he recommends that we revitalize our great cities—and all our cities. London, Paris, New York, Tokyo are vital civilizing centers. They must remain to perform their traditional role. They must be protected from urban erosion. Around these centers of learning and culture there should be areas for human habitation. Another circle must be for farms and agricultural areas. The need to recreate being fundamental; Dubos recommends natural areas be provided for this purpose. Access from one to the other should be easy. In this manner man can satisfy basic needs. He feels strongly too that areas of wilderness should be provided to startle and delight the human imagination.[7] These rings would comprise a harmonious ecosystem respecting human needs and an environment capable of supporting and recreating all forms of life. Although these ideas are best articulated in *Only One Earth: The Care and Maintenance of a Small Planet*, they are very much a part of the texture of *So Human an Animal* and *A God Within*.[8]

Dubos's view is a global one. He speaks eloquently to all peoples in all parts of the world. A *God Within* ends with the bells of Easter Sunday ringing out with Dubos's commentary on the growth of mushrooms where once bombs had fallen.

The third and last author to be considered is Pierre Teilhard de Chardin—Jesuit, world-renowned, French-born paleontologist, co-discoverer in 1924 of Peking man. Although he is probably best known for *The Phenomenon of Man*, I will concentrate on *Building the Earth* in which the famous quotation appears: "The age of nations is past. The task before us now, if we would not perish, is to shake off our ancient prejudices, and to build the earth." He is not immediately concerned with the charm of rural settings, awe-inspiring landscapes, or depletion of ground-water. His concept of building the earth is a complex one. Chardin stresses the fact that all peoples must unite in a common effort to create a healthier moral climate for the whole planet. The provincial, chauvinistic, and nationalistic must yield to the global and the transcendent. However, this is not to say he is insensitive to aesthetic considerations or ecological problems. Rather his landscape is an inner human one, and his originality lies in a description of our spiritual odyssey through this new environment. Like Pascal, he begins with the infinitely small and goes to the infinitely great. His is a cosmic voyage and a cosmic vision. In a frightened age he speaks with hope about the future of humankind.

Chardin was fascinated by matter from early childhood. He collected pieces of metal and was upset when they began to rust. Early in his thinking he developed the idea that matter contains its own future evolutional development. Like a Japanese paper novelty of pre-World War II that on contact with water unfolds as a lovely plant or geometric pattern, so also does the evolutionary scheme. Evolution is a light, according to Chardin, illuminating all facts, a curve that all lines must follow. Central to this evolutionary thrust from alpha to omega, from God to God, is the human growing more and more complex, conscious of self, cerebral. People are reaching out more to one another politically, technologically, and spiritually. Eventually total union will come at the omega point. These ideas are fully developed in *The Phenomenon of Man* and implied throughout *Building the Earth.*

As humans move toward greater union aided by a growing and inexhaustible psychic energy, tangential energy decreases proportionately—such is the law of thermodynamics. In the culminating synthesis of evolution a universal consciousness will fuse at the omega point. In his conclusion of *Building the Earth,* Chardin emphasizes that:

> Tomorrow, a new "psyco-dynamics" will probably be of more use than our present electro — and thermo — dynamics.[9]

Human energy will replace nature's energy. To Chardin, then, the earth is a vehicle for humankind on its voyage to the infinite. At the point of greatest human perfection, the earth will have lost its energy resources and will disintegrate as a vehicle for human life. Is this a somber comment on the future of humankind or a realistic appraisal of our future by a man deeply concerned and totally committed?

From Egyptian mythology we learn that the god Ptah created order from primordial chaos and that the goddess Maat imposed moral standards and social harmony on the future inhabitants of the Nile fringes. Every great civilization has since wrestled with the questions of creation, order in the physical and moral world, and the purpose of life. In examining the attitudes of these writers toward the land, we learn that they have addressed themselves to these questions. Willa Cather sees life as a human struggle to impose order on a beautiful, but oftentimes hostile environment. Dubos feels the earth will take care of us if we in turn husband the earth. And finally Chardin believes we are searching for moral perfection in an orderly universe of diminishing energy. Struggle, husbandry, and search summarize their respective attitudes toward life and the land.

NOTATIONS

1. Willa Cather, *Death Comes for the Archbishop.* New York: A.A. Knopf, 1955, p. 44

2. *Ibid., p. 31*

3. *Ibid., p. 233*

4, Rene Dubos, *A God Within,* New York: Scribner, 1972, p. 169.

5. *Ibid., p. 161*

6. *Ibid.*, pp. 256-291, *passim,* chapter entitled "Arcadian Life Versus Faustian Civilization."

7. *Ibid.*, pp. 142-143

8. Rene Dubos and Barbara Ward, *Only One Earth: The Care and Maintenance of a Small Planet.* New York: W.W. Norton & Co., 1972. See pp. 78-115 "Man's Use and Abuse of the Land."

9. Teilhard de Chardin, *Building the Earth.* Wilkes-Barre, Pa.: Avon, 1965, p. 54

10. *Ibid.*, p. 111

SPRING AND SUMMER BIRDS OF THE PIGEON LAKE REGION

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Pigeon Lake is located at 46°21′N, 91°20′W, in Drummond Township of Bayfield County, Wisconsin. It is about 30 miles north of Hayward and is surrounded by the Chequamegon National Forest. The study area is located in a mixed hardwood-conifer forest, mainly second growth, with interspersed tilled land, pasture and abandoned fields. There are several streams, numerous small ponds and lakes, the latter generally oligotrophic or mesotrophic. In addition there are many bogs, some at lake edge, and a few cat-tail (*Typha*) communities. It is a lightly settled region, with approximately seven people per square mile.

A field station, currently run by cooperating campuses of the University of Wisconsin, has been in operation at Pigeon Lake since 1960. Observations during this period have resulted in the accumulation of information on the avifauna; primarily through field trips by ornithology classes. Several students (see bibliography) conducted nesting studies for extra credit, and the senior author studied nesting birds of the area in 1974 and 1975. These data are summarized here for use by future students and researchers.

The study area for this report (Fig. 1) is defined as a five mile radius from the field station. The nearest location for which there is published ornithological material is the Lake Owen region, approximately 2 miles east of the study area. Here Schorger (1925) listed 75 species observed July 3-10, 1920 and June 9-20, 1924, including breeding information on 25 of these. Jackson's (1941) paper covered the northwest quarter of the state; the closest he worked to this area was at Namekagon Lake, about 10 miles southwest of the station (9 days in May and June, 1919). Bernard's (1967) report on neighboring Douglas County is much more detailed; his list of woodland species is comparable to that of this study.

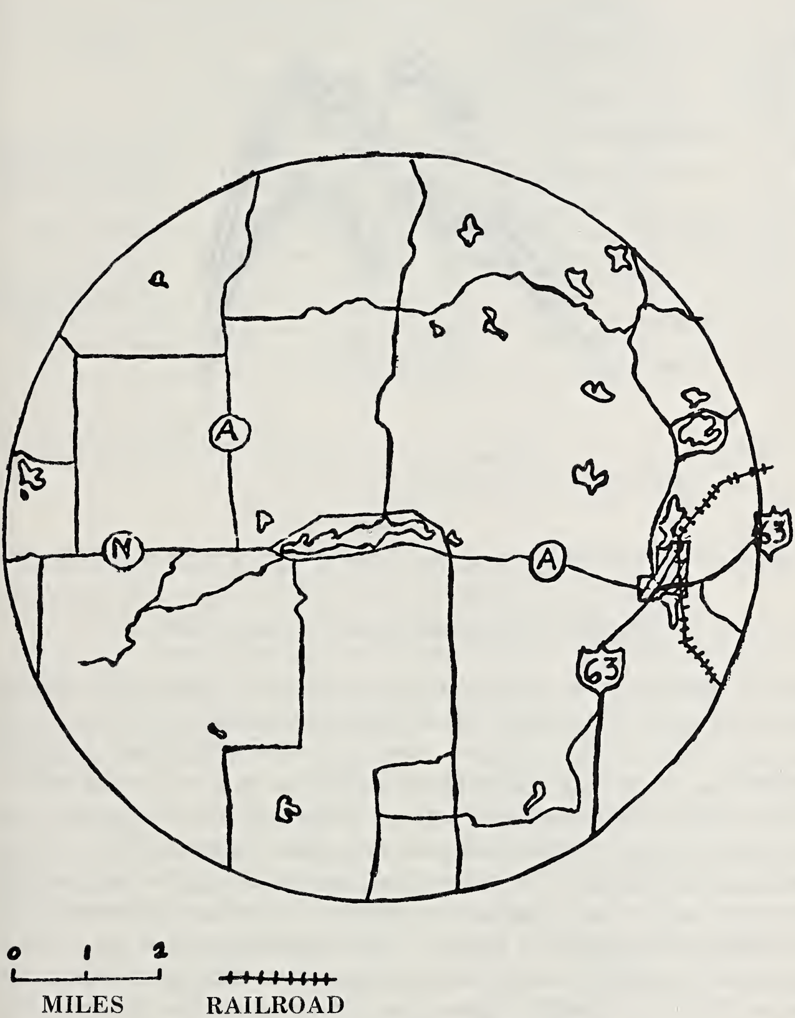

FIGURE 1. The Pigeon Lake Region

Breeding Information

Information on the progress of the breeding season and on nest success was gathered by Christopherson (1969), who observed 20 nests of 16 species; Gates (1973), 23 nests of 10 species; and Young's observations during 1974 and 1975 on 251 nests of 41 species. A total of 294 nests of 54 species were observed. A typical progression of the

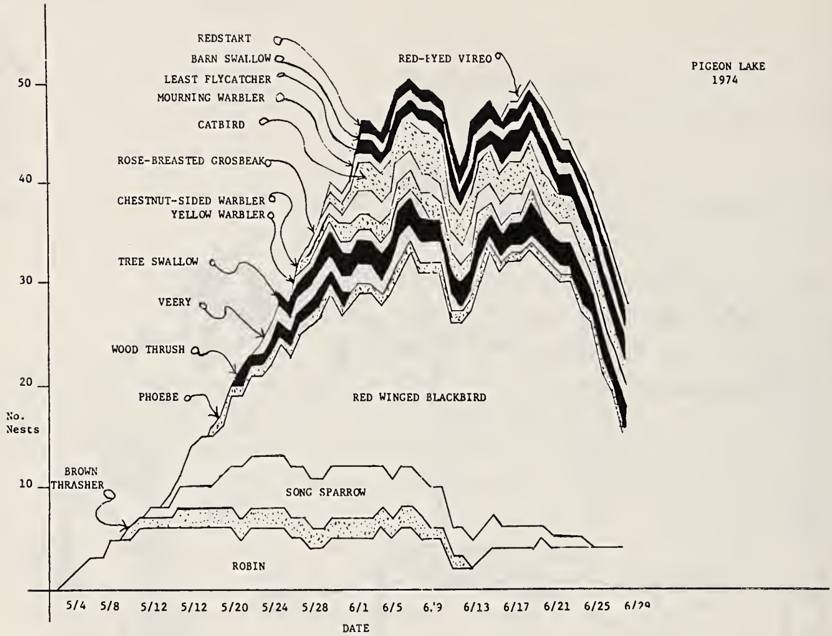

FIGURE 2. The Nesting Season at Pigeon Lake

nesting season as far as density increase and species involved is shown in Fig. 2. The abrupt termination is an artifact, reflecting the time that field studies stopped. Nest success data gathered in 1974 and 1975 are summarized in Table 1. These success ratios appear to be low when compared with other studies of mixed species. For example, Young (1949) found 47% successful nests and 40% of eggs producing fledglings. However, the only species for which a good sample of nests was obtained at Pigeon Lake was the Red-winged Blackbird. Data for the Pigeon Lake records on this species are compared in Table 2 with those gathered in 1959 and 1960 at La Crosse (Young, 1963). Here the success seems comparable,

TABLE 1 — PIGEON LAKE: NEST SUCCESS

	1974	1975	Totals or Averages
No. of Species	22	29	35
No. Active Nests	60	135	195
% Successful	32	33	33
% Eggs Producing Fledglings	29	23	25

TABLE 2 — NEST SUCCESS: RED-WINGED BLACKBIRD

	Active[a] Nests	% Suc-[b] cessful	Total Eggs	% Hatched	% Fledged	% Eggs Producing Fledglings
Pigeon Lake 1974	29	31	100	43	63	27
Pigeon Lake 1975	69	23	220	60	39	17
Total or Percent	98	26	320	55	46	20
Stoddard 1959	238	35	730	54	53	28
Stoddard 1960	280	24	902	45	40	18
Total or Percent	518	29	1632	49	46	23

[a]containing at least one egg
[b]fledging at least one young bird

suggesting that the low overall success at Pigeon Lake may be influenced by small sample size for numerous species.

It is of interest to note the latitudinal effect on breeding time when comparing studies made at Pigeon Lake with those made in southern Wisconsin. Table 3 shows the differential effect on early breeders (Robin, Red-winged Blackbird) and a relatively late breeder (Gray Catbird).

The Robin, which is the earliest breeder of the three, has a breeding season which runs from 3 weeks to a month behind that in southern Wisconsin. Robin breeding had essentially stopped when observations ended at Pigeon Lake on July 11, 1975. Nestling robins have been observed as late as August 18 at Madison (Young, 1955), so the northern breeding season is about 70 days shorter than the southern. Since the nestling cycle takes about 35 days, there is no time for a third brood, which is occasionally produced in the south, and there is lessened opportunity for re-nesting after failure.

The Red-winged Blackbird, which breeds somewhat later than the Robin, has a breeding season about 30 days shorter than that in the south.

In contrast, the Gray Catbird has essentially the same breeding season at Pigeon Lake and at Madison. By the time it arrives in the north, conditions are such that breeding can shortly occur.

With sufficient data it is probable that this varying pattern could be shown with numerous species.

TABLE 3 — CHRONOLOGY OF NESTING ACTIVITIES

A. *Start of Nest Construction*

	Earliest		Latest	
	South	Pigeon Lake	South	Pigeon Lake
Robin	4/2	5/4	7/14	6/14
Redwinged Blackbird	5/3	5/14	7/8	6/20
Gray Catbird	5/21	5/22	6/24	6/26

B. *First Egg*

	Earliest		Latest	
	South	Pigeon Lake	South	Pigeon Lake
Robin	4/10	5/12	7/6	6/21
Redwinged Blackbird	5/13	5/21	7/15	7/4
Gray Catbird	5/29	6/1	6/30	6/24

C. *First Nestling*

	South	Pigeon Lake
Robin	5/6	5/27
Redwinged Blackbird	5/27	6/5
Gray Catbird	6/14	6/13

Since quantitative data are lacking, designations such as common, scarce, etc., in the following sections are subjective. In general the terms used to indicate relative abundance can be interpreted as follows:

Abundant — usually recorded in good numbers on all trips
Common — often seen in substantial numbers
Fairly common — seen on approximately half of the trips
Occasional — erratic in appearance
Scarce — only a few individuals observed each season
Rare — less abundant than the preceding; only 1 or 2 records for the area.

Breeding status is based on the finding of active nests, or observations of adults with young. For other species, Gromme's (1963) breeding range maps and Barger, et al. (1960) were consulted. Where appropriate breeding ranges were found, these species were listed as assumed breeders, unless the study area did not have suitable habitat.

The following list contains 150 species recorded in the area, of which 58 are known breeders. It is probable that an additional 63 species breed within the study area, and 40 (25 possible breeders) species are included in a hypothetical list, since they probably occur at least occasionally in the area, but have not been observed.

GAVIIFORMES

[1]Common Loon (*Gavia immer*). Occasional on Pigeon Lake and Rust Flowage at Drummond. A nest with 2 eggs at Pigeon Lake (1973) was flooded out.

COLYMBIFORMES

[2]Pied-billed Grebe (*Podilymbus podiceps*). Scarce in immediate area; observed at Rust Flowage.

CICONIIFORMES

Great Blue Heron (*Ardea herodias*). No rookeries known within study area. Seldom seen on shore-line of Pigeon Lake, but individuals have been observed flying over area.

[2]Green Heron (*Butorides striatus*). Has been seen on Rust Flowage, Drummond Lake and Pigeon Lake; fairly common.

[2]American Bittern (*Botaurus lentiginosus*). As preceding.

ANSERIFORMES

Whistling Swan (*Olor columbianus*—A single bird on Pigeon Lake for one afternoon, June 8, 1978.

[1]Mallard (*Anas platyrhynchos*). A sparse breeder in the immediate area. In 1974 a nest near the shore of Pigeon Lake hatched nine young on June 14. A hen with a brood of six was seen on Pigeon Lake in the summer of 1975.

[1]Black Duck (*Anas rubripes*). Rare. A hen with a brood of seven, seen on a small lake 4½ miles north of the station (July 1971) is the only record.

[2]Blue-winged Teal (*Anas discors*). Seen only during migration.

[2]Wood Duck (*Aix sponsa*). Rare.

Ring-necked Duck (*Aythya collaris*). Rare, one observed on Pigeon Lake, May 1966.

Lesser Scaup (*Aythya affinis*). Rare, observed at Pigeon Lake in May 1965 and 1968.

[2]Hooded Merganser (*Lophodytes cucullatus*). One flying over Pigeon Lake, May 1974. Occasionally seen on ponds in the study area.

Common Merganser (*Mergus merganser*). Only record: several on Pigeon Lake, May 1966.

Red-breasted Merganser (*Mergus Serrator*). One seen at Drummond Lake, July 1968.

FALCONIFORMES

Turkey Vulture (*Cathartes aura*). Three records. A pair landed on the shore of Pigeon Lake in 1962. A single bird was present for several days in May 1975 and also in May 1978.

[2]Sharp-shinned Hawk (*Accipiter striatus*). One mist-netted at the field station, 1965. Probably common.

[2]Red-tailed Hawk (*Buteo jamaicensis*). Most frequently observed hunting in agricultural areas north of Pigeon Lake.

[2]Red-shouldered Hawk (*Buteo lineatus*). Rare, one over field station, May 1976.

[1]Broad-winged Hawk (*Buteo platypterus*). Definitely the most common hawk of the region. Nests have been found in the Drummond woods, and near the west end of Pigeon Lake. In the latter, two young hatched about June 18, 1975.

[1]Bald Eagle (*Haliaeetus leucocephalus*). A regular visitor to Pigeon Lake. Nests are within the study area (George Phillips, DNR Game Warden, Personal Communication 1975), but were not visited.

[1]Osprey (*Pandion haliaetus*). Fairly common. Nests are within study area (Phillips, Personal Communication, 1975) but were not visited.

[1]Kestrel (*Falco sparverius*). Common in more open areas, along roadsides and in brushy fields.

GALLIFORMES

[1]Ruffed Grouse (*Bonasa umbellus*). Common in wooded areas.

GRUIFORMES

[2]Virginia Rail (*Rallus limicola*). A single record from Pigeon Lake, June 1967, also heard at Lake Drummond, May 1978.

[1]Sora Rail (*Porzana carolina*). Uncommon, one nest on Pigeon Lake 1975.

CHARADRIIFORMES

[1]Killdeer (*Charadrius vociferus*). Common, most often sighted at Lake Drummond. Local young observed on several occasions.

Black-bellied Plover (*Pluvialis squatarola*). A single record from Lake Drummond, May 1973.

[1]American Woodcock (*Philohela minor*). Common; newly hatched young seen, 1975.

[2]Common Snipe (*Capella gallinago*). Fairly common; in marshy areas associated with lakes.

[1]Spotted Sandpiper (*Actitis macularia*). A few along shoreline of Pigeon Lake and Lake Drummond. Nest found at edge of Pigeon Lake, June 1966.

Solitary Sandpiper (*Tringa solitaria*). Occasional; transient birds seen at west end of Pigeon Lake, usually in August.

Dunlin (*Erolia alpina*). One bird at Lake Drummond, May, 1978.

Greater Yellowlegs (*Tringa melanoleucus*). A single record from Pigeon Lake, May 1967.

Semipalmated Sandpiper (*Calidris pusillus*). A few migrants found on the shore of Lake Drummond.

Ring-billed Gull (*Larus delawarensis*). A single record from Lake Drummond, May 1973.

[2]Black Tern (*Chlidonias niger*). Occasionally seen in marshy places.

COLUMBIFORMES

[1]Mourning Dove (*Zenaidura macroura*). Common.

CUCULIFORMES

[2]Black-billed Cuckoo (*Coccyzus erythropthalmus*). Fairly common, usually first appearing between May 15-20.

STRIGIFORMES

[2]Great Horned Owl (*Bubo virginianus*). Often heard calling in vicinity of Pigeon Lake.

[2]Barred Owl (*Strix varia*). Apparently more common than the preceding.

CAPRIMULGIFORMES

[2]Whip-poor-will (*Caprimulgus vociferus*). Common.

[2]Common Nighthawk (*Chordeiles minor*). Common.

APODIFORMES

[2]Chimney Swift (*Chaetura peligica*). The population is concentrated in the Drummond area.

[1]Ruby-throated Hummingbird (*Archilochus colubris*). A common summer resident. Nest found on station grounds, 1974.

CORACIIFORMES

[2]Belted Kingfisher (*Megaceryl alcyon*). A few pairs in the general region.

PICIFORMES

[1]Common Flicker (*Colaptes auratus*). Common, nest found on station grounds, summer 1975.

[2]Northern Pileated Woodpecker (*Dryocopus pileatus*). One bird at Lake Drummond, May 1978. Old workings are present near Pigeon Lake.

[2]Red-headed Woodpecker (*Melanerpes erythrocephalus*). Scarce.

[1]Yellow-bellied Sapsucker (*Sphyrapicus varius*). Most abundant woodpecker of the area, and a common breeder. Five nests were found in 1975. It is interesting to note that Schorger (1925) did not see this species at all.

[1]Hairy Woodpecker (*Dendrocopus villosus*). Although Jackson (1941) and Zirrer (1941) indicated this to be more abundant than the following, Young's (1961) study did not support their views. Not common in study area, one nest found in 1975.

[1]Downy Woodpecker (*Dendrocopus pubescens*). Seen more frequently than the preceding, but Schorger (*op. cit.*) found it less abundant than *villosus* at Lake Owen. Nest found near western end of Pigeon Lake in 1967.

PASSERIFORMES

Tyrannidae

[1]Eastern Kingbird (*Tyrannus tyrannus*). Most common in open area, 2 nests found in 1967, Schorger (*op. cit.*) also found it nesting at Lake Owen.

[1]Northern Crested Flycatcher (*Myiarchus crinitus*). A common summer resident of the forested areas. A nest was found in 1975, near the eastern edge of Pigeon Lake.

[1]Eastern Phoebe (*Sayornis phoebe*). Common. Two nests were found in 1974; one on the station grounds had 4 young ready to fledge on June 28th. The other, in an abandoned shed several miles east of the station, had 4 eggs on June 28th, with the parents in attendance. Two nests were found on the station grounds in 1975 and also in 1978. Christopherson (1969) and Gates (1973) also found this species breeding.

Yellow-bellied Flycatcher (*Empidonax flaviventris*). No nesting records for the study area. One was mist-netted at the station on June 1, 1973.

Alder Flycatcher (*Empidonax alnorum*). In shrubby areas. Logging operations provide habitat for this species.

[1]Least Flycatcher (*Empidonax minimus*). Abundant. Two nests found in 1974 were both about 30 feet up in a sugar maple. The first had 4 eggs on June 11th, 4 young on June 28th; the second was under construction on June 19th, and had 2 eggs when last checked on June 28th. Another nest found in 1975 again was approximately 30 feet high in a sugar maple.

[2]Wood Pewee (*Contopus virens*). Common, doubtless breeds in study area.

Olive-sided Flycatcher (*Nuttallornis borealis*). Uncommon, has been found in wind-blown area east of the station.

Hirundinidae

[1]Tree Swallow (*Iridoprocne bicolor*). Common, nests in dead stumps near lake shores, and in bird houses in various locations. A nest checked in 1974 had 4 eggs on June 17th, 4 young on June 28th. Five nests were found in 1975.

[1]Bank Swallow (*Riparia riparia*). Fairly common. Several pairs nested in a gravel pit about 1½ miles west of the station in 1974.

[1]Rough-winged Swallow (*Stelgidopteryx ruficollis*). Uncommon. Two pairs nested in the gravel pit during 1974.

[1]Barn Swallow (*Hirundo rustica*). Fairly common near buildings. One pair nested at the station in 1974 and had 4 small young when last checked on June 28th. A single pair nested at the station in 1975 and also in 1978.

[1]Cliff Swallow (*Petrochelidon pyrrhonota*). Common. There was a small 5-nest colony on a south-shore cottage at Pigeon Lake in 1974, and a large 94 nest colony in Drummond. The latter, which had been in existence for several years, was abandoned in 1975; a new colony

started at Drummond was destroyed by heavy rain. A single pair nested at the station in 1975, evicting a pair of Barn Swallows and remodeling their nest.

[1]Purple Martin (*Progne subis*). Common, several pairs nested in homes erected near Pigeon Lake, and in Drummond.

Corvidae

[1]Blue Jay (*Cyanocitta cristata*). Fairly common. A nest was found in May 1974, in mixed deciduous woods about 1 mile east of the station.

[2]Raven (*Corvus corax*). Common, usually in small flocks, congregate in dumping areas.

[2]Crow (*Corvus brachyrhynchos*). Common, small flocks in agricultural areas.

Paridae

[1]Black-capped Chickadee (*Parus atricapillus*). Fairly common, nest found on station grounds in 1968 and 1975.

Boreal Chickadee (*Parus hudsonicus*). Rare, one observed near Pigeon Lake in June 1968, a second in June 1975.

Sittidae

[2]White-breasted Nuthatch (*Sitta carolinensis*). Fairly common.

[1]Red-breasted Nuthatch (*Sitta canadensis*). Less common than the preceding; nesting pair on station grounds, 1975.

Certhiidae

[2]Brown Creeper (*Certhia familiaris*). Fairly common.

Troglodytidae

[1]House Wren (*Troglodytes aedon*). Common near human habitation, utilizing artificial nest boxes.

Winter Wren (*Troglodytes troglotydes*). One on shore of Pigeon Lake, April 1974.

Mimidae

Mockingbird (*Mimus polyglottus*). Rare, a pair seen in Drummond, May 1973.

[1]Gray Catbird (*Dumetella carolinensis*). Common. Five nests found in 1974, the earliest started May 30. Of 17 found in 1975, the earliest was May 22, the latest on June 26.

[1]Brown Thrasher (*Toxostoma rufum*). Common, nesting in 1974 started May 10.

Turdidae

[1]American Robin (*Turdus migratorius*). Common nester, particularly near open areas. The earliest nest in 1974 was started May 4; the same year another nest still had eggs on June 28. In 1975 the

first nest was started on May 12; a female was sitting on nest July 3rd. Despite the abundance of trees, two females nested on the ground in 1974.

[1]Wood Thrush (*Hylocichla mustelina*). Common. A 1974 nest had 4 eggs on May 31, but was robbed. The single nest found in 1975 had 4 eggs on May 29, but was later abandoned.

[2]Hermit Thrush (*Catharus guttata*). Mainly restricted to bog areas; a persistent singer.

Swainson's Thrush (*Catharus ustulata*). Fairly common migrant.

Gray-cheeked Thrush (*Catharus minima*). Fairly common migrant.

[1]Veery (*Catharus fuscescens*). Nest found on station grounds, May 1973. One found in 1975 had eggs hatching on June 1st.

[2]Eastern Bluebird (*Sialia sialis*). While no nests have been found within the study area, the bluebird is a fairly common summer resident.

Sylviidae

[2]Golden-crowned Kinglet (*Regulus satrapa*). Fairly common migrant.

[2]Ruby-crowned Kinglet (*Regulus calendula*). More common than preceding.

Motacillidae

Water Pipit (*Anthus spinoletta*). A single record, May 1973; one individual on the shore of Drummond Lake.

Bombycillidae

[1]Cedar Waxwing (*Bombycilla cedrorum*). Common, but irregular. Observed nest-building on station grounds, June 1974; nest found near eastern edge of Pigeon Lake in 1975.

Sturnidae

[2]European Starling.(*Sturnus vulgaris*). Primarily restricted to the village of Drummond.

Vireonidae

[1]Yellow-throated Vireo (*Vireo flavifrons*). Fairly common, particularly where maples are abundant. Nested on station grounds, 1978.

[1]Solitary Vireo (*Vireo solitarius*). Not common. One seen near Pigeon Lake, July 4, 1968. A nest was found on the station grounds in 1975.

[1]Red-eyed Vireo (*Vireo olivaceus*). Abundant. A 1974 nest on the station grounds had its first egg on June 23. This perhaps was a renesting, since in 1975, the first egg was laid on June 6.

Philadelphia Vireo (*Vireo philadelphicus*). Fairly common spring migrant.

[2]Warbling Vireo (*Vireo gilvus*). Uncommon, but usually present in the town of Drummond.

Parulidae

[2]Black and White Warbler (*Mniotilta varia*). Uncommon.

[2]Golden-winged Warbler (*Vermivora chrysoptera*). Uncommon, best area about 1 mile east of station, where bushy growth has sprung up in old tornado path.

Tennessee Warbler (*Vermivora perigrina*). Fairly common spring migrant.

Orange-crowned Warbler (*Vermivora celata*). Uncommon migrant.

[1]Nashville Warbler (*Vermivora ruficapilla*). Common, a 1975 nest had 5 young on June 2.

[2]Parula Warbler (*Parula americana*). Fairly common.

[1]Yellow Warbler (*Dendroica petechia*). Common. Five nests found in 1975, nesting starts in the 3rd week of May.

[2]Magnolia Warbler (*Dendroica magnolia*). Common spring migrant.

[2]Cape May Warbler (*Dendroica tigrina*). Fairly common spring migrant.

Black-throated Blue Warbler (*Dendroica caerulescens*). Rare, seen June 1971 at Bearsdale Spring; one singing near station, May 1975.

[2]Yellow-rumped Warbler (*Dendroica coronata*). Abundant migrant, fairly common summer resident.

[2]Black-throated Green Warbler (*Dendroica virens*) Common summer resident, most abundant in areas with many maples.

[2]Blackburnian Warbler (*Dendroica fusca*). Fairly common summer resident.

[1]Chestnut-sided Warbler (*Dendroica pensylvanica*). Abundant. A 1975 nest was started on June 11th, 2′ high in hazel.

Blackpoll Warbler (*Dendroica striata*). Uncommon migrant.

[2]Pine Warbler (*Dendroica pinus*). Common summer resident.

[2]Palm Warbler (*Dendroica palmarum*). Common migrant. Although the study area is within the nesting range, no summer records were obtained.

[1]Ovenbird (*Seiurus aurocapillus*). Abundant summer resident. One 1975 nest was started on May 18th, another still had young in the nest on July 1st.

[2]Northern Water-Thrush (*Seiurus noveboracensis*). Fairly common spring migrant.

[2]Connecticut Warbler (*Oporornis agilis*). Uncommon spring migrant.

Mourning Warbler (*Oporornis philadelphia*). Common. Nests found 1974 and 1975, both were on the ground.

[1]Yellowthroat (*Geothlypis trichas*). Common in low moist areas. Nest found in 1975 was 2′ high in hazel, started about June 20th.

Wilson's Warbler (*Wilsonia pusilla*). Common spring migrant.

[2]Canada Warbler (*Wilsonia canadensis*). Common spring migrant.

[1]American Redstart (*Setophaga ruticilla*). Common summer resident; one nest found in 1975.

Ploceidae

[1]House Sparrow (*Passer domesticus*). Common permanent resident in populated areas.

Icteridae

[2]Bobolink (*Dolichonyx oryzivorus*). Spring flock in field south of station, May 1976.

[2]Eastern Meadowlark (*Sturnella magna*). Uncommon summer resident.

[2]Western Meadowlark (*Sturnella neglecta*). Uncommon summer resident.

[1]Red-winged Blackbird (*Agelaius phoeniceus*). Abundant breeder, nesting most extensively along the shores of Pigeon Lake.

[1]Northern Oriole (*Icterus galbula*). Common breeder, old nests observed in trees at Drummond.

[1]Brewer's Blackbird (*Euphagus cyanocephalus*). Occasional in more open areas and along roadsides. Nest found in field, ca. 2 miles west of field station.

[1]Common Grackle (*Quiscalus quiscula*). Fairly common, nests on south shore of Pigeon Lake.

[1]Brown-headed Cowbird (*Molothrus ater*). Commonly observed, but only 4 eggs were found: 2 in nests of the Chestnut-sided Warbler, and 1 each in nests of the Solitary Vireo and Red-eyed Vireo.

Thraupidae

[2]Scarlet Tanager (*Piranga olivacea*). Fairly common.

Fringillidae

[1]Rose-breasted Grosbeak (*Pheucticus ludovicianus*). Common breeder, nest found on station grounds in 1974.

[2]Indigo Bunting (*Passerina cyanea*). Common, usually arrives in late May or early June.

Evening Grosbeak (*Hesperiphona vespertina*). Uncommon, but may eventually be found nesting in area.

[2]Purple Finch (*Carpodacus purpureus*). Fairly common.

[1]Pine Siskin (*Spinus pinus*). Uncommon, one nest found, 1969.

[2]Eastern Goldfinch (*Spinus tristis*). Common and probably breeds; observations stop before start of nesting season.

Red Crossbill (*Loxia curvirostra*). One observed at Pigeon Lake, July 1968.

[2]Rufous-sided Towhee (*Pipilo erythrophthalmus*. Fairly common.

[2]Vesper Sparrow (*Pooecetes gramineus*). Scarce in more open areas.

[2]Dark-eyed Junco (*Junco hyemalis*). Fairly common.

[1]Chipping Siarrow (*Spizella passerina*). Common breeder.

[1]Clay-colored Sparrow (*Spizella pallida*). Common in brushy areas, seen feeding young.

[2]Field Sparrow (*Spizella pusilla*). Scarce in more open areas.

White-crowned Sparrow (*Zonotrichia leucophrys*). Uncommon.

[2]White-throated Sparrow (*Zonotrichia albicollis*). Common.

Fox Sparrow (*Passerella iliaca*). Uncommon.

[2]Swamp Sparrow (*Melospiza georgiana*). Fairly common.

[1]Song Sparrow (*Melospiza melodia*). Abundant breeder.

Lapland Longspur (*Calcarius lapponicus*). One individual, near Drummond in May 1973.

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[1]Definite breeding record for study area

[2]Assumed breeder

HYPOTHETICAL LIST

COLYMBIFORMES
[3]Horned Grebe

ANSERIFORMES
Canada Goose

CICONIIFORMES
[3]Least Bittern
[3]Gadwall
[3]Pintail
[3]Green-winged Teal
[3]Am. Wigeon
[3]Shoveler
Redhead
Canvasback
[3]Common Goldeneye
Bufflehead
[3]Ruddy Duck

FALCONIFORMES
[3]Goshawk
[3]Cooper's Hawk
Rough-legged Hawk
[3]Harrier

GRUIFORMES
[3]Coot

CHARADRIIFORMES
Semi-palmated Plover
[3]Upland Sandiiper
Lesser Yellowlegs
Pectoral Sandpiper
Least Sandpiper
Herring Gull
[3]Common Tern

CUCULIFORMES
[3]Yellow-billed Cuckoo

STRIGIFORMES
[3]Screech Owl
[3]Long-eared Owl

PASSERIFORMES
Troglodytidae
[3]Marsh Wren
[3]Sedge Wren
Bombycillidae
Bohemian Waxwing
Laniidae
[3]Loggerhead Shrike
Parulidae
Bay-breasted Warbler
Icteridae
Rusty Blackbird
Fringillidae
[3]White-winged Crossbill
[3]Savannah Sparrow
[3]Grasshopper Sparrow
[3]Henslow's Sparrow
Tree Sparrow
Lincoln's Sparrow

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[3]Possible Breeders

Summary

One hundred and fifty species have been recorded during the spring and summer for the Pigeon Lake region. Fifty-eight are known breeders, with 63 more probable breeders.

A hypothetical list of 40 species includes 25 possible breeders.

The breeding season and nesting success are discussed.

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AQUATIC MACROPHYTES OF THE PINE AND POPPLE RIVER SYSTEM, FLORENCE AND FOREST COUNTIES, WISCONSIN

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ABSTRACT

Field surveys of the rivers, 5 tributary creeks, 9 lakes and 5 impoundments provide data on distribution, relative abundance, general ecology and taxonomic problems of about 50 species in the streams and 44 in the lakes. Accurate identification of species in the streams was often difficult due to lack of reproductive structures, confusing flowing-water forms, apparent hybridization in broad-leaved *Potamogeton*, and species problems in *Elodea, Ranunculus, Nuphar* and *Nymphaea*. Submerged and occasionally emergent aquatic vegetation was present in most of the streams and all the very diverse stream habitats. Vegetation sometimes filled the entire channel, but cover was usually low, and several miles of stream below the Pine River power dam were barren. *Sparganium chlorocarpum* was most abundant, followed by *Potamogeton richardsonii, P. alpinus* and hybrids, and *Elodea*. Distributions of some species were apparently without pattern while others were restricted to special habitats. Although many aquatic growth forms occurred, submerged rhizomatous plants predominated. The stream flora was characteristic of mesotrophic habitats and lacked extremely oligotrophic dwarf rosette indicator species. About 13 species were restricted mostly to lakes and 14 mostly to streams.

INTRODUCTION

This paper presents data from field studies during 1967 and 1968 of most of the navigable streams, 9 natural lakes and 5 impoundments in the Pine-Popple River watershed (Fig. 1). Essentially no other information is available from herbarium or other sources. Included are distribution, relative abundance, general ecology, and taxonomic problems of the aquatic plants; vegetation of wetlands, banks, bars and uplands is described only in broad descriptive terms.

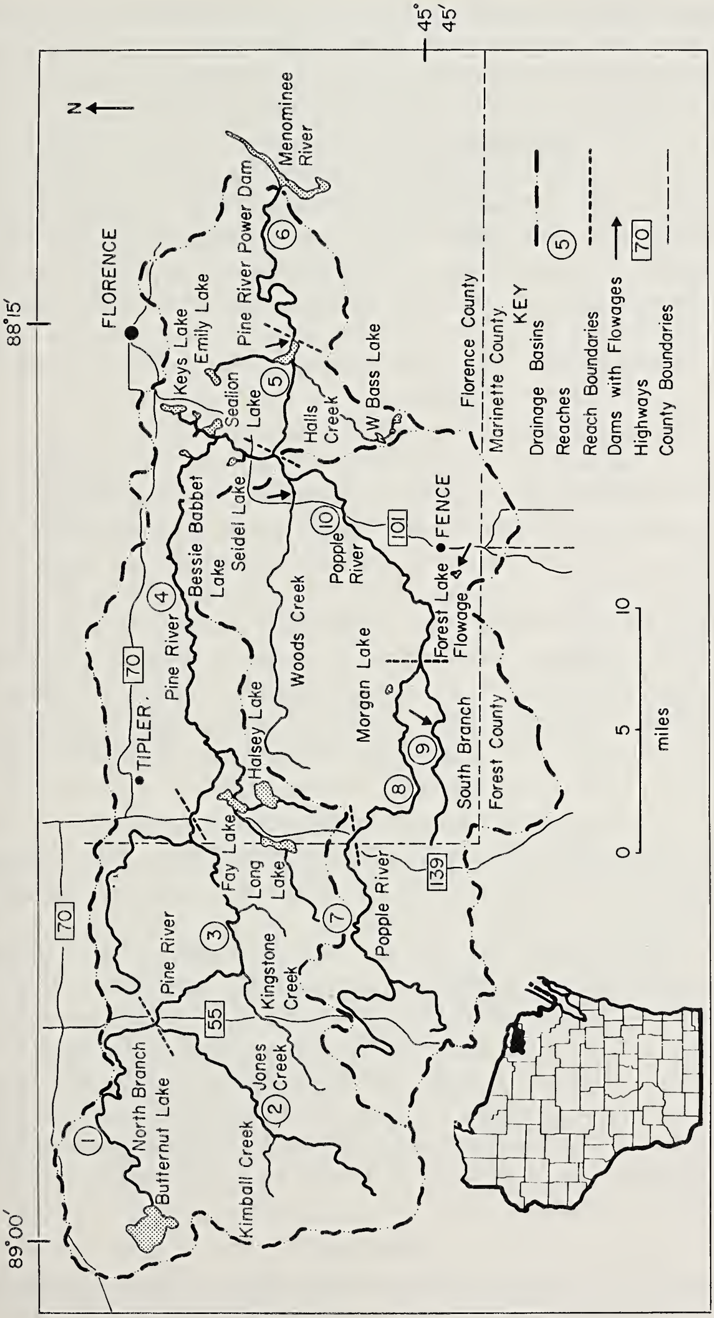

FIGURE 1. Pine and Popple River system, Forest and Florence Counties, Wisconsin.

An additional important objective is to stimulate interest in the ecology of the macrophytes of flowing water, which is a badly neglected field of study in most of the world (Hynes 1970; Westlake 1975). Except for a similar but less detailed study of the Brule River in the north by Thomson (1944) and a brief survey of Whitewater Creek in the southeast by Smith (1973a), no other similar data are available for Wisconsin streams (Curtis 1959). In adjacent states, very brief lists of species have been published for the streams draining into the north shore of Lake Superior in Minnesota (Smith and Moyle 1944) and the upper Mississippi River (Peterson 1962). Only a few other papers are concerned with the general ecology of macrophytes of North American streams (Ricker 1934; Hunt 1963; Minkley 1963; Haslam 1978).

The Pine and Popple Rivers were established as wild rivers by the Wisconsin legislature in 1965 (Becker 1972a). The hydrology and other physical characteristics were described by Oakes et al. (1973), the Northeastern Wisconsin Regional Planning Commission (1970), and Hole (1974). The fish and water chemistry were described by Mason and Wegner (1970) and Becker (1972b). The land is mostly wild and forested with rolling topography between 1,068 and 1,830 feet (326 and 558 m). Varied glacial deposits overlie Precambrian bedrock of diverse mineral composition. About 70 lakes are included. The waters are essentially unpolluted and clear, with low to medium hardness. Surface temperatures reach over 75°F (23°C) in summer. In streams, turbidity is generally low but a brown stain is present in some reaches especially during periods of runoff. Springs are generally small and inconspicuous. The climate is humid continental, with most precipitation falling as rain in spring and summer.

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METHODS

A broadly descriptive approach was taken to make possible the observation of most of the stream system, including many relatively inaccessible localities that could not have been visited if more time had been spent on detailed sampling. Only plants that were submerged, emergent or floating at normal water levels were considered in detail. The field studies were conducted during June, July and August, in 1967 by the author and Robert K. Rose, and in 1968 mostly by Robert K. Rose and William Hummel. Almost all navigable portions of the system were floated in a canoe at least once including streams greater than 3 m in width. A few non-navigable reaches were surveyed on foot. The major lakes with surface drainage into the stream system as well as some lakes lacking surface drainage were also studied. Within each reasonably uniform reach of stream, ranging from several hundred feet to several miles, the relative abundance and importance of each species was visually estimated. Notes were taken also on stream form, width, depth, current, bottom type, water color, turbidity, bank vegetation, and any other factors that seemed likely to affect the distribution and abundance of the plants. The entire stream system was divided into 15 major reaches for purposes of summarizing data on occurrence and abundance (Fig. 1, Table 1). Voucher specimens were collected for deposit in the herbaria of the University of Wisconsin at Madison and Whitewater. Nomenclature follows Fassett (1960) except where there are more recent revisions. State Trunk Highway and County Trunk Highway are herein abbreviated STH and CTH.

ECOLOGICAL REGIONS OF THE RIVER SYSTEM

The stream system may be divided into three ecological regions: (1) The small upstream portions (Reaches 1 and 2 of the Pine and 7 and 9 of the Popple, plus the tributaries in the western part of the watershed, especially Kimball, McDonald, Jones and Lilypad Creeks) flow slowly over sand or silt substrates. They drain extensive wetlands and often meander through wet meadows. Beaver dams are common, although most have been removed to improve trout habitat. Lake-like portions on the North Branch of the Pine and in the headwaters of the Popple are heavily silted.

(2) The medium-sized reaches in the center of the system (Reaches 3, 4 and 5 of the Pine, and 8 and 10 of the Popple)are characterized by areas with fast currents and coarse substrates alternating with areas of slow currents and fine substrates. Many rapids and falls occur where the rivers flow over granite, gneiss and metamorphic bedrock. The hydroelectric dam and reservoir on the Pine River

Table 1. Characteristics of major stream reaches.

	1 Pine R., N. Branch	2 Pine R., S. Branch	3 Pine R. from N. Branch to STH 139	4 Pine R. from STH 139 to Popple R.
Length (approx.)	14 mi/23 km	13 mi/21 km	13 mi/21 km	26 mi/42 km
Width (m)	3-12 (15)	5-15	9-15	10-20
Depth (m)	0.6	1	0.1-1 (2)	0.1-0.3
Current	slow/moderate	slow/mod.	slow/mod./fast	slow/mod./fast
Substrate	sand (rock, silt, muck)	sand	sand/rock	sand/cobble/rock
Form	mostly meandered	mostly meandered	meandered/straight	meandered
Banks	alder (conifer swamp, upland forest)	wet meadow	wet meadow/upland forest	wet meadows/upland forest (deciduous floodplain)
Impoundments	beaver below Windsor Dam	many inactive beaver	none	none
Color/Turbidity	locally turbid	brown	brown at high stages	almost none
Comments	origin at Butternut Lake outlet	Kimball Creek meandered through meadows, ca 5-10m wide	Kingstone Creek meandered in brushy meadows, bottom sandy	Bessie Babbet Lake outlet creek meandered in *Typha* marsh and wet meadow near lake, upland forest near river

	5 Pine R. from Popple R. to Flowage	6 Pine R. from Flowage to Mouth (a) Pine R. Mouth (at Menominee R.) (b)	7 Popple R. above FSR 2167	8 Popple R. from FSR 2167 to S. Branch
Length	5 mi/8 km	11.5 mi/18.5 km	10 mi/16 km	18 mi/29 km
Width (m)	30-60	30-60	5-50	10-30
Depth (m)	0.3-1.5	0.1-0.6	0.5-1.5	(0.1) 0.3-1
Current	moderate (falls)	moderate (slow/falls)	slow (moderate)	slow/rapids
Substrate	sand/cobble (bedrock)	sand/cobble (silt/ bedrock)	silt/sand (cobble, boulder)	silt/sand/rock
Form	nearly straight	straight entrenched meanders	meandered (straight)	meandered/ straight
Banks	high, upland forest	high, upland forest, sandy, eroding	tamarack swamps/ meadow/alders	meadow/alder high, upland forest
Impoundment	power dam forming Pine River flowage	Menominee River flowage	beaver; semi-impound. above FSR 2167	none
Color/Turbidity	none	none	brown	medium brown
Comments	great daily fluctuations in water levels in flowage	great daily fluctuations in water levels due to power dam; Lepage Creek sandy, 3-6m, beaver dam near mouth	log jams in Sec. 18; headwaters in swamps in Sec. 15 of R13E, T38N	silty abandoned meanders (Sec. 7, 8, 17 e. of STH 139)

	9 Popple R., S. branch	10 Popple R. from S. branch to Pine R.	11 Woods Creek	12 Halls Creek
Length	4.5 mi/12.5 km	15 mi/24 km	5 mi/8 km	4 mi/6.5 km
Width (m)	5-12 (60 in impound.)	25-30	3-6	3-6+
Depth (m)	0.1-2	0-0.6 (2)	to 1.5 m	0.2-1
Current	slow	moderate/fast rapids/falls	moderate	slow (fast near Pine R.)
Substrate	muck/silt	sand/cobble/rock	sand/gravel	silt/sand/organic (rocky near Pine R.)
Form	straight	straight (meandered)	straight (meandered)	sharply meandered (straight)
Banks	upland forest	upland forest (swamp forest, wet meadow)	alder (upland forest)	wet meadow (swamp, upland forest)
Impoundment	dam ca. 2 m high near Sec. 19/30 boundary 0.2 mi west of FSR 2383	none	dam forming "Dooley's Pond" e of STH 101	none
Color/Turbidity	brown	medium brown	none	none
Comments	small springs in Sec. 26	Lamon-Tangue Creek ca. 5-8 m wide in alders, colorless	cold water	many fallen black spruce logs

	13 Jones Creek	14 Kingstone Creek from FSR 2168 to Pine River	15 Long Lake Outlet Creek
Length	3 mi/5 km	1 mi/1.6 km	1.5 mi/2.4 km
Depth (m)		0.5-1.0	
Width (m)	5-8 m (60)	3-15	-30
Current	slow (moderate/fast)	slow	slow (moderate)
Substrate	silt/sand (rocky)	sandy/silty	silt/organic
Form	meandered (straight/ braided)	many sharp meanders	straight
Banks	wet meadow/alder/ conifer swamp (upland forest)	high; mud banks upland forest and meadow	marsh/disturbed
Impoundments	many beaver (2 ponds) in headwaters and above STH 55	none.	semi-impounded above STH 101
Color/Turbidity	brown	clear, brown tinge	clear
Comments			Extensive human disturbance; begins at dam on recreational lake

form the downstream boundary of this region. Wetlands are not common along the streams, which mostly flow through shallow but narrow valleys in upland forests.

(3) The large downstream Reach 6 of the Pine River below the dam is characterized by a deep V-shaped valley in sandy glacial deposits. Currents are uniformly moderate and bottom materials are mostly gravel to sand except near the mouth of the Pine where the impoundment on the Menominee River forms a backwater. The operation of the power dam causes a large daily fluctuation in discharge, especially for the first two or three miles below the dam.

VEGETATION OF THE WATERSHED

The Pine-Popple River watershed is vegetated predominantly with xeric to wet northern forests as described by Curtis (1959). Cleared areas constitute less than 5% of the land area and are used mostly for hay production. The well-drained uplands support a complex mosaic of second-growth mixed evergreen and deciduous forest that has been greatly affected by a history of logging and burning. The poorly drained lowlands support mostly swamp conifer forests dominated by black spruce *(Picea mariana),* white-cedar *(Thuja occidentalis)*, and tamarack *(Larix laricina).* Swamp forests are extensive along the tributary streams of the western half of the watershed, especially near the headwaters of the "South Branch" of the Pine River and both branches of the Popple River. These swamps are probably the source of the brown stain of the water in these portions of the stream system. Deciduous flood plain forests are very uncommon (e.g., the Pine River just upstream from Wisconsin Hwy. 101).

Treeless wetlands are not extensive. There are a few *Sphagnum* bogs in the forested lowlands, sedge mats along the shores of some lakes, emergent *Scirpus acutus* stands in many lakes, and small marshes along some lakeshores and stream banks, especially on sediments deposited at the junctions with tributary streams. The type of treeless wetland that is most extensive along the streams is perhaps best described as northern sedge meadow (Curtis 1959), in which grasses, broad-leaved herbs and low shrubs are usually also important. Wet meadows occupy many of the floodplains of the smaller streams. They are often inundated at high water stages and include many old stream meanders that are in various stages of succession from submerged aquatic vegetation to sedge meadow. Sedge meadows are most extensive in the western half of the stream system, especially along the Pine River upstream from the confluence with the North Branch, along Kimball Creek in the same region, the North Branch of the Pine River upstream from Windsor Dam and near the Howell Lake outlet creek, the South Branch of the Popple River south of Morgan Lake, and Halls Creek. The treeless meadows intergrade with black spruce-tamarack swamp forest as well as with thickets of willow *(Salix)* and alder *(Alnus)* that often dominate the banks of the streams.

VEGETATION OF STREAMS

Identification Problems

Accurate identification of aquatic plants in the streams was sometimes difficult, primarily because of the following three factors: (1) Most of the plants in moderate to fast currents lacked flowers and fruits that are often necessary for determination of species. (2) Some species developed flowing-water forms—mostly with unusually long flexible leaves—that are neither adequately described in the taxonomic literature nor represented in herbarium collections. (3) Some groups of species (especially in *Potamogeton*) are taxonomically difficult even with flowers and fruit available.

The following genera presented particular problems in identification:

(1) *Sparganium*: Although in rapidly flowing water they produced only very thin and flexible completely submerged leaves without keels, in quieter water the bur reeds often formed stiff, keeled emergent leaves and sometimes flowers. Except for the much larger *S. eurycarpum*, which was found at only two localities, all flowering bur reeds were *S. chlorocarpum*. Some submerged plants with broader leaves may have been another species such as *S. americanum*, which is common in this region (Voss 1972). The much more slender *S. angustifolium* was apparently restricted to lakes, where it was very uncommon. Terrestrial forms such as *S. chlorocarpum* var. *acaule* were not noted.

(2) *Sagittaria*: All emergent, flowering arrowheads that were definitely identified were *S. latifolia*. It is possible however that some young plants that were not collected were the morphologically similar *S. cuneata* or *S. engelmanniana*. They never formed submerged rosettes and grew only in places with little or no current.

Sagittaria cuneata was locally common in deep water with moderate current, where it formed completely submerged rosettes of flexible phylloidal ribbon leaves ranging from nearly linear throughout to narrowly oblanceolate and about 15mm wide near the apex. These plants often closely resembled *Sparganium* or *Vallisneria*. The submerged ribbon leaves intergraded gradually with the characteristic floating sagittate blades that formed in quieter waters (Boigin 1955; Hotchkiss 1967). Although submerged inflorescences were occasionally formed in August, no fruits or emergent flowers were observed. Although in my experience this form of *S. cuneata* is locally common in streams in the Western Great Lakes area, it is seldom recognized or collected. It should be added to the aquatic flora of the Brule River (Thomson 1944) on the basis of several of Thomson's unidentified collections in the UW-Madison Herbarium.

(3) *Potamogeton*: The broad-leaved species *P. richardsonii*, *P. alpinus*, *P. gramineus* and *P. illinoensis* all apparently hybridized in the streams. The last two also intergraded in lakes. Hybrids are reportedly common in our region (Ogden 1943; Stern 1961; Voss 1972) and several probable hybrid combinations were identified in our collections by E. C. Ogden. Hybrids involving *P. richardsonii* are fairly easily recognized by their half-clasping leaf bases, moderately fibrous stipules, and moderately prominent main veins in the leaves. Other hybrids are much more difficult to recognize, especially if the plants are depauperate due to fast currents. Many plants recorded in the field and listed in Table 2 as *P. alpinus* were probably closer to *P. gramineus*.

Plants identified herein as *P. nodosus* were identified by E. C. Ogden from our dried specimens as "perhaps an ecological form of *P. natans* or *P. illinoensis*." These were locally abundant in deep water and moderate currents of medium-sized to large streams. They were usually completely submerged and formed great masses, the shoots sometimes exceeding 2 m in length with leaves 1 m. Many plants had linear leaves only 2 to 4 mm wide and suggested very robust *P. natans* without floating leaves. These peculiar plants seemed to intergrade with rather long and slender *P. nodosus* in a few places with very slow currents (e.g., the lower Pine River below Pine Creek). They occasionally formed flowers but no fruits.

In flowing water the linear-leaved species *P. foliosus* formed very robust plants strikingly different from the much smaller and more bushy plants of quiet water. *Potamogeton pusillus*, which is here considered to include *P. berchtoldii* following Haynes (1974), only formed small plants in quiet water, where it could not always be distinguished from *P. foliosus* in the field.

(4) *Ranunculus:* The aquatic buttercups recorded all belonged to the *R. aquatilis* complex. According to the world-wide monograph by Cook (1966), the only Wisconsin species are *R. trichophyllus* and

R. longirostris, and most of the vegetative characters traditionally used to separate the species in this complex (see Fernald 1950; Gleason 1963) are too plastic to be reliable. All our flowering or fruiting specimens have the small flowers, greenish sepals, short peduncles, and deciduous styles characteristic of *R. trichophyllus*.

(5) *Elodea:* the few flowering specimens collected apparently are *E. nuttallii (E. occidentalis)*. These include both pistillate plants with the very small attached flowers and staminate plants with the detached floating flowers characteristic of this species. The leaves are mostly 1.5 to 2.5 mm wide, and on several pistillate collections are 2.5 to 3.0 mm wide, whereas *E. nuttallii* is supposed to have leaves only 0.3 to 1.3 mm wide (St. John 1965). As our one flowering collection from quiet water (the impoundment on the South Branch of the Popple) has mostly leaves only 1.5 mm wide, it seems likely that *Elodea nuttallii* forms unusually broad leaves in flowing water. Although *E. canadensis* is very common in the upper Great Lakes region and we observed many vegetative plants with relatively short leaves to 3 mm broad, the presence of this species in the Pine-Popple system has not been verified from flowering plants.

(6) *Nymphaea* and *Nuphar:* Flowering water lilies were very uncommon in flowing water. The yellow lilies that were definitely identified were *Nuphar variegatum*, and it is assumed that all *Nuphar* observed belonged to this polymorphic species (Beal 1955). The few white water lilies in flower were *Nymphaea tuberosa*. As this species intergrades with *N. odorata* (Williams 1970), however, the vegetative *Nymphaea* of the Pine-Popple River System were identified to genus only.

(7) *Fontinalis:* As three very similar species were identified by Dr. Winona Welch from our vouchers, field identifications of these mosses were to genus only.

(8) *Chara* and *Nitella:* These taxonomically difficult genera were identified to genus only pending study of the voucher specimens by specialists.

Stream Bars and Banks

Wet bars of silt, sand or gravel were common in most of the stream system, both along the banks and forming small islands in the middle of the stream. Although these bars were submerged at high water stages, which occurred approximately weekly during the study period, they were often emergent at low stages. The vegetation was usually a very dense cover of perennial herbs with pioneer shrubs such as *Salix* spp. established on the more stable areas. Most of the species we recorded are facultative aquatics that also occur submerged or emergent in shallow water and therefore are listed in the table of aquatic plants herein. Of the following characteristic species, the four indicated with an asterisk were probably most important: *Agrostis stolonifera, Callitriche verna, Cardamine pennsylvanica, Carex rostrata, *Eleocharis erythropoda (E. calva), E. smallii, Equisetum fluviatile, *Glyceria grandis, *G. striata, Leersia oryzoides, Sagittaria latifolia, *Scirpus validus, Sparganium chlorocarpum, Typha latifolia.*

The stream banks of most of the system were densely vegetated and therefore stabilized by plants of diverse herbaceous and woody communities that were not studied in detail. The only prominently eroding banks were noted in Reach 6 along the lower Pine River downstream from CTH U where the river has cut down through an area of sandy hills.

General Nature of the Aquatic Vegetation

Aquatic vegetation was present in all major reaches of the stream system. The amount present was extremely variable, however. Vegetation cover occasionally approached 100% and at the other extreme many reaches, usually a mile or less long, were barren of vegetation. Where present, plants usually covered no more than 5 to 10% of the substrate.

About 50 truly aquatic macrophyte species belonging to 30 genera and 25 families were recorded in the streams (Table 2). By far the most diverse family was Potamogetonaceae, with 17 species of *Potamogeton* recorded. The remaining families were represented by only one or two species each except for Cyperaceae with four unimportant species. Although flowering plants predominated, charophyte algae *(Chara* and *Nitella)*, mosses *(Fontinalis)*, and horsetails *(Equisetum)* were locally common. Among macroscopic plants not covered in this report, aquatic leafy liverworts (e.g. *Porella pinnata)*, as well as both crustose and foliose lichens, were occasional on rocks in rapids. Filamentous green algae *(Cladophora* and others*)* were locally abundant attached to most kinds of substrates, occasionally forming very large colonies approaching the flowering plants in size.

Abundance and Distribution of Species

Both the abundance and distribution of the species in the stream system were extremely variable. Total abundance values for the various species, computed by summing the relative abundances in the 17 major reaches listed in Table 2, provide a rough quantifica-

Table 2. Distribution and relative abundance of aquatic vascular plants, bryophytes and charophytes in major reaches of the Pine and Popple Rivers and five tributary creeks.[1]

	Aquatic Plant Type[2]	Pine R., N. Branch	Pine R., "So. Branch"	Pine R. from N. Branch to STH 139	Pine R. from STH 139 to Popple R.	Pine R. from Popple R. to Flowage	Pine R. from Flowage to Mouth	Pine R. Mouth (at Menominee R.)	Popple R. above FSR 2167	Popple R. from FSR 2167 to So. Branch	Popple R., So. Branch	Popple R. from So. Branch to Pine R.	Woods Creek	Halls Creek	Jones Creek	Kingstone Creek	Long Lake Outlet Creek
		Reach No.															
Species		1	2	3	4	5	6a	6b	7	8	9	10	11	12	13	14	15
Acorus calamus	E					*1											
Alisma plantago-aquatica	E							2									
Calligeron cordifolium	S																x
Callitriche verna (palustris)	S	1	2	1	1	2	1	2	2	1	1	1	1	1	2		
Callitriche hermaphroditica	S							2									
Caramine pennsylvanica	ES	1							1								
Ceratophyllum demersum	S		1			*1				2							2
Chara sp.	S													2			

		Pine R., N. Branch	Pine R., "So. Branch"	Pine R. from N. Branch to STH 139	Pine R. from STH 139 to Popple R.	Pine R. from Popple R. to Flowage	Pine R. from Flowage to Mouth	Pine R. Mouth (at Menominee R.)	Popple R. above FSR 2167	Popple R. from FSR 2167 to So. Branch	Popple R., So. Branch	Popple R. from So. Branch to Pine R.	Woods Creek	Halls Creek	Jones Creek	Kingstone Creek	Long Lake Outlet Creek
REACH NO.		1	2	3	4	5	6a	6b	7	8	9	10	11	12	13	14	15
Elodea nuttallii (occidentalis)	S	x				x				x	x	x					3
**Elodea sp.	S	2	1	3	2	2	1	2		2	2	2				2	
Eleocharis acicularis	S					*1											
Eleocharis "palustris" (E. erythropoda, E. calva and E. smallii)	E		1						1		1	1		1			1
Equisetum fluviatile	E	1	1	1	1					1		1		1			
Fontinalis antipyretica	S		2														
Fontinalis duriaei	S		1							1							
F. nova-angliae	S														1		
**Fontinalis sp.	S				1	1	1		2		1		1			1	

Glyceria sp. ?	S		1														
Heteranthera (Zosterella) dubia	S				2	2	1			1		1					1
Lemna minor	F											1					
Ludwigia palustris	ES							2									
Megalodonta (Bidens) beckii	S							1									1
Myriophyllum exalbescens	S							3						1			
M. verticillatum	S							2									
Naias flexilis	S	1						2									
**Nitella sp.	S	2	1					x		1				2	1		
Nuphar variegatum	SF	1	1			*1			2					1	1		3
**Nymphaea sp.	SF													1			3
Penthorum sedoides	E							2									
Polygonum amphibium (natans)	SF		1						1					1	1		

		Pine R., N. Branch	Pine R., "So. Branch"	Pine R. from N. Branch to STH 139	Pine R. from STH 139 to Popple R.	Pine R. from Popple R. to Flowage	Pine R. from Flowage to Mouth	Pine R. Mouth (at Menominee R.)	Popple R. above FSR 2167	Popple R. from FSR 2167 to So. Branch	Popple R., So. Branch	Popple R. from So. Branch to Pine R.	Woods Creek	Halls Creek	Jones Creek	Kingstone Creek	Long Lake Outlet Creek
REACH NO.		1	2	3	4	5	6a	6b	7	8	9	10	11	12	13	14	15
**Potamogeton alpinus (tenuifolius)	SF	2		2	3	2	2		1	2	3	2	2	2	1		1
P. amplifolius	S	1				*1		3						1			3
P. epihydrus	SF	2	1		1	2			2	1		1		1		2	
P. foliosus	S								x	x	x	1	*1	1			
P. friesii	S																1
**P. gramineus	SF	x		1		x				x	x	x		2	1		
**P. illinoensis	S												*1				x
P. natans	SF										*2		*1	2			
**P. nodosus	SF			2	2	3	2	x		1		2					

P. obtusifolius	S	2		1	1					1	2	1	*1			3	1
P. pectinatus	S	1			2	2					1	1		1			1
P. praelongus	S																1
P. pusillus (incl. berchtoldii)	S							1			x	1	1	1			
P. richardsonii	S	2	2	3	2	2	1	2		2	1	2	2		2	1	
P. robbinsii	S							x									
P. zosteriformis	S					2		2	1	2	1	1		1			
**P. foliosus or pusillus	S	1				*1	1	1	1	2	1			1			
**Ranunculus trichophyllus	S	1		2	2	2	1	1		1	1	2	1			1	
**Sagittaria cuneata	SF	1		1	2	2			2	2	1	2			2		
**S. latifolia	E	1	1			1	1	2			1	1	1	1	1		1
Scirpus acutus	E													1			
S. validus	E	1				*1								1			2

		Pine R., N. Branch	Pine R., "So. Branch"	Pine R. from N. Branch to STH 139	Pine R. from STH 139 to Popple R.	Pine R. from Popple R. to Flowage	Pine R. from Flowage to Mouth	Pine R. Mouth (at Menominee R.)	Popple R. above FSR 2167	Popple R. from FSR 2167 to So. Branch	Popple R., So. Branch	Popple R. from So. Branch to Pine R.	Woods Creek	Halls Creek	Jones Creek	Kingstone Creek	Long Lake Outlet Creek
Sparganium eurycarpum	E							2									2
**S. chlorocarpum	SEF	3	3	3	2	2	1		3	3	3	3	2	3	3	3	1
Spirodela polyrhiza	F											1					
Utricularia intermedia	S					*1											
Utricularia vulgaris	S		x						2					1			1
Vallisneria americana	S						1	2									

[1]Numbers refer to abundance: 1—rare to uncommon; 2—common; 3—abundant, often forming extensive stands: x—present but abundance unknown. *Found in impoundment only. **Identification difficult (See Identification Problems). STH means State Trunk Highway and FSR means Forest Service Road.

[2]E= emergent; S = submergent; F = floating.

tion of the relative abundance of each species in the entire stream system. The maximum possible value is 51. The 10 most abundant plants and their values were *Sparganium* 38, *Potamogeton richardsonii* 26, *P. alpinus* (probably often including *P. gramineus* and hybrids) 26, *Elodea* 25, *Callitriche verna* 19, *Ranunculus* 16, *Sagittaria cuneata* 15, *Potamogeton epihydrus* 15, *P. nodosus* 13, and *P. obtusifolius* 13. Of these *Callitriche* occurred only as small scattered plants on shallow bars and in backwaters, whereas the others formed large, extensive colonies and were important components of the vegetation of the main channels of the streams. About one-half of the species had abundance values of 5 or less, reflecting the fact that most species were either very locally distributed or very uncommon. The distribution of many plants (e.g. *Elodea, Ranunculus, Potamogeton epihydrus*) seemed to be without pattern. Distinctive distribution patterns were evident among some of the less abundant species, however. For example, *Potamogeton obtusifolius* was mostly restricted to smaller streams, *P. nodosus* was restricted to larger streams, and *Vallisneria* was restricted to the Pine River downstream from the power dam. A particularly interesting distribution pattern was evident among a group of common lake species that were largely restricted to impoundments and to the slow-moving headwaters regions of the Pine River, Halls Creek and Long Lake outlet creek (see Vegetation of Lakes and Impoundments). Another group of plants were mostly restricted to a backwater at the mouth of the Pine River at its junction with the Menominee River (Reach 6b, Table 2).

Growth Form

The vegetation was composed mostly of submerged rhizomatous perennials such as the rosette-forming plants with long ribbon leaves *(Sparganium, Sagittaria cuneata, Vallisneria)* and plants with long flexible leafy shoots (mostly *Potamogeton*). Plants forming dense bushy masses (especially *Elodea* and *Ranunculus*) were locally important. Other growth forms as described by Fassett (1930), Sculthorpe (1967) and Westlake (1975) were relatively unimportant. Curiously, the small rosette plants typical of oligotrophic lakes (Fassett 1930; Swindale and Curtis 1957) were absent from the streams even though they were present in several lakes. In the more rapid current, plants usually formed completely submerged, depauperate shoots only 10-20 cm long, whereas in slower current plants of the same species often formed dense masses reaching or emerging from the surface, the leafy shoots or individual leaves reaching 1-2 m in length.

Aquatic Communities

The vegetation at any one place usually consisted of a mosaic of discrete colonies, each of which was composed of one to three species. Similar mosaics were described for streams in Kentucky by Minckley (1963) and in Great Britain by Butcher (1933). Diversity was low, as is true of aquatic vascular plant communities in general (Curtis 1959; Hynes 1970). Only about 1 to 5 species occurred in short reaches of about 30 m with a maximum of 14 species in reaches of about a mile in length.

The instability of the stream habitat probably prevents development of climax communities in the usual sense (Hynes 1970). The presence of well-developed vegetation in terms of both species diversity and size of plants probably indicates relatively stable local environmental conditions. Examples of such apparently stable reaches with well-developed vegetation are the Pine River between La Salle Falls and the power plant impoundment, portions of Reach 10 of the Popple River between Big and Little Bull Falls, two portions of Reach 1 of the North Branch of the Pine, several portions of Reach 3 of the Pine, the very wide and slowly flowing part of Reach 9 of the South Branch of the Popple, the delta of the Pine River at its junction with the Menominee, Halls Creek and Long Lake outlet creek.

In view of the probable absence of climax communities stream mactophyte community types in the Pine-Popple system are better defined using physical habitat features and growth form of the vegetation rather than species composition. The most important habitat factors appear to be current rate and the very closely related substrate type. For the sake of simplicity the following classification of community types ignores size of stream, variability in current, damming by beavers, nature of the surrounding land and other factors that may be locally important.

(1) Torrential reaches with rocky substrates. These were nearly barren of macrophytes except for a few algae, bryophytes and lichens on the rocks. Small colonies of *Sparganium* and other rooted species occasionally occurred in places protected from the strong current. Most quiet pools between rapids contained only a few scattered plants or were barren of vegetation.

(2) Areas of fast to moderate currents with cobble, gravel or sand substrates and vegetation of submerged rhizomatous plants that do not usually form silt mounds but are effective in stabilizing bottom materials. Plants developed to full size only in slower currents and

on finer substrates. *Fontinalis* and large filamentous algae attached to rocks were locally important in smaller streams.

(3) Areas as in type 2 but with vegetation consisting predominantly of dense bushy masses (especially *Ranunculus* and *Elodea*) that are most effective in forming silt mounds.

(4) Reaches with very slow currents, silt or organic bottom and often very dense vegetation of various growth forms including the waterlilies *(Nymphaea* and *Nuphar)* and several large *Potamogeton* species with floating leaves. This type was especially well developed in the broad parts of South Branch of the Popple River (Reach 10), Halls Creek (Reach 12) and other reaches that represent a transition between stream habitats and eutrophic lake habitats, as well as in the man-made impoundments

(5) Permanently submerged bars with little current and silt or organic bottom, with submerged vegetation of most growth forms except rootless plants, especially small, delicate plants of *Callitriche, Potamogeton pusillus* and *P. foliosus.*

(6) Shallow areas, including bars and islands, with slow currents and silty bottom and with mostly emergent reed-like vegetation such as *Sparganium* and *Equisetum.*

(7) Deep channels in medium sized reaches where the current is moderate near the surface but very slow near the bottom, the vegetation predominantly bushy masses of rootless plants *(Ceratophyllum* and *Utricularia).*

(8) Old channels partially cut off from the main stream with soft black mud bottom, the vegetation often dense and consisting mostly of submerged leafy plants such as *Elodea, Ranunculus* and *Potamogeton.* These channels occurred only on the small streams, were usually surrounded by sedge-grass-shrub meadows, and usually held about enough water to float a canoe.

(9) Wet stream borders with vegetation consisting of perennial herbaceous or woody plants that tolerate flooding at high water stages. Plants rooted on the banks and floating out into tte streams *(Polygonum amphibium* and *Potentilla palustris)* were occasional in the smallest streams and beaver ponds.

(10) Braided reaches with little vegetation were occasional on the smaller streams and supported most growth forms.

Environmental Relationships

Some of the apparent relationships between environmental factors and the presence, luxuriance and species composition of the vegetation are briefly discussed below. Since the stream habitat is extremely complex and dynamic (Hynes 1970; Westlake 1975; Haslam 1978), species-habitat relationships are exceptionally difficult to determine.

All rooted aquatics that formed either extensive colonies by means of rhizomes or dense masses probably were effective in stabilizing bottom materials. Dense masses of plants, particularly of "bushy" plants like *Elodea* and *Ranunculus*, also impeded the flow of the water and thereby formed mounds of sediments deposited among and downstream from the plants as described by Butcher (1933), Gessner (1955) and Minkley (1963).

Both the amount and species composition of the vegetation varied strikingly over short distances in most reaches without evident differences in the habitat. It seems reasonable to assume that such vegetational differences are often due to the instability typical of stream habitats; catastrophic events such as scouring of bottom materials at periods of high water, shifts in the channel, the movement of ice formed on the bottom in winter, and the impounding of smaller streams by beavers may suddenly eliminate vegetation from local areas and therefore prevent the establishment of stable communities.

As the Pine River was essentially barren of aquatic vegetation for several miles below the dam to an area about one mile east of the Florence County Highway N bridge, the power dam apparently has a pronounced adverse effect on the vegetation, probably because of the extreme daily fluctuations in discharge resulting from the operation of the power plant. Farther downstream, vegetation gradually increased in quantity and species diversity until it was comparable to areas upstream from the impoundment.

Small streams that were heavily shaded by overhanging alders were mostly barren of aquatic vegetation, whereas unshaded portions of the same streams were often well vegetated. Except for Woods Creek and some reaches of the smaller tributaries, streams in the Pine-Popple system were rarely heavily shaded.

The current velocity obviously has major effects on both the amount and species composition of the vegetation, although this environmental factor is extremely difficult to assess. Current largely determines average particle size of bottom materials as well as the accumulation of organic materials and fine silt particles that hold nutrients (Westlake 1975). General correlations between current and growth form of vegetation were described under Aquatic Communities and Growth Form. In addition, there was a general correlation between species and current. Some species (e.g.

Sparganium chlorocarpum and most submerged rhizomatous species) occurred in all but torrential currents, whereas others were found mostly in a narrow range of currents. Species restricted mostly to faster currents were *Sagittaria cuneata* and *Heteranthera dubia*. Plants restricted to very slow currents and silty substrates were the water-lilies, *Callitriche, Potamogeton pusillus*, unattached plants (*Ceratophyllum, Utricularia* and the floating duckweeds), floating bank plants of community type 9 and all emergents except *Sparganium cholorcarpum*.

Those few areas of bottom covered with dense layers of organic material were usually barren of vegetation. The following are notable examples: (1) The three reaches of the North Branch of the Pine River described below in the discussion of turbidity; and (2) just downstream from Kimball Creek in the upper Pine River, where the bottom was covered with submerged woody twigs and branches.

Vegetation was generally absent from water deeper than about 1.5 m. In addition, some species showed definite "preferences" for particular water depths. Plants largely restricted to water deeper than 1 m were *Sagittaria cuneata* and *Potamogeton nodosus* in moderate currents, and *Ceratophyllum* and *Utricularia vulgaris* in very slow currents. Plants largely restricted to shallow water were *Callitriche verna, Elodea, Potamogeton foliosus* var. *macellus, P. pusillus, Ranunculus* and all of the emergent aquatics.

The only three turbid reaches noted, all of which were bordered by tamarack and white cedar swamps in slow flowing portions of the North Branch of the Pine River, were nearly barren of vegetation in contrast to the clear reaches immediately adjacent, which were generally well vegetated. Two of these turbid reaches, each about 1/2 mile long, were upstream from Windsor Dam, one in Section 17 and the other in Sections 20 and 21; the third was just upstream from a beaver pond about 1 mile downstream from Windsor Dam in Section 15 or 22.

In all three reaches, numerous brown, flocculent masses of organic bottom material a few cm in diameter were floating on the surface, and the turbidity was apparently due to particles carried into the water by gas bubbles formed in the finely divided organic bottom. As these were also the only reaches in which this type of bottom was noted, both the turbidity and lack of vegetation appear to be related to bottom conditions.

Brown stain was especially pronounced in the water of Reach 2 of the Pine River upstream from the junction with the North Branch, in Reaches 7 and 8 of both branches of the Popple River, and in Jones Creek. The stain was more pronounced during periods of high flow. It apparently originated in the large tamarack and black spruce swamps present near these reaches. It gradually became less evident downstream, presumably due to dilution with clear waters, until the Pine River below the junction with the Popple was nearly colorless at low flow. Neither the amount of vegetation nor the number of species were markedly different in the reaches with brown water compared with the reaches with colorless water (Tables 1 and 2).

Comparison of the available data on water chemistry (Mason and Wegner 1970; Northeastern Wisconsin Regional Planning Commission 1970; Oakes et al. 1973) with distribution of aquatic plants in the Pine-Popple system reveals no obvious correlations. The effects of water quality are suggested by the restriction of several species (Table 2) to the mouth of the Pine River where water is impounded by a power dam located on the Menominee River about two miles downstream, as well as by the very dense masses of *Potamogeton nodosus* in the lower Pine River (Reach 6) just downstream from the entrance of Pine Creek, in which a nitrate concentration of 9.1 mg/1—more than 10-fold higher than in most other analyses—was reported by Oakes et al. (1973).

Plant assemblages recorded in particular major reaches always included a mixture of species normally found in soft water and oligotrophic habitats as well as species normally found in hard water and eutrophic habitats according to the data of Moyle (1945) and Swindale and Curtis (1957). The important "soft-water" species were *Callitriche verna*, *Potamogeton alpinus* and *P. epihydrus:* the important "hard-water" plants were *Potamogeton richardsonii*, *P. zosteriformis*, *P. pectinatus*, *Ranunculus* sp., and probably also *Elodea* sp. and *Sagittaria cuneata*. It is therefore reasonable to conclude that all major reaches were moderately rich in available plant nutrients and could be termed mesotrophic. The electrical conductivities and other parameters reported by Oakes et al. (1973) fall generally in the range of the mesotrophic plant communities studied by Swindale and Curtis (1957). Hard-water species (Groups 3 and 4 of Swindale and Curtis 1957) were about twice as important in downstream reaches 4, 5, 6, 8 and 10 as in the upstream reaches 1, 2, 3, 7, and 9, suggesting that the general availability of nutrients and hardness increased downstream as would be expected. Soft water species were about equally abundant in both upstream and downstream reaches.

Finally, two emergent species deserve special mention as indicators of particular environmental conditions. *Sparganium eurycarpum* was recorded only in two locations where unusually high nutrient contents might by expected: on deep, soft organic bottom in Long Lake outlet creek, which may receive septic drainage from the resorts on Long Lake, and on silt bars near the mouth of the Pine River, where water is backed up by a dam on the Menominee River. In my experience in the Midwest, this species is restricted to very eutrophic habitats and is probably a good indicator of nutrient-rich conditions. Also, *Scirpus validus*, which was very common on stream bars but absent from lakes, is mostly restricted to pioneer habitats and thus is an indicator of disturbance of the substrate (Smith 1973b).

Vegetation of Stream Reaches

The following brief characterization of the vegetation of the 14 major reaches emphasizes exceptional features. Because of the great variability of most reaches, much information must be omitted. Many tributary creeks not described separately are described for about 100-200 m upstream from their mouths. See Figure 1 and Table 1 for description of reaches and Table 2 for species lists.

Reach 1. Very little in the upper reaches except in the slow reach near the Howell Lake outlet creek; very dense and luxuriant, often forming 50-100% cover, in three reaches east of Howell Lake near the FSR 2434 and 2174 accesses in Sections 17, 18 and 20 of R13E, T40N, and just west of STH 55 in Sections 23 and 26.

Reach 2. Generally very scattered and poor in species; dense beds of *Nitella* and *Fontinalis* in and near the headwaters, deeply submerged *Ceratophyllum* between Pine River Campgrounds and Jones Dam. *Kimball Creek:*Mostly dense *Sparganium* beds.

Reach 3. Moderately developed; greatest diversity (9 species) and abundance in several reaches with moderate current and sandy bottom upstream from the county line near FSR 2169 (Sections 11, 12 and 1 of R12E, T39N), where *P. nodosus* reached its upstream limits in the Pine River.

Reach 4. Mostly very scattered, with large areas barren; moderately well developed in (1) a sandy reach about one mile long in Section 2 just upstream from Chipmunk Rapids which supported an unusually rich flora of 9 species, (2) a cobbled reach about 100 m long in the middle of Section 5 east of Chipmunk Rapids with 5 species and a plant cover of about 50%, and (3) a similar cobbled reach with 6 species about 1/4 mile upstream from the Bessie Babbet Lake outlet creek. Bessie Babbet Lake outlet creek: Meandered through *Typha latifolia* marsh and wet meadow near the lake and then conifer-hardwood forest to the river.

Reach 5. Often abundant and luxuriant, even in the main channel, down to the rock ledge at Halls Creek just above the flowage, the 15 species generally similar to those of the reaches of the Pine upstream from the Popple except that *Potamogeton nodosus* was the most abundant species and both *P. epihydrus* and *P. zosteriformis* were common. The Pine Flowage was largely barren of vegetation except for locally dense colonies in the north arm.

Reach 6. Completely lacking for about three miles downstream from the dam except for *Fontinalis* on rocks near the banks, then *Heteranthera, Potamogeton alpinus* and *Vallisneria* (noted elsewhere only at the Pine River mouth) gradually becoming common to occasionally abundant in the north part of Section 26 and south part of Section 23; *P. nodosus* nearly filling the main channel just downstream from Pine Creek and occasionally abundant down to the mouth; vegetation abundant and luxuriant in the semi-impounded reach of about 3-400 m near the mouth; luxuriant and rich in species in a backwater on the north side of the river mouth, including several species recorded nowhere else in the streams.

Lepage Creek (Section 19, R19E, T39N): Barren of aquatic vegetation.

Reach 7. Very luxuriant and completely filling the water in slowly flowing reaches, common elsewhere; flora transitional between that typical of flowing water and that typical of lakes; widest reaches with little current dominated by *Nitella* and *Utricularia vulgaris* with smaller colonies of *Nuphar, Potamogeton alpinus, P. epihydrus, P. zosteriformis, Ceratophyllum* and *Fontinalis;* narrower reaches with more current supporting abundant *Sparganium* with some *Sagittaria cuneata, Potamogeon zosteriformis* and *Callitriche.*

Reach 8. Poorly developed in most reaches except for locally dense stands of *Sparganium* throughout; moderately abundant and diverse in the meandered reach in Sections 13, 14, and 23 (10 species) as well as in a reach in Section 18 south of Morgan Lake (9 species).

Reach 9. Locally luxuriant but some reaches barren; *Potamogeton alpinus* generally common and 7 other species very local down to the slow reach near FSR 2159; luxuriant, with 14 species, in about one mile of slow-moving reaches upstream and mostly downstream from FSR 2159 where *Sparganium chlorocarpum, Sagittaria cuneata, Elodea nuttallii, Potamogeton alpinus, P. obtusifolius* and *P. pectinatus* and *P. zosteriformis* dominant just above the impoundment, which was about 60 m wide, nearly filled with silt, and occupied by a dense stand of emergent *Eleocharis "palustris"* and *Leersia oryzoides* as well as *Potamogeton zosteriformis, P. pectinatus* and *P. natans* (observed in streams only in the upper reaches of Halls Creek).

Reach 10. Often luxuriant except for rapids areas, with 14 species, between the South Branch and Little Bull Falls (Section 14/23 boundary), especially in a region of swampy forest in the NE 1/4 of Section 23 and SE 1/4 of Section 14; very luxuriant, with 14 species, in a small reach downstream from the 2nd rapids below Little Bull Falls; elsewhere very sparse.

Lamon-Tangue Creek: Abundant flowering *Ranunculus.*

Reach 11. Locally common but nowhere very luxuriant, much less abundant than in Halls Creek, poor in species. Dooley's Pond nearly barren but with scattered, mature plants of 6 species including 4 not observed elsewhere on Woods Creek. (Tables 2 and 3).

Reach 12. Locally abundant but absent from some areas; unusual features were locally extensive colonies of musk-grass *(Chara)* and several typical lake species, mostly between West Bass Lake and Halls Lake; an unusually rich flora of 23 species; *Sparganium* absent from Section 11, *Chara, Nitella, Nuphar* and *Nymphaea* abundant and seven other typical lake species present in "Halls Lake" (formed by large beaver dam).

Reach 13. Generally well-developed, *Sparganium* especially abundant, beaver ponds mostly barren.

Reach 14. Locally dense, *Potamogeton obtusifolius* unusually abundant.

Reach 15. Mostly very dense and luxuriant except for some barren areas with brown organic substrate; several large stands of emergent *Scirpus validus, Sparganium eurycarpum, S. chlorocarpum* and *Typha latifolia.*

VEGETATION OF LAKES AND IMPOUNDMENTS

The species and their relative abundance in 9 natural lakes and 5 artificial impoundments are listed in Table 3. Vegetation in most lakes was very locally distributed, with fairly dense colonies scattered in water about .6 to 1.8 m deep.

The lake flora was generally poor in both emergents and floating plants. The only important emergent was *Scirpus acutus*, which often formed colonies in 0.6 to 1.3 m of water, usually in sandy or gravelly substrates. Its sister species *S. validus*, which was common on stream bars, was recorded in lakes and impoundments only in the Pine River Flowage. Other emergents *(Eleocharis smallii, Dulichium arundinaceum, Sparganium angustifolium)* were extremely local. Floating plants (the duckweeds—*Lemnaceae*) were limited to a small amount of *Spirodela polyrhiza* on Fay Lake. The lack of duckweeds probably reflects the low nutrient content of most of the surface waters in the lakes.

Submerged communities ranged from those typical of very oligotrophic conditions to those typical of moderately eutrophic conditions according to the ordination of Swindale and Curtis (1957). Oligotrophic conditions were indicated by deeply submerged dwarf rosette plants *(Isoetes, Lobelia dortmanna, Eriocaulon septangulare, Juncus pelocarpus* and *Eleocharis acicularis)* in three sandy lakes with very small inlets and outlets, most notably Morgan but also Butternut and Keys Lakes. Relatively eutropic conditions were indicated by communities of large plants with elongated leafy stems (especially *Potamogeton* spp.) and floating-leaved plants *(Potamogeton natans, Nuphar, Nymphaea)*. The most extreme eutrophic conditions were evident where large amounts of soft silt and organic substrates had accumulated and were populated by very dense colonies of large submerged plants. In the natural lakes, eutrophic conditions were restricted to small deltas at the inlets (e.g., Long and Fay Lakes), whereas in three of the impoundments as described below eutrophic conditions extended throughout the entire pond. No communities at the extremely eutrophic end of Swindale and Curtis' scale were noted.

The five artificial impoundments on the streams differed strikingly in the luxuriance of vegetation. In the Pine River Flowage formed by the power dam, the plants covered only a very small percentage of the bottom, even though water depths were mostly less than 2 m, the water was quite transparent, and the river was densely vegetated immediately upstream from the flowage. "Dooley's Pond" on Woods Creek was also very poorly vegetated. In contrast, the following three impoundments were very densely vegetated, the plants nearly filling the entire water mass: (1) The small pond formed by a dam on the South Branch of the Popple River about 1 1/2 miles due south of Morgan Lake, (2) "Halls Lake" on Halls Creek, and (3) "Forest Lake Flowage" on Mud Creek, about

TABLE 3. Presence and relative abundance of aquatic macrophytes in lakes and impoundments of the Pine-Popple River watershed [1]

Species	Aquatic Plant Type[2]	LAKES									IMPOUNDMENTS				
		Morgan	Butternut	Keys	Fay	Bessie Babbet	West Bass	Emily	Long	Seidel	S. Br. Popple Pond (Part of Reach 9)	Pine R. Flowage (Reach 5b)	Woods Creek "Dooley's Pond" (Part of Reach 11)	Forest Lake Flowage	"Hall's Lake" (Part of Reach 12)
Acorus calamus	E											1			
Callitriche verna (palustris)	S			1							1				
Ceratophyllum demersum	S				1							2			
Chara sp.	S			3	2	3	3	3							3
Dulichium arundinaceum	E		2												
Elodea nuttallii (occidentalis)	S			3	3										
Elodea sp.	S											1			
Eleocharis acicularis	S		2	1						x		2			
E. smallii	E		2												
Eriocaulon septangulare	S	3													

Species	Aquatic Plant Type[2]	LAKES: Morgan	Butternut	Keys	Fay	Bessie Babbet	West Bass	Emily	Long	Seidel	IMPOUNDMENTS: S. Br. Popple Pond (Part of Reach 9)	Pine R. Flowage (Reach 5b)	Woods Creek "Dooley's Pond" (Part of Reach 11)	Forest Lake Flowage	"Hall's Lake" (Part of Reach 12)
Heteranthera (Zosterella) dubia	S									x					
Isoetes macrospora	S	2	2	2											
Juncus pelocarpus	S		2	1											
Lobelia dortmanna	S	3													
Megalodonta (Bidens) beckii	S				1				x	x					
Myriophyllum exalbescens	S				1					x					x
M. tenellum	S			1											
M. verticillatum	S				1										
M. sp.	S							x							
Naias flexilis	S			2	x		x				x				

Nitella sp.	S														3
Nuphar variegatum	SF			2	2	3	3		x			2		3	3
Nymphaea tuberosa	SF			2	2	3	3		x						3
Polygonum amphibium (natans)	SF					1			1						
Potamogeton alpinus (tenuifolius)	SF											1	1		
P. amplifolius	SF			3	3	1	3		2	x		1			
P. epihydrus	SF			2						x		2		2	2
P. filiformis	S							x							
P. foliosus	S				x								1	3	
P. friesii	S								2						
P. gramineus	SF			2		3	3			x	x				x
P. illinoensis	SF				1	x		x	3						
P. natans	SF				1	3			2		3			3	x

Species	Aquatic Plant Type[2]	LAKES									IMPOUNDMENTS				
		Morgan	Butternut	Keys	Fay	Bessie Babbet	West Bass	Emily	Long	Seidel	S. Br. Popple Pond (Part of Reach 9)	Pine R. Flowage (Reach 5b)	Woods Creek "Dooley's Pond" (Part of Reach 11)	Forest Lake Flowage	"Hall's Lake" (Part of Reach 12)
P. obtusifolius	S										1		1		
P. pectinatus	S			1		2						1			
P. praelongus	S				3	x	x		2						
P. pusillus (including berchtoldii)	S				x								x		
P. richardsonii	S				2							2	2	1	
P. robbinsii	S								2						
P. strictifolius	S			1	1?				1						
P. zosteriformis	S				3	1	x	x			3	1		2	x
P. foliosus or pusillus	S				1								1		1
Ranunculus trichophyllus	S											1	1		

Sagittaria cuneata?	S		3												
Sagittaria latifolia?	E			1											
Scirpus acutus	E		3	1	1	3		3	3	x				2	
S. validus	E											2			
Sparganium angustifolium	SFE	2													
S. chlorocarpum	SE								1						
S. sp.	S														x
Spirodela polyrhiza	F				1										
Utricularia intermedia	S				1	x						x			
U. vulgaris	S				2	x								3	
Vallisneria americana	S									x					

[1]Numbers refer to abundance: 1—rare to uncommon; 2—common; 3—abundant, often forming extensive stands; x—present but abundance unknown. *Found in impoundment only.
[2]E = emergent; S = submergent; F = floating.

1 1/2 miles west southwest of the village of Fence, Florence county. It seems likely that the density of vegetation in these three impoundments is due primarily to the fertility of their deep, soft, black bottom sediments, which may have been deposited during past logging and farming activities in the watersheds. The poor development of vegetation in the Pine River Flowage may be due to fluctuations in water level caused by operation of the power plant, whereas the sparse vegetation in Dooley's Pond may be due to the same unknown factors that limit the vegetation in Woods Creek.

A comparison of the floras of lakes and impoundments with those of streams shows that about 13 "lake plants" were mostly restricted to lakes whereas about 14 "stream plants" were mostly restricted to streams. The remaining species may be placed along a spectrum between these two extremes, except for the species that were recorded so infrequently that their habitat correlations are obscure.

The most notable "lake plants" were the five dwarf rosette plants of oligotrophic habitats (Fassett 1930) as described above. The following seven additional common lake plants were rare in streams, where they were restricted to locations with little or no current: *Chara*, *Nuphar*, *Nymphaea*, *Potamogeton amplifolius*, *P. illinoensis*, *P. natans* and *Scirpus acutus*. The "stream plants" include the three most important plants of the streams (*Sparganium chlorocarpum*, *Potamogeton alpinus* and *Ranunculus)*. Somewhat less important "stream plants" are *Callitriche verna*, *Elodea*, *Equisetum fluviatile*, *Fontinalis*, *Heteranthera*, *Potamogeton berchtoldii*, *P. foliosus*, *P. obtusifolius*, *P. nodosus*, *Sagittaria cuneata* and *Scirpus validus* (on bars). The following species were about equally common in lakes and streams: *Potamogeton epihydrus*, *P. gramineus* and *P. zosteriformis*.

The contrast between stream and lake floras is particularly evident at lake inlets and outlets. Observations were made especially at Keys, West Bass, Bessie Babbet, Long and Butternut Lakes as well as at the impoundments studied. Characteristically, there was a pronounced change in flora within 30 m or less along a transect from the lake into the flowing water of the stream. Calculations for two lakes (Keys and Bessie Babbet) and three impoundments (Pine River Flowage, South Branch of Popple and Dooley's Pond) show that only about 5 to 35% of the total number of species found in a particular lake and its inlet or outlet stream were present in both the lake and the stream; in other words, from 65% to 95% of the species were restricted to either the lake or the stream. As the lake floras usually included more species than did the stream floras, more species were usually restricted to the lakes than to the streams. Occasionally, as at the head of the Pine River at Butternut Lake and at the outlet of Long Lake, fragments of typical lake plants (e.g., *Myriophyllum*, *Ceratophyllum*, *Naias flexilis*) were established just below the lake outlet, but these did not occur more than a mile or two downstream.

A striking exception to the rule that stream vegetation differs from lake vegetation is Long Lake outlet creek, which supported luxuriant vegetation floristically more typical of lakes than streams (Table 2). This stream is unusual (probably unique) in this region in that it receives water over the top of a small dam from a lake that has several resorts on its shores. The stream also has been strongly influenced by construction of a railroad, a highway, and several dwellings.

The only apparent cultural eutrophication of a lake was at Fay Lake where massive floating blooms of filamentous algae (mostly *Cladophora*) adjacent to a resort near the south end of the lake suggested that large amounts of nutrients were entering the lake from the resort.

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THE STATUS OF THE TIMBER WOLF IN WISCONSIN — 1975

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ABSTRACT:

Wisconsin's breeding population of timber wolves (*Canis lupus*) was exterminated in the late 1950's. The results of a summer and winter search and a review of reported observations indicates that wolves are present, at least sporadically, in Wisconsin. Wolves currently existing in this state are believed to be immigrants from the Minnesota population. Human activity apparently prevents wolves from successfully reestablishing themselves in Wisconsin. Wolf populations in the Upper Peninsula of Michigan and in Wisconsin are extensions of the Minnesota peripheral wolf range.

INTRODUCTION

The eastern timber wolf (*Canis lupus lycaon*) is classified as an endangered species under the Endangered Species Act of 1966. The only viable populations existing in the conterminous United States are in northern Minnesota and in Isle Royale National Park, Michigan (Hendrickson, et al, 1975).

The native wolf population in the state of Wisconsin declined rapidly during the early 1950's (Keener, 1970) and was probably eliminated by 1960. However, periodic sign of these animals has been noted in the state since 1960. This study was made to determine the status of the timber wolf in Wisconsin in 1975. Field searches were conducted in three northern Wisconsin areas to determine if wolves were present during the summer of 1974 and winter of 1974-75. All three areas (Fig. 1) are located within the northern highlands geographical region (Martin, 1932) and are dominated by aspen (*Populus tremuloides*), sugar maple (*Acer saccharum*), and red maple (*A. rubrum*) on the well drained sites, and by balsam fir (*Abies balsamea*), white spruce (*Picea glauca*), and black spruce (*P. mariana*) in the lowlands. The field work in 1974 was funded by the University of Wisconsin-Stevens Point (UWSP) and the United States Forest Service (USFS).

Present range of timber wolf in Michigan (Hendrickson, et. al., 1975)

Consistent use areas of timber wolf in Wisconsin

1946-48 timber wolf range, Wisconsin (Thompson, 1952; Thiel, unpubl. notes)

Fig. 1. Timber wolf range in Wisconsin and Upper Peninusla of Michigan — 1975.

METHODS

Data on Wisconsin wolf activity had been collected between 1969 and 1974. Thirty-one individuals (trappers, permanent residents in areas of former wolf activity, and professional biologists) were contacted and 132 responses were received from the surveys. Reports were reviewed and accepted as valid only if the person reporting had a professional wildlife background or was considered a reliable observer.

A method of using broadcast howls is accepted for censusing wolves in heavily forested regions (Pimlott, et al., 1969). Joslin and Pimlott (1968) were also successful with this method in establishing the presence of red wolves (*Canis rufus*) in the southcentral United States. Broadcast howls were used to search for timber wolves in this study.

Tape-recorded howls were obtained from a recording of wolf howls produced by the US Museum of Natural History and were tested on captive wolves at Eagle, Wisconsin. The broadcasting equipment included an amplifier (20 watts); two high fidelity speakers (tweeter and woofer) mounted on top of an automobile; HF Control/crossover network (1000 cycles); and a Wollensac tape recorder. The system was powered by a 12-volt battery with a DC to AC converter. A second tape recorder (Soni) was equipped with a recording parabola to record wolf response. Broadcast howls had a minimum range of 1.6 km (1 mi.) in dense conifer cover with little or no wind. Human imitations of howls had a minimum range of 1.2 km (0.75 mi.) under the same conditions. Howls were broadcast at

1.2 to 2.0 km (0.75 to 1.25 mi) intervals, depending on wind. Human imitation of howls were used twice in areas inaccessible by automobile. Howls were broadcast for a period of two minutes and were followed by a listening period of four to five minutes. Howls were broadcast on 28 days between 16 July and 21 August, 1974; a time designated as a period of peak responsiveness (Joslin, 1967; Harrington, personal communications). Most howling was broadcast between sunset and midnight, the daily peak in responsiveness (Joslin, 1967). Additional howling was conducted between midnight and 0700 Central Standard Time (CST).

Track searches were made in the three study areas between 19 December, 1974 and 6 January, 1975. Roads in the study areas were traveled by slow moving automoble while an observer watched for tracks near the road.

All scats greater than 28 mm were collected for analysis. Tracks over 76 mm in diameter were considered potential wolf tracks; the arrangement and shape of the track aided in differentiating between large dog (*Canis familiaris*) and wolf.

RESULTS

Eighty-three observations of wolves or their sign were reported between 1 January, 1968 and 31 December, 1975. A minimum of 83 wolves were involved. Numbers of wolves were not reported in 19 instances. Single wolves were reported 50 times (60 percent) two wolves 12 times (29 percent); and trios on three (11 percent) occasions (Table 1).

Table 1. Reported observations of timber wolves in Wisconsin.

Year	Number of Observations	Number of wolves	Singles	Pairs	Trios
1968	6	10	5	1	1
1969	7	8	6	1	
1970	6	7	5	1	
1971	7	11	4	2	1
1972	9	10	8	1	
1973	16	21	12	3	1
1974	9	10	8	1	
1975	4	6	2*	2	
Total	64	83	50	12	3
Average/yr.	8	10.3			

*includes one car-killed animal.

Reports were clustered in four areas of which three were studied. Seventeen observations of wolves were reported from the Willow Flowage area (Willow Area) of west-central Oneida and east-central Price Counties. There were 31 observations reported from the northern portion of the Nicolet National Forest (Alvin Area) of eastern Vilas and northern Forest Counties, and nine observations in the No Mans Lake area of northeastern Iron and northwestern Vilas Counties. The fourth area in northeastern Washburn County (Fig. 1) was not studied although reports indicated occasional wolves.

Howling

Howls were broadcast for a total of 956 minutes over a distance of 1228 km (763 mi.). Listening time totaled 2811 minutes. A single timber wolf responded to human imitated howls on 16 August, 1974 at 1947 hours CST in the Alvin Area. This was the only wolf response elicited during the study. Coyotes (*Canis latrans*) replied to broadcasts of timber wolf howls on 39 occasions.

Winter tracking

The search for tracks covered 917 km (570 mi.) of road from 19 December to 21 December, 1974 in the Alvin, Willow and No Mans Lake Areas. From 2 January through 5 January, 1975, 1012 km (629 mi.) were traveled in the three study areas. Wolf tracks were not seen in any of the study areas during the survey.

Scat analysis

Five scats were collected from the Alvin Area during July and August, 1974. All scats were collected from roads and the diameters ranged from 29-40 mm. Red-backed vole (*Clethrionomys gapperi*) and meadow vole (*Microtus pennsylvanicus*) remains were found in 100 percent and 80 percent of the five scats respectively. Snowshoe hare (*Lepus americanus*) and insects each occurred in 60 percent of the scats. Grasses, balsam fir, and spruce fragments appeared in 100 percent, 40 percent, and 40 percent, respectively. Although scat volumes were not measured, voles were the primary and hare the secondary food items.

DISCUSSION

Distribution of wolves

Definite patterns in wolf activity are apparent from the distribution of observations in the northern counties. Random, sporadic activity is evident throughout northern Wisconsin. A report of a wolf wandering through a particular locality typifies such activity. Most areas do not possess adequate space secluded from human habitation and wolf activity is transitory.

In contrast, consistent use occurs in one northwestern and three north-central Wisconsin localities. Wolf activity is most intense in these areas where dispersing animals have the greatest amount of secluded habitat. Three of these areas lie within those that were the last to be inhabited by small family groups of wolves in the 1950's. Similar activity was also noted in Michigan's Upper Peninsula in recent years (Hendrickson, et al., 1975).

The Alvin Area, in the northern Nicolet National Forest, was the only area where timber wolf sign was located during the summer field work. Tracks of a pair of wolves were located on 9 March, 1975 less than 0.4 km (0.25 mi.) from the August, 1974 howl response. Wolves were not evident in the Alvin Area during the winter track survey suggesting that wolves using this region are probably wanderers and occasional visitors.

The Alvin Area wolf activity should be classified as contiguous with a range in Iron County, Michigan (Hendrickson, et al., 1975). Since the 1940's, Don Lappala has kept records of timber wolf activity in the Iron River, Michigan region. His reports since 1960, coupled with my findings during the past seven years, indicate that Wisconsin shares a small, unstable wolf population with the Upper Peninsula of Michigan (Fig. 1, Table 2).

Table 2. Yearly fluctuations in numbers of wolves reported from the Willow and Alvin, Wisconsin consistent use areas, and from southern Iron County, Michigan.[1]

Year	Number of wolves		
	Willow	Alvin	Southern Iron Co., Mich.[1]
1967	-	3	-
1968	3	1-2	1
1969	1	0	1
1970	1-2	1	1
1971	1-2	1	4[2]
1972	1-2	1	3
1973	1-2	1-3	1
1974	1	1	2
1975	0	2	2
Total (9 yrs.)	9-13	10-13	16

[1] Data supplied by Don Lappala, Iron River, Michigan.

[2] Two different pairs.

Developments in the Upper Peninsula of Michigan since the work of Hendrickson, et al., (1975) support the wolf distribution data from Wisconsin. In Menominee County, Michigan hunters shot a male wolf in November, 1974 and a female wolf in March, 1975. Of particular interest was a wolf, identified as a pup (Hendrickson, personal communications), killed by a deer hunter in the same county in November, 1966. Van Ballenburghe, et al. (1975) reported that pups in Minnesota were capable of extensive movements in late October, but that such movements were confined to the respective pack ranges. Kuyt (1972) studied a migratory Canadian wolf population and reported the recovery of a wolf pup 25.7 km (16 mi.) from its original point of capture in November, 1965. It is improbable that the Michigan pup dispersed from Ontario or Minnesota; it was more likely born in Michigan. Although sporadic breeding may help to maintain Michigan's small wolf population, Hendrickson, et al. (1975) overlooked this incident (Robinson; Hendrickson, personal conmunications). These recent occurrences east of Marinette County, Wisconsin, indicate the possibility of occasional use of northeastern Wisconsin by wolves.

State Population

The evidence (i.e., Hendrickson, et al., 1975; Weise, et al., 1975; and that in this paper) suggests that northern Wisconsin and the Upper Peninsula Michigan should be considered as one wolf range contiguous with Minnesota's peripheral wolf area. The actual number of wolves in Wisconsin is not known, but is undoubtedly low (Table 1). The number of wolves recorded for each year of this study provide a rough indication of the magnitude of the unstable Wisconsin population.

Maintenance of numbers

The presence of wolves in Wisconsin appears to be a result of individuals immigrating from Minnesota rather than of breeding in Wisconsin. A lone radio-tagged wolf in Minnesota traveled 207 air km (129 mi.) after release before its signal was lost (Mech, et al., 1971). Since the northwestern tier of counties in Wisconsin is approximately 193 km (120 mi.) from the primary wolf range and borders the peripheral wolf range in Minnesota it is probable that dispersing wolves do enter Wisconsin. Keener (1970) reported that a wolf was killed by a car in Douglas County in 1966. A 26.3 kg (58 lb.) yearling female wolf was killed by a car in the same county on 3 August, 1975. It is likely that both wolves were dispersing from Minnesota.

Habitat in Wisconsin

In addition to large blocks of land where wolves can roam, good wolf habitat requires adequate ungulate densities and secondary prey populations. Current deer populations (*Odocoileus virginianus*) in northern Wisconsin are approximately 3.9/km^2 (10/mi^2) (Wisconsin Department of Natural Resources, Unpubl. figures). This density can support wolves (Pimlott, 1967). Beaver (*Castor canadensis*) and snowshoe hare, considered secondary prey items of wolves in the Great Lakes region (Stebler, 1944; Mech, 1970), are present in northern Wisconsin. From the standpoint of food Wisconsin is capable of supporting wolves; however, large blocks of land where wolves can complete their normal life cycle unmolested are presently not available. Weise, et al. (1975) tabulated data on human densities occurring in several wolf ranges in the upper Great Lakes region. Wisconsin shows the highest densities with a rural population of 4.75 persons/km^2 (12.3 persons/$mi.^2$). High human density reflects a large, well developed rural road system which exposes wolves to an unnaturally high mortality rate caused by man. Mech (1973) stated that in areas of Minnesota with high road densities, lone wolves and occasional pairs constituted the largest social units and full-sized packs seldom had the chance to develop (Table 2). He observed that small populations persisted in accessible areas since there was a recruitment of wolves " . . . from the reservoir packs in wilderness areas".

A human density of 0.7 persons/km^2 (1.8 persons/$mi.^2$) is found in the 466 km^2 (180 $mi.^2$) Willow Area and in the 1093 km^2 (422 $mi.^2$) Alvin Area. Although this low human density enhances wolf habitat, the quality of these quasi-wilderness blocks is diminished by recreational pressure exerted by surrounding areas of high human density.

Limiting factors

At this time, deer hunters and coyote trappers are the greatest threat to timber wolves in Wisconsin. Hendrickson et al. (1975) attributed current low wolf numbers in Michigan to mortality from hunting and trapping. Two of four wolves transplanted into Michigan were shot, one was trapped, and one was killed by a car (Weise, et al., 1975). In addition, three native wolves were killed by hunters and one by a snowmobiler in recent years (Michigan Department of Natural Resources files).

Deterioration of Wisconsin's present wolf habitat may accelerate in the near future. Increased emphasis on year-round recreation and continued expansion of vacation home construction in northern Wisconsin may eventually destroy the last of Wisconsin's wild regions.

Recommendations

To reverse the deteriorating conditions which adversely affect the wolf, it is recommended that the Wisconsin Department of Natural Resources:

1) Require mandatory registration of coyotes taken in wolf activity areas. This may isolate the probable manner (i.e., trapping, sport and deer hunting) of wolf mortality.
2) Support effective zoning on federally or state owned lands to restrict the amount and type of human activity in the wilder regions.
3) Seek legislation that would allow farmers 100 percent unconditional reimbursement for depredations on livestock where coyotes and/or timber wolves were the proven cause of death (The current reimbursement is 80 percent of assessed value *if* the farmer's land is *not* posted against hunting).
4) Institute a public awareness program emphasizing the realistic, positive and negative aspects of the wolf.

If these steps are taken the final extirpation of the wolf in Wisconsin may be prevented. These actions may also enhance the possibility that wolves may be reintroduced successfully. Eventual reestablishment of a breeding stock of wolves is desirable. It is possible that northern Wisconsin will yet provide habitat for this unique wilderness species.

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LOSS OF ELM FROM SOME LOWLAND FORESTS IN EASTERN WISCONSIN

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ABSTRACT

Lowland forest communities in eastern Wisconsin have been decimated by Dutch elm disease (*Ceratocystis ulmi*). The three lowland stands studied were first infested in the early 1960s; many of the mature elms (mostly *Ulmus americana*) died long ago but their trunks are still standing. Incorporation of dead elm stems into importance value and density calculations reveal the former importance of elm in these communities. Density and basal area per hectare were substantially reduced by the loss of the larger elms. At present these stands include live elms, primarily in the smaller size classes. Elm appears to have the capability to persist, at least as a minor component for a decade and a half, but it is probable that associated species such as green and black ash (*Fraxinus pennsylvanica* var. *subintegerrima* and *F. nigra*) will become more important.

INTRODUCTION

Dutch elm disease, a vascular wilt caused by the fungus *Ceratocystis ulmi*, is thought to have entered the United States with infected elm timber designated for veneer; the disease was first identified in this country in Ohio in 1930 (Elton, 1958). The fungus is spread by several insect vectors and by root grafts; the most common vector in southern Wisconsin is the European bark beetle (*Scolytis multistriatus*), whereas the native bark beetle (*Hylurgopinus rufipes*) predominates in the northern half of the state (Worf, et al, 1972). The blight reached southeastern Wisconsin in 1956, and spread northward over most of the state by 1973

(Reynolds, Wisconsin Department of Agriculture, Plant Industry Division, personal communication).

Various studies have described forest devastation by the chestnut blight (Keever, 1953; Woods, 1953; Nelson, 1955; Woods and Shanks, 1957; and Mackey and Sivec, 1973); however, the effects of Dutch elm disease are less well documented. This study records the reduction of elm by the disease, documents the present composition of these forests and predicts future trends.

STUDY AREAS

Three communities with dead elms (*Ulmus americana*) were examined: stand 1 is in the Sheboygan County Arboretum, covering about 15 ha, SE 1/4 of the SE 1/4 of Section 19, T14N, R23E, stand 2 occupies about 5 ha in the S 1/2 of the SE 1/4 of Section 10, T16N, R21E; and stand 3, also approximately 5 ha, lies in N 1/2 of the NE 1/4 of Section 10, T13N, R21E; all are in Sheboygan County.

The soils in stands 1 and 2 are slightly acidic, deep muck in the Houghton series, and have a seasonal high water table. Stand 3 soils are Palms muck (slightly acid soil) and circumneutral Pella silty clay. These areas are examples of southern wet-mesic forest described by Curtis (1959).

METHODS

All woody stems over 2.54 cm dbh were sampled in 10x10 m quadrats; dead elms were included in this tally. These quadrats were established in a stratified random pattern (Oosting, 1956). A 1x4 m quadrat to sample woody stems less than 2.54 cm dbh was placed in a predetermined corner of each quadrat. Forty-five quadrats were sampled in stand 1 and forty quadrats each in stands 2 and 3.

Importance values (the sum of relative density, relative frequency, and relative dominance) were calculated for canopy trees (trees more than 10.2 cm dbh) and for the woody understory (2.5 to 10.2 cm dbh). Importance values were also calculated without inclusion of dead elms. The density of more important species was also tabulated by size class. Frequency and density was reported for seedlings and shrubs less than 2.5 cm dbh. Nomenclature follows Fernald (1950).

RESULTS

Elm importance in the overstory has been greatly reduced (Table 1). Elm density/ha and basal area (BA)/ha decreased in each stand, although the decline was much greater in stands 2 and 3 than in stand 1. Stand 1 is now dominated by yellow birch (*Betula lutea*), black ash (*Fraxinus nigra*), green ash (*Fraxinus pennsylvanica* var. *subintegerrima*), and red maple (*Acer rubrum*). Stand 2 is dominated by black ash, yellow birch, basswood (*Tilia americana*), and elm. Stand 3 is dominated by black ash, green ash, elm, and a red-silver maple hybrid (*Acer rubrum* x *A. saccharinum*).

Sapling data were divided into those for potential overstory species and for secondary trees and shrubs (Table 2). Dead elm had little or no effect on sapling importance values. The understory includes most of the canopy species. Secondary trees and shrubs are also important components in the understory, especially in stands 2 and 3; the secondary tree and shrub importance value is 50.8 in stand 1, 125.7 in stand 2, and 113.9 in stand 3.

Density was tabulated by size class to include dead elms (Table 3). It is evident that elm was formerly well represented in the larger size classes in all three stands. The smaller size classes contain large numbers of black ash in all stands, green ash in stands 1 and 3, yellow birch and red maple in stand 1 and box elder (*Acer Negundo*) in stand 2.

Density of woody species less than 2.5 cm dbh shows considerable variation (Table 4). In stand 1, with 25,889 tree seedlings/ha, the red-silver maple hybrid complex had the largest number followed by black ash, green ash, yellow birch, and finally elm. Stand 2, with 6188 tree seedlings/ha, contains black ash, box elder, elm, yellow birch and red maple, basswood, and sugar maple (*Acer saccharum*). Stand 3 contains even fewer seedlings, 3688/ha; including elm, green ash, and the red-silver maple complex. Conversely, the secondary trees and shrubs reach their highest value in stand 3, closely followed by stand 2, with fewest in stand 1.

DISCUSSION

Elm was formerly more important in these communities as indicated by incorporation of dead elms into the importance values for the reconstructed canopy (Table 1) and the reconstructed

Table 1. Species importance values with and without dead elm.[1]

Species	Stand 1		Stand 2		Stand 3	
	Incl. dead elm	Excl. dead elm	Incl. dead elm	Excl. dead elm	Incl. dead elm	Excl. dead elm
Betula lutea	89.9	108.8	36.7	66.1		
Fraxinus nigra	60.0	73.3	44.5	79.3	30.0	70.5
Ulmus americana	58.9	6.3	155.7	37.1	216.6	65.8
Fraxinus pennsylvanica var. *subintegerrima*	44.9	55.4	2.4	3.8	17.1	42.7
Acer rubrum	35.0	42.2	10.3	19.3		
A. rubrum x saccharinum	3.4	4.2			19.5	61.3
Betula papyrifera	3.2	3.8	9.1	16.6		
Acer saccharinum	3.0	3.8				
Tilia americana	1.7	1.9	30.5	60.9		
Acer Negundo			5.2	8.6		
Acer saccharum			2.4	3.9		
Carpinus caroliniana			2.4	3.9		
Salix nigra					11.9	47.9
Populus tremuloides					2.6	6.1
Quercus macrocarpa					2.5	5.5
Density/ha	613.3	540.0	290.0	172.5	377.5	130.0
BA (m^2/ha)	21.17	15.74	25.44	8.51	29.20	6.16

[1]Based on stems 10.2 cm DBH and larger.

Table 2. Summary of Importance Values for Trees and Shrubs 2.5-10.2 cm DBH

	Stand 1		Stand 2		Stand 3	
Potential overstory trees	**Incl. dead elm**	**Excl. dead elm**	**Incl. dead elm**	**Excl. dead elm**	**Incl. dead elm**	**Excl. dead elm**
Betula lutea	68.1	68.7	19.7	20.0		
Fraxinus nigra	66.2	66.8	45.6	46.2	48.5	49.7
Fraxinus pennsylvanica var. subintegerrima	50.3	50.9	11.7	11.9	91.1	93.2
Acer rubrum	32.4	32.7	22.5	22.8		
Ulmus americana	19.8	17.5	8.4	4.5	16.3	9.5
Acer rubrum x saccharinum	6.8	6.8			16.6	17.2
Acer saccharum	3.6	3.7	4.7	4.8		
Prunus serotina	.9	.9				
Tilia americana	.8	.8	16.6	16.9		
Ulmus rubra			2.8	2.9		
Acer Negundo			36.3	36.7	7.7	7.9
Betula papyrifera			7.7	7.7		
Salix nigra					3.2	3.4
Populus tremuloides					3.1	3.2
Quercus macrocarpa					2.0	2.1
subtotal	248.9	248.8	176.0	174.4	188.5	186.2

Secondary trees and shrubs						
Alnus rugosa	21.1	21.2			16.6	17.0
Prunus virginiana	9.8	9.8	13.6	13.9	15.8	16.2
Ilex verticillata	7.5	7.6	3.4	3.5		
Acer spicatum	6.6	6.6				
Amelanchier sp.	3.2	3.2				
Cornus stolonifera	1.7	1.7			5.4	5.5
Viburnum Lentago	.7	.7			39.6	40.5
Cornus alternifolia			71.0	71.9		
Crataegus sp.			8.2	8.3	3.6	3.7
Carpinus caroliniana			18.4	18.6		
Prunus nigra			4.8	4.9		
Salix Bebbiana			4.5	4.6		
Cornus obliqua					24.0	24.5
Vitis riparia					4.4	4.5
Cornus racemosa					1.9	2.0
subtotal	50.6	50.8	123.9	125.7	111.3	113.9
Density/ha	1433.3	1426.7	635.0	630.0	637.5	630.0
BA (m^2/ha)	2.96	2.92	1.14	1.13	1.41	1.36

Table 3. Density per size class per hectare for the important species.

Species	Size class in cm dbh 2.5-10.2	10.2-17.8	17.8-25.4	25.4-33.0	33.0-40.7	40.7-48.3	48.3-55.9	55.9-63.6	63.6	Total
Stand 1										
Betula lutea	286.6	168.9	51.1	13.3						519.9
Fraxinus nigra	351.1	57.8	53.3	15.6	2.2					480.0
Fraxinus pennsylvanica var. subintegerrima	235.5	31.1	22.2	13.3	6.7	2.2		2.2		313.2
Acer rubrum	131.1	51.1	15.6	4.4						202.2
Ulmus americana[1]	6.7	8.9	20.0	24.4	11.1	4.4	2.2	2.2		79.9
Ulmus americana	60.0	4.4	2.2	2.2						68.8
Acer rubrum x saccharinum	31.1	2.2		4.4						37.7
Stand 2										
Fraxinus nigra	110.0	20.0	15.0	15.0						160.0
Ulmus americana[1]	5.0	7.5	20.0	25.0	12.5	20.0	10.0	10.0	12.5	122.5
Acer Negundo	70.0	2.5	2.5							75.0
Betula lutea	32.5	20.0	2.5	12.5		2.5				70.0
Tilia americana	30.0	7.5	7.5	7.5	10.0	2.5				65.0
Acer rubrum	40.0	2.5	5.0			2.5				50.0
Ulmus americana	5.0	5.0	2.5	7.5	2.5	2.5				25.0
Fraxinus pennsylvanica var. subintegerrima	22.5	2.5								25.0
Stand 3										
Ulmus americana[1]	7.5	52.5	37.5	52.5	60.0	17.5	7.5	10.0	10.0	255.0
Fraxinus pennsylvanica var. subintegerrina	225.0	27.5								252.5
Fraxinus nigra	77.5	32.5	2.5							112.5
Acer rubrum x saccharinum	27.5	7.5	2.5	5.0	2.5	2.5		2.5		50.0
Ulmus americana	10.0	15.0	15.0	2.5						42.5
Acer Negundo	12.5									12.5

[1]dead trees only

Table 4. Woody species less than 2.5 cm DBH

Potential overstory trees	Frequency stand 1	2	3	Density/ha stand 1	2	3
Acer rubrum or A. rubrum x saccharinum	66.7	2.5	5.0	17722	188	625
Fraxinus nigra	46.7	47.5		2944	3688	
Fraxinus pennsylvanica var. subintegerrima	37.8		15.0	2778		1438
Betula lutea	24.4	2.5		2167	188	
Ulmus americana	11.1	15.0	17.5	278	625	1625
Tilia americana		2.5			125	
Acer Negundo		20.0			1313	
Acer saccharum		2.5			63	
Total				25889	6188	3688
Secondary trees and shrubs						
Ribes spp.	53.3	42.5	75.0	5278	8063	20000
Ilex verticillata	37.8	2.5		6000	500	
Cornus stolonifera	11.1	5.0	17.5	2944	2438	3438
Prunus virginiana	8.9	30.0	22.5	389	5625	1188
Acer spicatum	6.7	2.5		1389	63	
Rubus spp.	4.4	35.0	17.5	1222	13750	6563
Alnus rugosa	4.4			944		
Spiraea alba	2.2			111		
Amelanchier sp.	2.2			56		
Cornus alternifolia		50.0			5750	
Sambucus canadensis		10.0	2.5		1000	500
Cornus racemosa		10.0			1250	
Viburnum trilobum		5.0	2.5		688	2875
Viburnum Lentago		5.0	12.5		563	3000
Carpinus caroliniana		2.5			563	
Rhus radicans		2.5				
Cornus obliqua			17.5			5500
Vitis riparia			5.0			188
Total				18333	40250	43250

understory (Table 2) and by the prominence of dead elms in larger size classes (Table 3). Dutch elm disease entered Sheboygan County, Wisconsin in 1960 (Plant Industry Division, Wisconsin Department of Agriculture), and thus stand reconstruction is still possible; it will become progressively more difficult as standing dead elms fall. Reconstruction of these stands implies some reservations. Inclusion of dead elms gives an overestimation of the BA/ha and the density/ha, since the surviving trees have grown since the death of the elms. The BA of the dead elms is under estimated since many of these stems are devoid of bark at breast height; fortunately all dead trees encountered had enough bark to distinguish American elm from slippery elm.

Wetter lacustrine swamps in Wisconsin usually contain combinations of silver maple, green or black ash, and American elm. Based on importance values these species vary greatly in relative importance from stand to stand (Ware, 1955). The stands in this study show a considerable range in original importance of elm (Stand 1 20%, Stand 2 50% and stand 3 72%) (Table 1). Thus the loss of mature elms produces a greater degree of disturbance and change in composition in stands 2 and 3 than in stand 1. Stands 1, 2 and 3 have dead canopy or overstory elm (<10.2 cm dbh) densities of 73.2, 117.5, and 247.5/ha respectively. Stands 2 and 3 are now relatively open communities, with vigorous shrub-layer development. Secondary trees and shrubs have an importance value of only 50.8, in stand 1, but show values of 125.7 and 113.9 respectively in stands 2 and 3 (Table 2). The results of overstory losses are also seen in the seedling data (Table 4).

The well documented case of the American chestnut blight provides a model by which to estimate possible effects of the Dutch elm disease. Braun (1950) noted that, in forests damaged by the chestnut blight, the reduced canopy temporarily favored the least tolerant of the undergrowth trees. With the reduction of the elm, box elder, a species considered long-lived sub-climax by Ware (1955) and climax on bottomlands by Guilkey (1957), appears to be invading openings in stand 2, and to a lesser extent in stand 3. In Wisconsin lowlands, box elder develops near the edges of the stand (Vogl, 1969); it was assigned a low adaptation number by Curtis (1959). Spurr (1964) reported that the American chestnut was being replaced by its former associates. Replacement of the American elm by its former associates seems evident in this study, though the long term result is difficult to predict the elm disease entered the area only about 15 years prior to this study and a new equilibrium has not been established. Black and green ash seem successful in this replacement as indicated by high densities in the smaller size classes in all three stands. Yellow birch and red maple also seem to be benefiting from elm reduction in stand 1. However, high values of ash, birch and maple may have always been the norm in the understory.

Keever (1953) suggested that presence of a species in all size classes (seedlings, transgressives one to ten feet tall, understory, and overstory) indicates that the species will continue to hold its place in the community. The present important species (Table 3) will probably be represented in the future communities. Barnes (1976) concluded that American elm will be perpetuated by seeds produced by young trees, although the life span of the species will be reduced. His hypothesis calls for progressively longer lived elms as the inoculum and the beetles decrease following the loss of the mature elm and as selection for greater genetic resistance to the disease occurs in the future. Barnes found that elm makes up from 10 to 15% of the understory and seedling layers in southern Michigan and predicted that elm will maintain itself. In this study, elm now accounts for 1% of the seedlings in stand 1, a stand with a very high seedling density, and 10% and 44% in stand 2 and stand 3 respectively, both stands with low seedling densities (Table 4). It seems likely that American elm will continue to be a minor component of the lowland forest, while its former associates and other less tolerant species assume more importance.

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TORCHLIGHT SOLDIERS: A WISCONSIN VIEW OF THE TORCHLIGHT PARADES OF THE REPUBLICAN PARTY 'TANNERS' AND THE DEMOCRATIC PARTY 'WHITE BOYS IN BLUE'

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In the fall of 1868 the evenings were enlivened by the exciting music of military bands, the shouted commands of torchlight officers to marching units, and the sounds of the boots and shouts of hundreds of torch-carrying soldiers. Pseudo-military companies were organized that fall throughout Wisconsin to support the political candidates of the Republican and Democratic parties.

Both Republicans and Democrats organized Civil War veterans into companies, battalions and regiments. Milwaukee Republican 'Tanners' formed a torchlight soldier brigade; Oshkosh organized seven torchlight companies and a cavalry troop into a Tanner regiment; Fond du Lac, Janesville and La Crosse organized Tanner battalions; Tanner companies were organized in nearly every Wisconsin community.

In cities such as Ripon, Fort Atkinson-Jefferson and La Crosse these companies had 200 members each while smaller communities including Monroe, Brodhead, and Green Bay, could field 125-150 torches plus a military band. Mazomanie had a "large" Tanner company numbering at least 150 members. The village of Hudson, probably the most Republican-minded small village in Wisconsin in 1868, boasted a company of 200 mounted Tanners whose parades were "brilliant with banners, and exciting with the music of their band and glee club".

Wisconsin Democrats also organized units of torchlight soldiers from veterans of the Civil War. In Oshkosh the Democrats formed a regiment of eight companies of White Boys in Blue. Every company was officered by Civil War veterans, and every company contained a large portion of veteran soldiers. As a reporter for the Oshkosh *City Times* described it, "When Col. Bouck's order came to 'right face . . . forward march,' 550 torches and two military bands stepped off in parade".

Both groups hoped to increase voter turnout on election day, by marching in torchlight parades dressed in uniforms reminiscent of the Union armies. The Tanners sought to be the enthusiastic force, the active and aggressive wing, of the Grand Army of the Republic and of the Republican party. The White Boys in Blue had a similar purpose, although the Democratic torchlighters had to first emphasize their loyalty to the nation and its flag before indicating their political differences with Republican reconstruction policies.

Although the era of torchlight parading in American political campaigns began in the 1830's and lasted through the end of the century, torchlight parades were first used systematically as a political party campaign technique in 1860 when the Republicans organized the Wide Awakes. The Wide Awakes were a youth group who wore distinctive oilcloth capes and caps and carried torches and banners to generate enthusiasm for Abraham Lincoln. Richard Current, author of Volume II of the *History of Wisconsin*, (State Historical Society of Wisconsin, 1976) tells us that "at a torchlight procession in Milwaukee honoring Carl Schurz," in late October, 1860, "some 3,000 Wide Awakes paraded, fired off rockets and shouted hurrahs as they marched by the Newhall House".[1]

Similarly, at Oshkosh on October 30, 1860, there were 1,000 torches in a Wide Awake procession. "Fond du Lac, Rosendale, Appleton, Waupun, Ripon, Berlin, Neenah, Menasha and Vinland each sent its noble band of Wide Awakes who, together with their Oshkosh brethren, all bearing torches and accompanied by ten bands of music, made the grandest display of the kind ever seen in Northern Wisconsin (prior to the Civil War)."[2]

The peak of Wisconsin participation in parading with torchlights seems to have occurred in the fall in 1868, when U. S. Grant was elected to his first term as President. The last big year for torchlight parading may have been in 1884, when Grover Cleveland was first elected President. The last big torchlight parade in Wisconsin appears to have occurred on the evening of September 24, 1896, when fully 2,000 men carried torches through downtown La Crosse.

A typical duty of the torchlight soldiers in every city was to march to the local railroad station to meet visiting political celebrities and escort them to their hotel. A delegation of the most prestigious local dignitaries would join in meeting the celebrity and the combined procession then marched through the city streets to the hotel. The celebrity customarily made a brief speech, thanking and complimenting his escort, then retired to change his clothes, have dinner, and confer with local party personalities before the evening political meeting.

Later when the speaker was ready to proceed to the meeting place, the torchlight soldiers paraded through such major streets of the city as the political meeting managers had time for. Military bands, fireworks, bonfires, and booming cannon added heightened excitement to the occasion. Once arrived at the county courthouse square or meeting hall where the speakers were to give their orations, the appearance of the torchlight soldiers in their colorful uniforms, their cheering, their singing and their patriotically impressive presence added to the political excitement of the evening.

Probably the highest ceremonial honor torchlight soldiers could confer on a visiting celebrity was to form two lines and permit him to "pass through." Six Tanner companies in Oshkosh honored Wisconsin Governor Lucius Fairchild in this manner in the week of September 24, 1868, when they formed two lines of Tanners along Main Street, and with their torches held in the position of rifle salute, invited Governor Fairchild, accompanied by Sen. Rich, Hon. George Gary and James V. Jones to "pass through," to the accompaniment of their loud cheers.[3]

A pleasant duty for many torchlight soldiers was to receive a unit flag which sometimes was presented to the unit by the Republican or Democratic women's organization. This gift had been a customary one for Civil War volunteer companies, the presentation ceremony taking place only a few days before the company was to leave the camp or the state for service in Civil War battle zones. The custom was remembered in 1868 to the benefit of the torchlight soldiers of both parties; thus it was that the Oshkosh Tanners received "an elegant silk regimental flag" from the Republican ladies on October 7th, and the Oshkosh White Boys in Blue received a regimental flag from the Democratic ladies of Oshkosh at a flag presentation ceremony at McCourt's Hall on October 21, 1868.

Local political personalities were sometimes serenaded. The Oshkosh Tanner companies A, B and C, on the evening of September 9, 1868, marched to the home of Congressman Philetus Sawyer on Algoma Street. Congressman Sawyer's thanks and remarks were received, according to the newspaper account, with loud cheers. Four other local dignitaries then made short speeches, following which the Congressman provided refreshments for all the Tanners in the form of peaches, cigars and appropriate beverages for the thirsty. Before bidding their host good night, the battalion gave three cheers for Sawyer, three more cheers for Grant and Colfax, then returned to their armory.[4]

The most interesting duty of the torchlight soldiers probably was to travel to neighboring communities to participate in their torchlight parades. Out-of-town trips by the torchlight soldier companies had the political value of doubling or tripling the total torchlight soldier participation in a given parade and, therefore maximized the political impact. For example, the Oshkosh Tanners were reinforced at their parade on October 22, 1868 by contingents of visiting Tanners from Neenah-Menasha, Appleton, New London, Berlin, Omro and Fond du Lac, most who arrived and later departed by steamboats. On the preceding evening, Fond du Lac Tanners had been the hosts to 250 Tanners and a brass band from Oshkosh, 100 Tanners from Waupun and an additional 200 men from Ripon. Similar "home and home" arrangements for reciprocal pooling of torchlight paraders to accumulate largest possible concentration occurred in Madison, Milwaukee, Janesville and Jefferson.

The Republican torchlight soldiers in Wisconsin and Illinois were called "Tanners", because General U. S. Grant had worked for a time as a tanner while a young man and had learned his business so well, Republicans said, that he had been able to "tan" the seccessionist rebels who in the Civil War had taken up arms to destroy the nation. Another reason for adopting the name Tanners was that Democrats in the summer of 1868 were sneering at the very thought of a tanner being President. Democrats had sneered similiarly at Abraham Lincoln's having once been a rail splitter. Since the smear hadn't seemed to hurt Lincoln's voter appeal. Republicans hoped that popularization of the word tanner would turn the Democratic calumny into a Republican asset.[5]

According to the Chicago *Tribune*, the first Tanner club of torchlight soldiers was organized in Chicago on July 24, 1868. The name 'Tanner' took like wildfire; 1,000 Tanner clubs sprang up within two weeks, and within two months there were fully 10,000 Tanner companies.[6]

The title of the Democratic party's "White Boys in Blue," first adopted in state conventions in April of 1868, sought to emphasize that northern Democrats had been loyal soldiers in the Union's armies and implied that the Republicans had no monopoly on either patriotism or loyalty. The term White Boys referred to strong

Democratic opposition at the time to voting by blacks, loud opposition to the Freedmen's Bureau which had been organizing black schools in the South, and bitter opposition to Republican reconstruction policies.[7]

Wisconsin's population had reached only 1,055,000 in 1870 and its cities were small, thus the number of participants in the political rallies of 1868, in proportion to the total population, seems truly remarkable. Milwaukee was a city of only 71,000 people in 1870, yet it had a political parade on the night before the November 3 election in 1868 of 3,000 torch-carrying Tanners and a Tanner cavalry unit, which "drew the largest crowd of the campaign." Oshkosh, with 12,600 inhabitants in 1870, saw a Tanner parade on October 22, 1868 that featured 2,000 torches and a dozen bands.

The city of Fond du Lac was the second largest city in Wisconsin in 1870 with a population of 12,700. On October 21, 1868, Fond du Lac Republicans staged a parade said to have been two miles long and featuring 1,500 torch-carrying Tanners from Fond du Lac, Oshkosh, and neighboring communities. The parade also included a rifled cannon which had been captured by the 14th Wisconsin Regiment at Pittsburg Landing (Shiloh). Neenah-Menasha had a combined population in 1870 of only 5,138, yet on October 15, 1868, they had 1,000 torchlight-carrying veterans marching in their big campaign parade. Janesville, Racine, Kenosha and Madison that fall had torchlight parades which are said to have included from 500 to 600 torchlight soldiers in each city.

The uniforms of torchlight soldiers were colorful, designed to be both patriotic and as visible as possible in night-time parades. The oilcloth capes protected a wearer's clothing from kerosene drippings as well as rain. The Democratic party's White Boys in Blue seem to have had the most colorful uniforms, consisting of blue shirts, blouses or jackets trimmed with white, including a white rosette on the left chest and fastened with U. S. Army military buttons. Each man had a red belt and a red cap or an army forage cap with a white crown piece. He also carried a torch to the staff of which was attached a small American flag. The names of the Democratic Presidential candidates, i. e., Seymour and Blair, were usually stitched on the flag.

The regimental officers of the White Boys in Blue were usually mounted on horses, and they wore the same U. S. Army uniforms they had worn on active duty in the Civil War. The captains and lieutenants marched with their companies and wore Army regulation military dress.

The uniform of the Republican Tanners was a little less colorful, but it was unmistakable and distinctive. The Tanners wore blue oilcloth caps of a military pattern, with a white top and a red, white and blue band. They usually used white or red oilcloth capes, although both the capes and caps were permitted to be of any color the company chose and be trimmed to suit their local taste. Tanners uniformly wore leather aprons, which was their most clearly identifying characteristic. Tanner officers wore the U. S. Army military insignia and their N.C.O.'s wore stripes.

Within this degree of uniformity, some Tanner companies which had been recruited on the basis of ethnic groups, often adopted additional distinctive items of dress to distinguish them from other companies within their own battalion or regiment. For example, Oshkosh Tanner Company G was a group of sixty Scandinavians who, in addition to their Tanner uniform, wore red, white and blue scarves, red sashes and leather belts. In the 1870's and 1880's manufacturers developed increasingly gaudy torchlight uniforms which included plumed caps or helmets, boots, epaulets, and swivel torches having a rifle-like stock which permitted torchlight paraders to perform a full rifle manual of arms (Fig. 1).[8]

Campaign torch, 1868. (Smithsonian photo 49457-C.)

Patent model of 1860 campaign torch. (Smithsonian photo 50555.)

The organization of the torchlight clubs began with the political parties. Then, as now, the Democrats and Republicans had county, city and ward units, but in 1868 it was apparently customary to rename local party units with the last names of the party's presidential candidates. The Oshkosh Republicans thus renamed themselves the Oshkosh Grant and Colfax Club, and the Oshkosh Democrats became the Seymour and Blair Club.

In addition to changing their names to those of the party's national standard bearers, the campaign clubs reorganized themselves on a civil and military basis. The Civil Departments of both the Grant-Colfax and Seymour-Blair Clubs were concerned with the standard and multiple political tasks of fund raising, organizing rallies, scheduling speakers and renting meeting halls, enlisting party workers, creating, producing and scheduling advertising, etc. The Military Department was related exclusively to the enlisting, drilling, uniforming, equipping, scheduling, transporting and often planning for the feeding of the torchlight soldiers and their torchlight marcher guests from out-of-town.

The Berlin *Courant*, August 13, 1868, notes the civil-military separation of political and torchlight club functions:

> The Berlin Tanners Club was organized into a Civil Department, the officers being the club president, vice president, recording secretary, corresponding secretary, treasurer, janitor and an executive committee of three. The club's Military Department consists of a captain, first lieutenant, second lieutenant and a sergeant for every ten men.

This organizational dualism wasn't universally practiced, however, as the Beaver Dam Republicans merged their Grant Club into a Tanners Club.

Since 1868 was only three years after the end of the Civil War, both the Republican Tanners and Democratic White Boys in Blue had large numbers of veterans in their local communities from whom to recruit their torchlight soldiers. These men still had, or could obtain, army uniforms. They also remembered close order drill, knew how to both give and execute drill commands and did not have to be told how army units were organized and administered.

A brief announcement in the Fond du Lac *Commonwealth* of October 14, 1868, illustrates the transition from ward and ethnic clubs of the political parties to the standardized military organization of army companies used by the torchlight soldiers:

> Hereafter the Fond du Lac "Uptown" club will be known as Company A, the Fifth Ward club as Company B, the Fourth

> Ward club as Company C, and the colored club as Company D. the clubs having been lettered according to the dates of their organization. (A fifth company, i.e., Company E was organized ten days later.)

The kind of standardization to military letters illustrated above in Fond du Lac changed the titles of numerous ward clubs and also of a variety of ethnic torchlight clubs. The Scandinavian Tanners of Oshkosh became Oshkosh Tanners Company G. Similarly, the Welsh Tanners of Milwaukee, the Irish Republican Club, the Milwaukee and Oshkosh Tanner cavalry units, the German Grant and Colfax Club of Madison and colored Tanner companies formed at both Janesville and Fond du Lac, became designated by company letters in their city torchlight organizations. Oshkosh didn't have a colored company but did have some fifteen blacks interspersed among its white Tanner companies, leading the Oshkosh *City Times* of September 15, 1868 to charge the Tanners with being "Black and Tanners."

The torchlight soldier marching corps, dressed in their political party uniforms and swinging their torches as they marched or cheered or sang Civil War patriotic songs were a colorful element but were not the entire parade. How can one have an exciting parade without a band to play spirited, patriotic music? There weren't any university or high school bands at the time and the musical capabilities of today's drum and bugle corps hadn't been developed, but city brass bands, cornet bands, military bands and fife and drum corps existed even in small communities.

At the Republican parade in Oshkosh on October 22, 1868, two Tanner companies from Berlin had come down the Fox River by steamboat to join the Oshkosh parade and brought the Berlin City Brass Band with them. Neenah and Menasha Tanner companies in the same Oshkosh parade were accompanied by what was described as "two excellent bands of martial music." Fond du Lac Tanners 350 strong are reported to have brought a "splendid brass band and a drum corps" to the same parade. A Democratic rally in La Crosse a month previously had been enlivened by the playing and marching of "a fine brass band and the drum corps of the Seymour Invincibles."

Both military and brass bands a century ago were far smaller than the university or high school bands of today which march on football fields or in holiday parades; a typical band numbered only sixteen musicians. The Democrats of Oshkosh, however, organized a martial band in the fall of 1868, to provide music for the parades of the Democratic White Boys in Blue; it was led by five drum majors, all having served as regimental band drum majors in Civil War regiments.[9]

The music played by marching bands of 1868 would be largely unfamiliar to the ears of most of us. John Phillip Sousa, had not been born and obviously had not yet composed the magnificent military march, "Stars and Stripes Forever." Most of the band music played in 1868 had a patriotic sound associated with the Civil War. For example, the Oshkosh Regiment of White Boys in Blue paraded on the evening of September 24, 1868 to the "Music of the Union." Similarly, the Neenah-Menasha newspaper *Island City Times* reported that the "stirring notes of 'The Slogan' was heard far in advance of the Tanners marching column." Favorites for marchers and singers alike were "Tramp, Tramp, Tramp the Boys are Marching", and "Rally Round the Flag."

Group singing was a common feature of these political gatherings. The Hudson, Wisconsin, *Star and Times* tells us that on the evening of October 15th, 1868, their most prominent local citizen, General Harriman, led a Hudson audience in singing "Tramp, Tramp, Tramp the Boys are Marching." In Milwaukee that fall, a Republican glee club sang an allegedly lively song, "Let Every Republican Rally Around." Madison meetings that fall opened their political meetings or closed them by singing "the good old song, 'Rally Round the Flag'." At the biggest rally of the campaign in Madison, the audience on October 14th, joined a Republican party glee club in the choruses of "The Union Forever," "Tramp, Tramp, Tramp," "Glory Halleluja," and "On, On, the Boys Came Marching."

A torchlight battalion or regiment usually had a company which was also a glee club. Company C of the Oshkosh Tanners, in addition to marching, served as the regiment's glee club; both the Madison and Mazomanie Tanners had glee clubs. Oshkosh Tanners Company C sang at six party meetings as well as carried torches in a dozen torchlight parades. Company C seems to have also been a kind of special services company, since we read that "the magnificent stand of colors presented to the Oshkosh Tanners by the Republican ladies of Oshkosh was carried thereafter by the Company C color guard."

Torchlight parades featured the torchlight soldiers, but the major parades included a variety of wagons, which we call floats. A huge wagon in the Hudson parade of October 20th was pulled by fourteen horses and consisted of a large flatbed platform on which were seated a dozen old men including "the venerable David Stiles." The title banner of this wagon-float read "Old Guard." A banner hung from one side of the wagon rack read "David Stiles, aged 102; the century plant blooms for Grant." A banner on the opposite side of the wagon rack read, "For Washington in 1789, for Grant in 1868." A wagon in a Fond du Lac parade the same week was pulled by six horses, carried a load of lumber and shingles and had two banners which read, "Fond du Lac lumbermen vote for Grant and Colfax," and "We are building Salt River rafts for Seymour and Blair." In the same parade, another wagon entry simply consisted of a mammoth saw log pulled by a team of six oxen.

A wagon at an Eau Claire parade September 26th was pulled by a six mule team driven with one rein by a man who sat astride the nigh wheel mule, regular army fashion, the wagon containing fifteen voters holding a huge American flag. In the same parade the Chippewa Falls delegation had a large wagon pulled by four spirited horses and gaily trimmed with flags. Seated on a terraced platform were thirty-seven young ladies dressed in white representing each of the states of the Union, with each lady holding an American flag across which had been sewn in white the name of the state she represented. A variation on this thirty-seven state theme in an Eau Claire parade on October 22nd, was a band-wagon pulled by six horses and containing the "Goddess of Liberty," encircled by ladies "richly dressed in white with turbans representing all the states of the Union and holding small American flags. This wagon was trimmed in red, white and blue as well as with banners, mottoes and ensigns."

Craft theme floats were a major feature of the final Tanner parade of the campaign in Milwaukee on November second. A large wagon entered by the Union Iron Works carried boilmakers busily at work ostensibly assembling a steam boiler. A wagon of Hays and Veitch boxmakers plied their vocation with such will that they drew cheers at every corner. The wagon of Edward Guenther's hatters carried transparencies advertising "The Grant, a Great Fall Style." Cream City brickmakers were represented by two wagons carrying brickmakers busily making bricks. The wagon of a Milwaukee thresher manufacturer carried transparencies exhibiting mottoes predicting a threshing for Democrats in the November third election.

The carpenters' wagon in the Milwaukee parade had carpenters busily building a "coffin" and a "tombstone" with transparencies announcing "Democratic funeral on Tuesday—Seymourners." There was a "Union Tannery" wagon which represented a tannery in full operation. This wagon was decorated with streamers and carried transparencies proclaiming to the world, [Copperhead] "Snake skins tanned November 3rd." The dockers and caulkers were represented by a long lumber wagon carrying a display labeled "drydock" and "shipyard," followed by another wagon carrying a boat. The Milwaukee iron workers had a wagon ostensibly carrying casks of scrap iron. The cask heads were converted into illuminated transparencies with the motto "Iron Brigade Votes for Grant." The transparencies of the plasterers and masons wagon promised, "We'll plaster Seymour tomorrow."

One of the most interesting units in torchlight processions was the cavalcade of horsemen. In the Milwaukee Tanner parade of November 2, 1868, a Milwaukee *Sentinel* reporter saw 500 horsemen carrying Chinese lanterns, American flags and banners proclaiming political phrases. The Milwaukee cavalcade seems to have been casually informal, but the Eau Claire Tanners organized a troop of Tanner cavalry under the command of a Captain Sherman which comprised a well-disciplined column half a mile long. Captain Sherman's group included eight lady equestriennes each dressed in form-fitting blue bodices on which white stars had been sewn. The skirts of their dresses were made of "intermingled red and white." They rode at the head of the cavalry escort and at the next position to the rear of the cavalry. To add to the military flavor of the unit, the Eau Claire Tanner cavalry carried nine foot guidons at the perpendicular.

Tanner torchlighters in Milwaukee, Oshkosh and Madison had cavalry units organized as troops within the Tanner marching organization. Cavalry troops were used as honor guard escorts for visiting celebrities. Cavalrymen tended to be an elite Tanner unit, since they almost invariably were mounted on fine horses and showed a drill proficiency which clearly marked them as veteran Union Army cavalrymen.

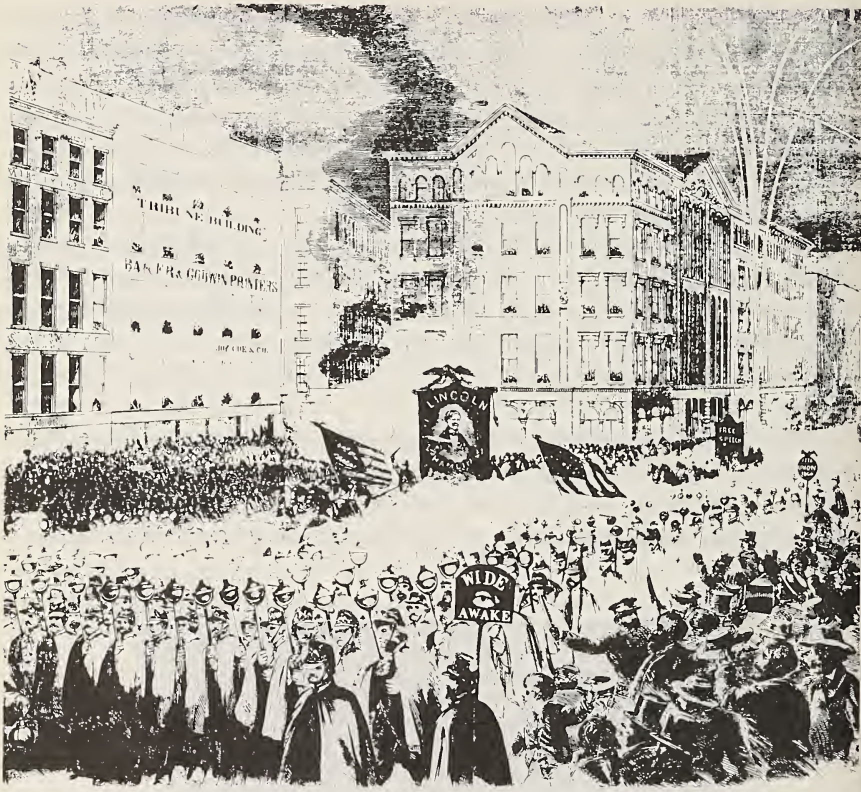
After the bands, torchlight soldiers and floats had passed on the parade route, parade marshals scheduled great numbers of private carriages and farm wagons carrying partisan supporters, the vehicles usually adorned with flags and mottoes. For example, the village of Harmony in Grant County sent 75 wagons to a Republican mass meeting in Janesville, one wagon was drawn by six grey horses and carried banners on which were sewn the mottoes

"Ullysses Forever, Horatio Never," and "Cursed be he who the Union would sever." The Janesville *Gazette* reported that the town of Milton sent a wagon procession to the same Janesville meeting which was half a mile long. The Milton wagons carried transparencies showing mottoes, two declaring, "We won't vote for the men we shot at" and "Northern Copperheads and Southern Rebels; links of one sausage from the same dog."[10]

The Madison *State Journal* had similar reports of great numbers of wagons attending or participating in torchlight parades. They reported, for example, that at Jefferson on October 20th, "George Blanchard of Lake Mills was out with a 16 horse team, Fort Atkinson sent about 70 teams, Hebron had 25, Sullivan about as many," etc.

Newspaper descriptions of torchlight parades refer repeatedly to transparencies. Essentially, the transparency consisted of a wooden frame, the sides which were covered with cheesecloth canvas, glassine paper, or vegetable parchment paper (Fig. 2). One or more

Transparency, 1860.
(Smithsonian photo 48331–A.)



"Grand procession of wide-awakes at New York on the evening of October 3, 1860," from *Harper's Weekly*, October 13, 1860.

three-burner torches were fastened to the interior of the transparency to provide enough light to make the painted images visible to the curbside public. Political slogans were then painted on the outside fabric of the transparency, or a local artist would paint a picture of the candidate. If the artist was a competent caricaturist he sometimes painted a cartoon or copied a printed caricature available in such nationally circulated periodicals as *Harpers Weekly*, *Frank Leslie's Illustrated Newspaper*, or the *Illustrated London News*. Thus the brilliant political sketches of nationally famous caricature artists such as Thomas Nast were sometimes the source of transparency paintings in Wisconsin torchlight parades.

The *Illustrated London News*, October 15, 1864 shows several transparencies which apparently were square boxes about three feet on a side and mounted on a pole. Such a device was small enough to be carried or held by a single man. The Smithsonian Institution has a triangular transparency from the campaign of 1860, each side of which is 27½" wide and 21½" high and has the painted title "Old Abe" above a large cutout engraving of Abraham Lincoln. *Harpers Weekly* on October 13, 1860, showed a wide awake procession in which a huge portrait transparency of Lincoln was mounted on a wagon drawn by four horses, the triangular transparency seeming to have been ten or twelve feet high (Fig. 3). Some descriptive examples of transparencies used in Wisconsin in 1868 follow.

At Hudson, Wisconsin, on October 15, 1868, a transparency had been painted to represent a storm-ridden Confederate ship in distress. Below the picture was the caption, "One sea-more (Seymour, the Democratic Presidential candidate) and this old Democratic hulk goes down forever." In the same Hudson parade another transparency was a painting of figures of nationally-prominent Democrats (Seymour, Blair, Hampton, Beauregard and Forrest) playing musical instruments in an orchestra. Belmont, leader of the orchestra, pointed to Vice Presidential candidate Blair with his baton and said, according to the caption, "too loud on the second violin." Below the cartoon was the slogan, "Trouble in the Democratic orchestra."

A Berlin parade on October 7th had a transparency which pictured Gen. Grant tanning the hide of Horatio Seymour. A village of Harmony transparency in the Janesville parade was a painted scene titled "Ku Klux Logic." Under this motto was a cartoon of two dead men hanging by the neck to a limb of a tree which was probably a plagiarism of one of Thomas Nast's cartoons published in *Harper's Weekly* during the 1868 campaign. Similarly, a Madison parade transparency showed an immense copper colored snake, a-la-Nast, coiled around a pole, the head of which was labeled "Seymour." Another with a similar theme showed Seymour addressing a group of copperhead snakes as his "dear friends." Another showed a negro carrying a huge torch with the motto, "Democrats enslaved me, Republicans freed me." Still another transparency showed the body of the Democratic party jackass with Blair's head. The caption read, "The Lord opened the mouth of the ass and he spoke."

Nearly any partisan who was handy with wood working tools was able to build a transparency in a few hours, although many of the transparencies were produced in commercial sign painters shops.

In daytime parades, where artificial light was unnecessary to exhibit an image, huge portraits of the candidates were sometimes carried by the marchers. Thus it was that the Soldiers and Sailors parade in Chicago at the time of the Republican National Convention had two greater than life-size portraits of General Grant and Schuyler Colfax (Speaker of the House of Representatives) which were carried by men accompanying General Salomon and his staff.

Humor, when it can be achieved, can vastly increase public enjoyment of a public event, as the popularity of circus clowns, rodeo clowns and television comedians certainly indicates. Transparency paintings in 1868 must often have drawn chuckles from the crowds, but the Wisconsin award for "Best Humor Exhibited in a Torchlight Parade" ought to have been given to a group of 25 Madisonians who, on October 30th, 1868, in the last Madison parade of the campaign, played the dramatic roles of a pseudo Ku Klux Klan. Twenty-five fellows mounted on horseback costumed in rebel gray and masked, carried banners with a skull and crossbones and other devices of the Ku Klux Klan. They occasionally made a mock dash at the procession and "raided through it," drawing a crowd and attracting delighted attention wherever they went. While the procession was zig-zagging down Pinckney Street, they dashed ahead and a large crowd gathered around them in front of the Methodist Church, where one of them, impersonating Wade Hampton, pleaded for the restoration of the "lost cause," in familiar Ku Klux style, shutting up and fleeing, however, when one of his band announced the approach of the Republican Radicals.[11]

An auxiliary but vital supporting function for the torchlight soldiers was local organization for feeding unusually large numbers of people. The written accounts make it evident that no restaurant or hotel was equipped to feed a thousand or more people at one sitting, but the written records also barely hint at the tremendous amount of planning needed for cooking and serving food to a vast multitude. Thus a single sentence in a Fond du Lac story about a Republican torchlight parade of 1,000 torches and a record-breaking crowd at Amory Hall to hear the famous orator, Mathew H. Carpenter, remarked at the end of the story, "After the meeting was over the Tanners marched to Amory Hall where a fine supper had been prepared for them by the Grant and Colfax ladies of Fond du Lac."

A Fond du Lac account of the final Democratic rally before the election described a parade of 1,500 torchlight bearers and bandsmen and 200 teams, then concluded: "After the parade, all who were Democratic and hungry were fed at Amory Hall".[12] Similarly, the Janesville *Gazette* described a parade of 1,000 Tanner torchlighters and concluded with the sentence: "Republican women served dinner to the marchers in the grove east of the speakers stand."[13]

The Oshkosh *Journal* had a far more detailed account of the "Feeding of the Multitude at Neff's Hall," written by H.A.T., one of the ladies who participated.

> Early in the morning some of our patriotic women gathered at Neff's Hall (presently the Metal Fabricators Inc., i.e. the Frank Leach building at Seventh and South Main in Oshkosh), and commenced preparations for the dinner, assisted by a few energetic men . . . who were willing to lend a hand where it was most needed. The dining room of the hall and the hall proper were the work rooms for the day. Here were two long tables—one devoted to meats, pies, pickles, etc., the other to cakes, sandwiches, bread and other needfuls. Long before noon the tables (were full) and additional supplies were stacked underneath in baskets and boxes.
>
> When the (steamboat) *Berlin City* came in . . . the Tanners from Berlin, Omro and Waukau were given lunch at the door. Baskets of sandwiches, doughnuts, etc., were set out and promptly emptied. By three o'clock five tables accommodating 450 persons were heavily laden and still another was set up on the platform. A part of the ladies were stationed at the tables as coffee servers; the rest prepared for the second spread.
>
> About half past four the companies from abroad (i.e., out-of-town) came, a hungry throng happy enough to give three tremendous cheers for Grant and Colfax, and three more for the ladies of Oshkosh. Then the victuals and coffee—and the men—disappeared. Then came the clearing up and resetting process. Before seven the companies from Neenah and Appleton were fed. Four new tables were then prepared for the Fond du Lac boys, a reinforcement of pies having been added to the stores on hand. After all the visiting Tanners had been fed, over 1,000, just think of it, our Oshkosh Tanners came in and had an evening lunch . . . H.A.T.[14]

Another auxiliary supporting element of the torchlight parades was a great variety of fireworks and "illuminations." The larger parades included substantial quantities of sky rockets, Roman candles, Chinese lanterns, bonfires, Bengal lights, locomotive headlights and the illumination of the facades of buildings. The Fond du Lac *Commonwealth*, for example, reported that "fireworks were set off at different points on the line of march," and said that "the Tanners had also provided themselves with sky rockets and

Roman candles which at the high point of the parade every man set off at a given signal. Rockets and other fireworks were also displayed at stations along the parade route."[15]

An observer of a Milwaukee torchlight parade reported that "rocket after rocket shot with crash and whiz through the air and Roman candles by the thousands shot their beautiful and many colored balls hither and thither."

Bonfires were apparently used in the days before street lights had much candle power, to mark the vicinity at which a public political meeting was to be held. Since most streets were mud or gravel, there apparently was not much fire hazard in building a bonfire in a street intersection, in a street in front of a hotel or in a public square in front of a county courthouse. Some bonfires seem to have been used to mark a corner on a parade route. Others were chiefly festive. Thus, prior to a Milwaukee Democratic mass meeting reported by the *Daily Milwaukee News* on October 11, 1868, "an immense bonfire was lighted at the intersection of Milwaukee and Michigan streets and another (bonfire was lighted) at the crossing of Main and Huron near the third ward club rooms."

At a Democratic rally in La Crosse "a bonfire was lighted near the crossing of Pearl and Second and directly in front of the St. Nicholas Hotel . . . Speeches were delivered from the balcony of the St. Nicholas Hotel."[16] In Milwaukee "a large bonfire was blazing at 8:00 in front of the Skating Rink [where a political meeting was to be held] . . . and at frequent intervals the steamboat *John F. Potter* sent forth its whistle" to add to the atmosphere of celebration.[17]

To show solidarity or accord with the political views of a given group of paraders, fellow partisans along a known parade route would place tallow dips, lamps or candles in the front windows of houses, or would fasten Chinese lanterns to the limbs of trees in the home's front yard. We are told that "Many residences on High and Algoma streets in Oshkosh were brilliantly illuminated in honor of the occasion." At Hudson, Wisconsin, "Mrs. Bowen had every front room lighted of the Chapin House and the windows and balconies were crowded with spectators to watch the parade." At a Janesville parade "many buildings were illuminated", while in Milwaukee "every window of Lake House was illuminated . . . (and) many mansions were brillantly illuminated. The house of George W. Allen was one blaze of light, while Chinese lanterns were pendent from every bough in the yard. His pyrotechnic display was also splendid."[18]

The same desire to indicate approval of the politics of the torchlight paraders caused store owners to light up their show windows. In one store "the windows were covered with stripes of red, white and blue tissue paper behind which were placed lights, thus producing a grand effect." In another illumination of a business house, "the newspaper office was suddenly lit up with the shooting of hundreds of sky rockets, the bursting of Roman candles, the glare of red, blue and other colored lights and the shimmer of myriads of falling sparks."

While electric lights had not been invented in 1868, railroad engine headlights were sometimes borrowed to light up a parade route. For example, a Democratic parade in Milwaukee on October 26, 1868 included "a large car on wheels bearing in a massive revolving frame four locomotive headlights which flashed their . . . brilliant light in every direction."[19]

A second type of searchlight or signal light was called a Bengal light, a dazzlingly bright light which could be adapted to show a variety of colors. "Now all about would seem to be azure blue and then red and then this or that color, and before the eye had adjusted to one color another would take its place, dazzling the eye to a degree of pain."

The most spectacular illumination of the torchlight era, however, were the massed torches. In Oshkosh, on the night of October 22nd, the Tanner parade:

> Numbered about 2,000 torches as it marched across the (Fox River) bridge and up Main Street, presenting a spectacle at once sublime and inspiring. Marching in files of four it took the torchlight carrying soldiers twenty-five minutes to pass a given point . . . Main Street of Oshkosh that night was a turbulent river of pulsating fire from Seymour House (at Eighth and South Main) on the south side of the river to the Empire House and Wagner's Fourth Ward saloon (N.E. corner of Merritt and Main) on the other. The music of the numerous bands, the dense throng of onlookers upon the sidewalks, the waving of handkerchiefs from the windows, the commands of the officers, the numerous transparencies and flags, all combined to make it a scene long to be remembered.[20]

Defenders of democracy are fond of saying that it is far better for a society to use ballots than bullets. Few would disagree, but political violence has occurred with varying degrees of frequency for a least seven millenia. The 1868 torchlight period included several instances of violence. The Oshkosh *Northwestern* reported that at a Democratic meeting late in the 1868 campaign:

> A disgraceful fight took place at Neff's Hall between three or four Tanners and about a dozen White Boys in Blue. The hall was filled with White Boys in Blue and the presence of the Tanners in uniform appeared to raise their ire to an ungovernable pitch, and frequent threats were made to "clean out them d- - - -d Tanners!" Before Eldridge (Democratic candidate for Congress) commenced his speech one of the Tanners made some offensive remark concerning the meeting, when a White Boy struck him in the face. The melee then became general. Some six or eight White Boys immediately attacked the Tanners with lamps and torches. One was struck on the head with a torch, cutting a severe gash and causing partial insensibility for some time. The row was ended by the retreat of the Tanners from the scene.[21]

The Madison State Journal reported a torchlight parade at which:

> Young Ireland was out in force, cheering for Seymour and Blair and crying "Nigger, Nigger, White Nigger," etc., etc., at every turn . . . The Democracy were not content with hurling abusive epithets, but threw stones and eggs several times in different parts of the city. The writer had his torch staff hit by a stone which grazed a man in the rear and struck one before him. Two or three eggs struck in his immediate vicinity, one of them plastering up a gentleman's coat sleeve and a transparency was riddled with stones . . .[22]

A rotten egg throwing incident in Oshkosh in which the victims were Democratic White Boys in Blue was described with editorial disapproval by the Oshkosh *Journal* (a Republican paper) as follows:

> A shameful outrage was perpetrated on the German Company of White Boys in Blue . . . as they were marching up Main Street. A party of rowdies threw a volley of rotten eggs at them with considerable precision and then fled for fear of consequences. Such weapons are not usually used by Republicans and we sincerely hope they were not in this case. However much one may differ from another politically, there is no excuse for such low-lived dastardly conduct . . .[23]

The Oshkosh *City Times*, a Democratic paper, reported the same incident with almost unbelievable restraint. After reporting that the White Boys in Blue had had rotten eggs thrown at them from the corner of Main and Washington Streets the preceding Wednesday evening, the editor confined himself to the comment, "Let us . . . manifest our political preferences quietly . . .[24]

The closest facsimile to a political riot in Wisconsin in 1868 seems to have occurred at the Republican meeting at Jefferson on October 21st which is reported to have drawn a crowd of 10,000 and to have included a parade two miles long which included "Tanners by the hundreds." According to a Madison *State Journal* reporter:

> The Democrats congregated on the opposite side of the street in and around a rum hole known as Spangler's Saloon. The Republican speaker was frequently interrupted by the following expressions: "You lie," "You're a damned liar," etc., etc. During Mr. Bean's remarks he asked the Democrats if they would have the debt we owe the widows and soldiers repudiated and a shout went up from the Ku Klux Democrats in the affirmative . . . A shower of brickbats was thrown in the direction of the speaker's stand. A lady named Donallson was hit in the temple and severly injured (the brickbat probably had been aimed at the speaker), whereupon the Krogville Tanners, followed by the Lake Mills and Waterloo boys, attacked the saloon containing the offenders. In they went, smashing in doors and windows and rushing in by scores. Many received bloody noses and black eyes. After a few knockdowns and many words, with a general cleaning out of the saloon, the boys in "capes" marched out amid the cheers of the multitude. No more disturbance occurred and after Mr. Bean's address was concluded, the crowd dispersed.[25]

The torchlight parades of the 1860's reveal a number of, now extinct, nineteenth century political and social customs. One such custom which was commonly observed by both political parties in 1868 was the ratification meeting. This was a local political meeting held within a day or two of a national political convention nomination. The purpose of the ratification meeting was to publicize local agreement with, i.e., ratification of, the national convention's nominations. For example, the Oshkosh *Northwestern* on May 21, 1868, published the news that the Republican nominees for President and Vice President were Gen. Grant and Schuyler Colfax, Speaker of the House and congressman from Indiana. Only two days later the Oshkosh Republicans held a ratification meeting at the corner of Church and Main Streets. The Oshkosh City Band played, Mayor C. W. Davis presided and ratification speeches approving the Grant and Colfax nominations were made by six local party leaders.

The Oshkosh Democrats in 1868 prepared for their ratification meeting by bringing out their cannon, gathering wood for bonfires, and hiring the Oshkosh Cornet Band. When the news arrived that the Democratic Party's nominations in 1868 had gone after 21 ballots to Horatio Seymour, who as governor of New York had been bitterly and vocally critical of Abraham Lincoln's administration and to General Frank Blair, a Missouri general who had a good military record for the Union but a philosophical copperhead who felt that the nation should return to the *status quo ante bellum*, Oshkosh Democrats gathered at Wagner's Corners "to listen to those who felt concurrence in the nominations. After speeches . . . , the meeting gave three lusty cheers for Seymour and Blair . . . then adjourned amid the sound of patriotic music, the booming of the Democratic cannon, etc., etc."[26]

A second custom commonly observed by political groups in the 1860's was the practice of group cheering. Newspapers in 1868 often reported that an audience gave "three cheers for the ticket and three for the speaker." A variation on this theme was a meeting which gave three times three for Mr. "X," three times three for Mr. "Y," and three times three for Mr. "Z." On really special occasions a "tiger" was also called for at the end of the cheering. An amusing variation on the tiger was the tactic of Republican Radicals calling for loudly audible groans for President Andrew Johnson who had been impeached but not convicted in the spring of 1868. A technique still used today was to shout or chant political slogans in unison.

A third political custom which passed into oblivion in the early twentieth century was the two hour speech. For reasons which modern television viewers find it hard to understand, it seems to have been customary for the main speaker of a political meeting to orate for as much as two hours. In the 1868 campaign the reports of political meetings state that "ex-Governor Salomon spoke for two hours," or that "Mr. Carpenter spoke for two hours and held the vast and uncomfortable audience perfectly spellbound," or that "Mr. Carpenter spoke at the Eau Claire Wigwam for two hours, then took a carriage to Chippewa Falls where he spoke in the evening for another hour and one half."[27]

These speeches were delivered without the aid of electronic public address systems, which means that the speaker had to shout and scream for two hours so his voice would carry adequately.

The appetite for, or tolerance of, long political speeches by nineteenth century audiences extended to the customary use of many more speakers both at a specific meeting and in a whole campaign. For example, at an Oshkosh meeting in 1868, "Judge Levi Hubbel was the first speaker, followed by U. S. Senator Howe, C. G. Williams, Judge Barlow and Col. Kershaw." Many a meeting seems to have been addressed by a full roster of a party's prominent personalities.

Possibly related to the use of what today seems an unusually large number of speakers, was the need to train and schedule innumerable meetings in small halls in both urban and rural country, which seldom seated more than 200 plus standing room. Not only were there few large auditoriums; the parties had to schedule meetings in every rural county. Governor Lucius Fairchild, for example, was scheduled to speak on October 29, 1868, in Pleasant Prairie and in Bristol in Kenosha County. An incumbent governor today, that late in the campaign, would never schedule meetings in small communities.

The huge size of nineteenth century political crowds, in proportion to the total population has not been duplicated in recent generations. When one reads that 10,000 Republicans attended a mass meeting in Janesville or 6,000 in Hudson, one must remember that thousands of people had to come in from twenty-five miles around because in each case the figures cited exceeded by a wide margin the total population of each community.

The amazing length of the torchlight parades has not been seen since torchlight parades passed into history. It would be extremely hard for political parties today to merely match political parades which were two, three and five miles in length. The Philadelphia Republican parade of October 1-2, 1868, was said to have been eight miles in length, a record likely to stand for all time.

The firing of cannon to celebrate truly unusual events was a fairly common part of mid-nineteenth century celebrations. Such a custom died out in twentieth century America except for the artillery salute ceremonials involving foreign dignitaries visiting the President of the United States. Then, as now, the greater the victory or the more prestigious the personality being honored, the greater were the number of guns fired. The cannons being fired in nineteenth century celebrations were placed at some open space in the general vicinity of the public gathering, i.e., a river bank, a lake shore or large open square. When the cannon salute was fired the gun crews would leave a two to three minute interval between the gun reports, so the firing of a true "feu de joie," of 100 guns lasted for two and one half to three hours.

Several words and phrases commonly used to describe aspects of the nineteenth century torchlight parades are archaic today or have disappeared from 20th century usage. A superlative cheer in 1868 was described as one which would "make the welkin ring," but today the phrase is no longer used. Another forgotten phrase was to speak of the time between sundown and darkness as "early candle lighting." Torchlight soldiers were often told "there will be a meeting tomorrow night in the Court House square at early candle light." The term "band of music" was used to describe what today we simply call a band. The word "jollification" is understandable to us today but no one in the late twentieth century would describe a victory parade as a "victory parade jollification."

The election night party today hasn't changed very much from what it was a hundred years ago, except for the invention and use of telephones, radio and television. Bourbon and beer still belong, cold cuts and cheese are still popular.

But since the November 3, 1868 election was the objective toward which the torchlight parading had been focused, an Oshkosh *Journal* report of the Republican election night party in 1868 reveals some interesting differences between then and now:

> In the evening at early candle lighting, they (Republicans) began to assemble at McCourt's Hall to hear the returns . . . First came the returns from the various wards in the city, and as they were announced, cheers were given with a will. Then the (telegraph) wires began to bring the news from abroad; a bundle of dispatches, on which there were charges of $45.00 were ready to be opened and read as soon as the money to pay for them was raised, which was soon done by passing the hat. Then a dispatch would be read, after which a song by Stickney, the audience joining in the chorus, was in order. Then another dispatch. Then a speech by Drew. Then a dispatch, then "Hurrah for Grant and Colfax" by "Old Kentuck", a colored orator Andrew Jackson by name, which put the audience into laughter. Then a speech and "Hurrah for Sawyer (the candidate for Congress) by everybody, and another dispatch. Then some laughable and apropos anecdotes by the group's principal anecdotist. Then a dispatch, then . . . more singing. Report from Chicago and three cheers for the same . . . When it became apparent that Congressman Sawyer would be re-elected, the crowd demanded a speech and Sawyer reluctantly came forward. He made a short and very neat little speech thanking the assembled Republicans for their support and promised that "when work was to be done, he would always be found at his post". The jubilee kept up until past midnight . . .[28]

Political victory parades in America are rare because both parties pace their campaigning to achieve an all-out and final crescendo of effort in the weekend before the general election. The Republican Tanner torchlight soldiers of Oshkosh, however, turned out for their final parade on Thursday evening, November 5, 1868. With band music and a general atmosphere of relaxed rejoicing after the long campaign. The Tanner victory parade was also notable for demonstrating the speed with which new transparencies could be made (three days) and store windows redecorated to reflect the new fact of Grant's election.[29]

Wisconsin voters gave U. S. Grant a 24,147 vote popular majority in 1868 and the state's eight electoral votes. Tanners in the Oshkosh victory parade, therefore, carried new transparencies on November 5 on which were lettered "Victory," and "Liberty and Law." A large number of private residences were illuminated in honor of the occasion as were a great number of the buildings on Main Street. In one store window there was "a representation of two game cocks, one flat on his back, the other in the act of crowing vociferously." In a clothing store window were the words "Grant will suit us fine," very handsomely created from colored paper. Many merchants decorated their show windows with American flags against a background of red, white and blue colored paper.

On a final note of victory, the Oshkosh *Journal*, a Republican newspaper, reported that in preparation for the victory parade, "The Journal office invested in candles (to illuminate its windows) and lifts its hat in acknowledgement of the three rousing cheers given it by the Tanners in passing. About nine o'clock the cannon began to peal forth its music . . . "[30], [31], [32]

NOTATIONS

1. Current, Richard N., *The History of Wisconsin* II, 284 (Madison, Wis. S.H.S.W., 1976).

2. Oshkosh Weekly *Northwestern*, November 2, 1860.

3. Oshkosh Weekly *Northwestern*, September 24, 1868. Technically, the Republican party in 1868 was titled the National Union Republican party.

4. Oshkosh Weekly *Northwestern* , September 10, 1868.

5. The Chicago *Tribune* of September 29, 1868 reprinted a letter to the editor published in the Chicago *Evening Post* from Edward S. Salomon, Commanding General, Chicago Tanner Corps, crediting Gen. R. W. Smith with first suggesting the name Tanners and also crediting Gen. Smith and Major J. R. Hayden with organizing the first Tanner club in the Chicago Tenth Ward on July 24, 1868. The Tenth Ward Republican Club adopted the campaign name Grant Tanners, adopted a uniform consisting of an oil cloth cape, a military style cap, a tanners leather apron and a torch. For the aesthetic taste of other companies which they hoped to organize, they provided that both the cape and cap could be of any color and be trimmed to suit local taste. The persons who signed the first Tanner Club muster roll on July 24th were Generals R. W. Smith, Edward S. Salomon, Major J. R. Hayden and about a dozen others.

6. The Chicago *Tribune* editor claimed in the *Tribune* issue of September 29, 1868, that Major J. R. Hayden had consulted with him about organizing Tanner companies prior to the organization of the first Tanner club, that the editor had been the first to urge that "Each man must wear a tanners apron". The editor also authorized Major Hayden to "tell those at your meeting tonight that I heartily second Smith's suggestion of the name Tanner, and believe it will spread like wildfire. Tell them the *Tribune* may be depended upon to do all it can to encourage and multiply Grant Tanner clubs in Chicago and the west."

While there appears to be no reason to doubt the Chicago *Tribune* editor's account of the origin of the name Tanner, it is also true that the Tanner organization in 1868 was merely a variation on the major theme of the (Republican) Boys in Blue. The Tanners were also closely related organizationally to the famous Civil War veterans organization, the Grand Army of the Republic.

The organizational origin of the (Republican) Tanner clubs of Wisconsin can be traced to September, 1865, when Radical Republican soldier-politicians organized the Soldiers and Sailors National Union League. In Wisconsin the president of the League was J. K. Proudfit, Madison, a Republican member of the Wisconsin Legislature and a close friend of Wisconsin Governor Lucius Fairchild. Cassius Fairchild, the governor's brother, was secretary of the Wisconsin League and Governor Fairchild was himself a prominent League member.

The Wisconsin Soldiers and Sailors voted in a June convention in 1866 to join the Grand Army of the Republic, becoming the GAR's Wisconsin Department. In a mere change of the guard, Gen. James K. Proudfit, former Wisconsin president of the S. & S. N. U. L. was elected Wisconsin Deputy Commander of the GAR, Cassius Fairchild became one of the GAR vice presidents, Gen. T. S. Allen, Wisconsin Secretary of State was elected to the GAR Administrative Council and Governor Fairchild and future governor Jeremiah Rusk were among prominent Republicans who became charter members of the first Wisconsin GAR post in Madison.

By February of 1868 the Republican Radicals and their GAR allies had decided to back Gen. U. S. Grant for the Presidency and also decided that for political reasons it would be advisable for them to keep the GAR officially out of politics in 1868. Both objectives were served by promoting a call for an *ad hoc* National Convention of Soldiers and Sailors in the very same week and in the same city as the Republican party's national convention. The motivation for this interesting timing was to give the Soldiers and Sailors Convention the political legitimacy to speak for all Republican veterans and at the same time to exert political pressure on the Republican National Convention in behalf of the candidacy of Gen. Grant.

The Soldier and Sailor delegates reportedly paraded through Chicago's streets "with much band blaring and flag waving, with cheers for Grant and groans for President Andrew Johnson". More to the point, the Soldiers and Sailors delegates adopted resolutions declaring Grant the choice for President of Republican veterans of the Union's armed forces. The Soldiers and Sailors Convention then had the cleverness to choose a Committee of One Hundred of their most prestigious soldiers to carry their request for Grant's nomination to the Republican Convention which only the next day opened a two day run at Chicago's Crosby Opera House.

Of interest to Wisconsin people, the temporary chairman and by an unusual circumstance, the permanent chairman of the Soldiers and Sailors Convention in Chicago in 1868 was Wisconsin Governor Lucius Fairchild. Consequently, when the Soldiers and Sailors voted to send their endorsement of Gen. Grant to the Republican National Convention, it was Governor Fairchild who headed the delegation. When the Soldiers and Sailors Committee of One Hundred proceeded to the stage of Crosby Opera House where the Republican Convention was being held, they walked to the accompaniment of thunderous cheers from not only the Grant delegates but from many others who were thrilled to see the most famous Civil War Republican soldiers in the nation. Governor Fairchild, who himself symbolized soldier sacrifices in the Civil War, having lost his left arm at Gettysburg, told the Republican Convention that the Soldiers and Sailors wanted Grant nominated for President. The veterans pressure tactic succeeded in so upstaging other potential candidates that Grant was nominated on the first ballot.

Before the Soldiers and Sailors Convention of 1868 adjourned, they created a national continuing committee to organize local political clubs from Republican veterans for the Presidential campaign. This national committee of Republican veterans established a central committee in each Northern state. Gen. Chipman, National Adjutant General of the GAR at the time, acted as the national secretary of the Republican veterans clubs. The National Committee of Republican Soldiers and Sailors clubs decided that all clubs organized under their auspices in 1868 would be called "Boys in Blue".*

*Source: Mary R. Dearing *Veterans in Politics: Story of the GAR*, 148-151 (Baton Rouge, La.: LSU Press, 1952).

Republican Radicals appear to have organized Civil War veterans into army style companies of Boys in Blue from eastern Pennsylvania and New York to Massachusetts. Western Republican Radicals, however, including those in Wisconsin, appear to have organized Tanner companies identical with the Boys in Blue except for their name and distinctive leather aprons. Tanner companies were organized in the Presidential campaign of 1868 by local Republican clubs in areas as widely separated as Pittsburgh, Cleveland, Detroit, Chicago, Minneapolis, Omaha and Kansas City.

7. *Union White Boys in Blue: Constitution and Proceedings . . .* , Platform plank No. 4 (Indianapolis, Ind., April 8, 1868).

8. Collins, Herbert R., "Political Campaign Torches," *United States National Museum Bulletin* 241 Paper 45, pages 1-44, published in the *Smithsonian Institution's Contributions From the Museum of History and Technology*, Washington, D. C., 1964, examined 88 patented torches on record in the U. S. Patent Office. The earliest political torch was patented in 1837 and the last was

patented in 1900. In the 1860s the most popular torch in Collins' catalogue appears to have been a swivel type in which the torch frame was a half-moon shaped sheet metal strap with a swivel ring fastened at a right angle to the tips of the half-moon. The torch lamp was fastened to a pivot inside the ring so that the torch bowl would always swivel into an upright position regardless of how it was tilted. In the 1870s and later, most torches used a two tine frame with the pivots for the torch located almost at the inside tips of the tine. Most torches held 1-1½ pints of kerosene.

9. A curiosity of the base horns used in bands of the Civil War period is that the bells of the horns opened to the rear of the player instead of facing forward. In parades this may have made it easier for marchers to keep in step because the rhythm of the base horns would have been heard clearly far to the rear of the band.

10. Janesville *Gazette*, October 17, 1868.

11. Madison *State Journal*, October 31, 1868.

12. Fond du Lac *Journal*, November 5, 1868.

13. Janesville *Gazette*, October 17, 1868.

14. Oshkosh *Journal*, October 17, 1868.

15. Fond du Lac *Commonwealth*, October 28, 1868.

16. La Crosse *Daily Democrat*, September 18, 1868.

17. Milwaukee *Sentinel*, October 12, 1868.

18. *Ibid.*, November 3, 1868.

19. *Daily Milwaukee News*, October 27, 1868.

20. Oshkosh *Northwestern* and Oshkosh *Journal*, October 22, 1868.

21. Oshkosh *Northwestern*, November 5, 1868.

22. Madison *State Journal*, October 14, 1868.

23. Oshkosh *Journal*, September 26, 1868.

24. Oshkosh *City Times*, September 29, 1868.

25. Madison *State Journal*, October 22, 1868.

26. Oshkosh *City Times*, July 14, 1868.

27. Eau Claire *Free Press*, October 15, 1868.

28. Oshkosh *Journal*, November 7, 1868; the Sawyer quotation is from Richard N. Current, *Pine Logs and Politics*, 59-60 (Madison, Wis. State Historical Society of Wisconsin, 1950).

29. The largest victory parade in the nation was probably the parade of 20,000 Chicago Tanners held on the night of November 6th after the election. According to the Chicago *Tribune*, there were four miles of torchlights and a crowd of 200,000 people.

30. Oshkosh *Journal*, November 7, 1868.

31. Wisconsin Newspapers in which references were found to the Tanners and /or the White Boys in Blue:

Berlin *Courant*
Eau Claire *Free Press*
Fond du Lac *Commonwealth; Journal*
Green Bay *Advocate*
Hudson *Star and Times*
Janesville *Daily Gazette*
Kenosha *Telegraph*
La Crosse *Daily Democrat*
Madison *Daily Democrat; State Journal*
Milwaukee *Sentinel; Seebote; Daily Milwaukee News*
Neenah *Island City Times*
Oshkosh *City Times; Journal; Weekly Northwestern*
Racine *Advocate*
Sheboygan *Evergreen City Times*
Oshkosh *City Times; Journal; Weekly Northwestern*
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LOSS OF WETLANDS ON THE WEST SHORE OF GREEN BAY

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ABSTRACT

The Land Survey of 1832-66 found 86 square miles of coastal marshes and swamps on Green Bay's west shore. In recent years, marsh and swamp habitat on the west shore have been reduced severely until approximately 24.3 square miles remain at low water and 17.5 at high levels. Both natural and human influences have contributed to wetland diminution and species composition has been altered at several sites.

INTRODUCTION

Freshwater and marine coastal wetlands may serve exclusive (fish spawning habitat versus site for disposal of dredge spoils) or complementary (wildlife refuge and environmental education) purposes. In contrast to marine coastal wetlands, the impact of human alterations upon freshwater coastal wetlands is more difficult to assess, because there are few baseline studies of prealteration natural conditions. Both ecological and economic evaluations are required before a reliable assessment can be made of the probable impact of a proposed wetland use. An evaluation would be enhanced by a review of the environmental changes associated with each of the previous uses of a wetland site. This historical perspective provides for a more accurate assessment of the beneficial and deleterious influences affecting ecological integrity.

Bedford, *et al.* (1975) called for improved ecological data for the coastal wetlands of Lakes Michigan and Superior. The 495 miles of Lake Michigan shoreline in Wisconsin now support less than 30 miles of coastal wetland (Kleinert, 1970). These wetlands occur on the west shore of Green Bay, the eastern tip of the Door County peninsula, and the lower portions of several rivers tributary to Lake Michigan. This paper (Bosley, 1976) investigates the loss of coastal wetlands on the west shore of Green Bay between the Fox and Menominee Rivers. The early explorers (Kellogg, 1917; Martin, 1926a and b; Neville, 1926; Carver, 1956; Thwaites, 1959) provided only weak documentation of the species composition and appearance of the prominent marsh areas on the west shore; this precluded evaluation by recent wetland classifications (Shaw and Fredine, 1956; Cowardin and Johnson, 1973; Golet and Larson, 1974).

METHODOLOGY

The quantity of coastal wetland habitat of the study area was approximated through library and field studies. The term wetland refers to land that possesses a water table at or above the soil surface for at least part of the year and that supports plant species adapted to periodic or continuous flooded conditions. A marsh is wetland containing only herbaceous vegetation, while a swamp is wetland containing both woody and herbaceous vegetation. The early land survey plat maps (Federal Survey Plat Books, 1832-1866) and recent aerial imagery (Agricultural Stabilization and Conservation Service, 1958, 1966, 1967; Lake Survey Center, 1969; Bay-Lake Regional Planning Commission, 1975) were used to obtain the presettlement and recent estimates of the west shore coastal wetlands. Polar planimetry (Lind, 1974) of the maps and photographs was used to determine area. Howlett's (1974) examination of Green Bay coastal wetland vegetation delineated the marsh and swamp habitats for the planimetry. A marsh and swamp were considered coastal if they bordered the shoreline or were contiguous with wetland bordering the shoreline. The boundary delineation for marsh and swamp habitats seen in the recent imagery was verified with Lintereur (Personal communication, 1975, L. Lintereur, Area Game Manager, Wisconsin Department of Natural Resources) and by onsite inspection to clarify vegetation boundaries. The west shore tributaries used to delineate segments of wetland are the Fox River, Duck Creek, Big Suamico River, Little Suamico River, Pensaukee River, Oconto River, Peshtigo Marsh (coastal wetland on both sides of the Peshtigo River), and the Menominee River.

FRESHWATER COASTAL WETLANDS FROM THE EARLY 1840's UNTIL RECENT YEARS

The Land Office Survey and Plat Maps

The land survey of Wisconsin was conducted during the years 1832-1866. The west shore of Green Bay, where the majority of Wisconsin's Lake Michigan wetlands exist, was surveyed between 1834 and 1844. Finley (1951) and Curtis (1959) reviewed the procedures used by the surveyors. "Botanically, these surveyors' records constitute an unbiased sample of vegetation as it existed in presettlement times. . . . In addition to these figures on the trees, the surveyors also listed other species they saw along their traverse and gave a brief summary of the understory vegetation. When trees were lacking, as on prairies or on marshes, this fact was clearly indicated. Swamps were distinguished from uplands . . . From the surveyors' own statements as to the nature of the vegetation and from their maps, areas can be delimited which appear to be relatively homogeneous in composition." (Curtis, 1959; p. 64). Finley noted that the surveyors were given special instructions to record the location of all marshes and swamps and to differentiate between marsh and swamp in their field notes. The State of Wisconsin made its claim for federal land provided by the Swamp Land Act of 1850 based on the marshes and swamps recorded on the plat maps (Rohrbough, 1958).

Area of Coastal Wetlands in the 1840's

The land survey plat maps and field notes were used to approximate the presettlement coastal wetland area on the west shore of Green Bay. The water level of Green Bay, when the west shore was being surveyed, is not known. Because the water level at a particular time influences wetland area it was necessary to approximate the water level at the time of the survey. Examination of water levels at the gaging stations at Milwaukee, Sturgeon Bay, and Green Bay, Wisconsin (Lake Survey Center, 1836-1974; 1922-1975; 1953-1975) suggests that the probable water level in Green Bay in the early 1840's was in the same range as the water levels recorded in 1973-1975 at Sturgeon Bay and Green Bay. Equivalent water levels permit a reasonably valid comparison between presettlement years and the present.

The land survey plat maps (scale: 2″=1 mi.) revealed approximately 14.63 mi.^{2} of marsh and 71.51 mi.^{2} of swamp (Table 1).

Table 1. Marshland losses between 1834 and 1975.

Reference Area	Land survey (mi.^{2})	Imagery in 1975 (mi.^{2})	Area lost (mi.^{2})	Percentage lost at named site	Percentage of total area lost
Fox River — Duck Creek	2.53	0.27	2.26	89	26
Duck Creek — Big Suamico River	1.59	0.40	1.19	75	14
Big Suamico River — Little Suamico River	1.65	0.30	1.35	82	15
Little Suamico River — Pensaukee River	1.71	0.25	1.46	85	17
Pensaukee River — Oconto River	2.49	0.47	2.02	81	23
Oconto River — Peshtigo Marsh	4.58	4.20	0.38	8	4
North of Peshtigo Marsh — Menominee River	0.08	0.00	0.08	100	1
Total	14.63	5.89	8.74		100

The presettlement area of coastal marsh was calculated to include areas labeled "marsh", "meadow", "wet meadow and marsh", and "rushes and wild rice". The land survey field notes indicated that swamps were dominated by tamarack (*Larix laricina*) and white cedar (*Thuja occidentalis*), with varying amounts of black ash (*Fraxinus nigra*), alder (*Alnus*), elm (*Ulmus*), and other woody species. Except for the offshore rushes and wild rice, no species were identified in the marshes.

Present Extent of Coastal Wetlands

The coastal wetland area in recent years was obtained from aerial imagery. According to the Bay-Lake Regional Planning Commission (scale of photographs: 1″ = 800′), the high water elevation imagery revealed approximately 5.89 mi.^{2} of marsh and 11.57 mi.^{2} of swamp. The Peshtigo Marsh (T. 29 N., R. 23, 24 E.) comprises 3.36 mi.^{2} of the total coastal marsh (Table 1). Wetland area under low water elevation conditions was obtained from Agricultural Stabilization and Conservation Service photography (scale of photographs: 3″ = 1 mi.). Because the A.S.C.S. pictures did not include Sea Gull Bar (south of the Menominee River) an approximation of wetland area at this site was obtained from photography taken by the Lake Survey Center (scale of photograph: 4.2″=1 mi.). These aerial photographs (in combination) represent recent low water elevation conditions, which revealed approximately 17.08 mi.^{2} of marsh and 7.26 mi.^{2} of swamp (Table 2).

Howlett (1974) has provided the best recent documentation of vegetation along the west shore. A wide variety of aquatic plants is found throughout the area. At most sites, bluejoint (*Calamagrostis*), sedge (*Carex*), coontail (*Ceratophyllum*), smartweed (*Polygonum*), bulrush (*Scirpus*), and cattail (*Typha*) are the predominant marsh genera, while willow (*Salix*) is the predominant swamp tree.

DISCUSSION

Marsh and swamp habitat on the west shore of Green Bay has been influenced by both human activity and water elevation fluctuation for over 130 years. Comparison of the area of coastal marsh determined from the land survey plat maps with the estimated area determined under high water conditions in 1975 (comparable water levels as noted earlier), shows a marked difference (Table 1). The most dramatic loss occurred between the Fox River and Duck Creek. The 0.27 mi.^{2} of marsh remaining in

Table 2. Marsh Area approximation at recent low water levels.

Reference Area	Marsh (mi.^{2})
Fox River — Big Suamico River	4.21
Big Suamico River — Little Suamico River	1.41
Little Suamico River — Pensaukee River	2.02
Pensaukee River — Oconto River	1.66
Oconto River — Peshtigo Marsh	7.28
North of Peshtigo Marsh — Menominee River	0.50
Total	17.08

May, 1975, includes several parcels surrounded by dredge spoils and fly ash. Though some marsh was lost previously in the construction of the J. P. Pulliam power plant and oil storage tanks near the Fox River, the majority of this marsh was lost within the last ten years. Construction of U.S. Highway 41/141 near the mouth of Duck Creek, the deposition of dredge spoils in the Green Bay diked disposal area, and the use of land west of the disposal area for a landfill site were responsible (Bosley, 1976). This area is notable both for the quantity and quality of marsh destroyed; the marsh had provided excellent waterfowl habitat (Martin, 1913; Howlett, 1974; U.S. Army Corps of Engineers, 1975). Another area of heavy marsh loss lies between the Pensaukee and Oconto Rivers. The predominant reason for the 2.02 mi.^{2} loss in this segment resulted from loss of a 1.99 mi.^{2} marsh located two miles south of the Oconto River in Sec. 6, T. 27 N., R. 22 E., and Sec. 30-32, T. 28 N., R. 22 E. (as indicated on the land survey plat maps) — In summary, although the reasons for loss of marshes over the entire west shore were not thoroughly investigated, the predominant causes appear to be conversion to agricultural land, water pollution (in the southern segment of Green Bay), dredge spoil disposal west of the Fox River, and cottage settlement. When the water elevation of Green Bay recedes only a few feet coastal marsh habitat increases greatly. In contrast to high water conditions, when only prominent marsh areas could be recognized, the imagery taken at low water levels reveals marsh along nearly the entire west shoreline from Duck Creek to the Menominee River. Many sites with a low slope, especially those near river mouths, are exposed significantly when the water elevation declines. This was particularly notable near Duck Creek. Low water level imagery revealed an extensive delta, with abundant emergent vegetation originating at the mouth of Duck Creek. Other sites gaining notable amounts of marsh were Peter's Marsh (Sec. 1, T. 24 N., R. 20 E.; and the area directly south of the Big Suamico River, where Long Tail Point connects to the mainland. If the coastal marsh present at the time of the land survey is added to the marsh created through declining water levels in the years following the survey (Lake Survey Center, 1836-1974), the total amount of coastal marsh probably exceeded the amount estimated for the recent low water level. My estimate of the presettlement low water elevation marsh is approximately 26 mi.^{2} (Tables 1 and 2) including 17 mi.^{2} of recent low water coastal marsh, plus 9 mi.^{2} of marsh absent or lost at past and present high water levels. The quality of the marsh as fish and game habitat was probably higher in 1834-44 than at present. The poor documentation of qualitative presettlement habitat characteristics (based on the explorers' journals and surveyors' field notes) does not permit detailed conclusions on the attributes of the original marsh.

Extensive loss of swamp habitat is also evident near Green Bay's west shore. This loss of swamps (71.51 mi.^{2} recorded in the land survey plat maps and 11.57 mi.^{2} at high water level) has occurred primarily through timber harvesting, use for agriculture, and replacement of tamarack-alder-white cedar-black ash swamps by other tree species (Bosley, 1976). Prominent coastal swamps existed near the west shore between Duck Creek and the Peshtigo River, but reduction in area is particularly notable between the Oconto and Peshtigo Rivers (T. 28 N., R. 22 E., and T. 29 N., R. 22, 23 E.). This area contained 37.26 mi.^{2} of the 71.51 mi.^{2} of coastal swamp indicated on the land survey plat maps. Tilton (1871), Roth (1898), and Wells (1968) all remarked that the swamps in the west shore area rested on sandy soil overlain with peat (which impeded soil drainage). The peat was destroyed as the swamps were burned after timber harvest was completed. Peat destruction improved soil drainage after timber harvest was completed. The swamp trees were replaced by trees adapted to drier conditions. The difference in swamp approximations for recent low water (7.26 mi.^{2}) and high water conditions (11.57 mi.^{2}) is attributed to changing land use between the years when the photographs were taken.

Despite the changes noted in habitat quantity or quality, some sites on Green Bay's west shore today conform closely to notations on the land survey plat maps. For examples at the Peshtigo Wildlife Area (T. 29 N., R. 23, 24 E.) both the land survey plat maps and recent photographs indicate an extensive marsh bordered by woody vegetation and the Peshtigo River still broad and meandering at its mouth. However, the tamarack noted on the plat maps is no longer present. The Sensiba Wildlife Area (located immediately north of the Big Suamico River in T. 25 N., R. 21 E.) was noted as a site of "rushes and wild rice".

CONCLUSION

This study attempts to document: (1) the change in the quantity of Green Bay's west shore coastal wetland habitat between the 1840's and 1975; (2) the principal areas where changes have been the most prominent; and (3) the natural and human influences responsible. The wetland data suggest that changes in Green Bay's water level have a greater influence on the amount of marsh on the west shore of Green Bay than have the alterations caused by human intervention since 1840. Wetland loss through human interaction tends to be permanent although corrective measures can reclaim some wetland, whereas natural wetland lost as a result of rising water is regained when the water level declines. Qualitative changes in the wetland habitat have been documented (Howlett, 1974; Bosley, 1976), but the paucity of qualitative data from presettlement and early settlement years restricts conclusions. In examining Green Bay's west shore coastal wetlands, an historical perspective of ecological integrity may permit decisions affecting the future use of a particular area to be made with greater wisdom and foresight.

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SMALL MAMMALS OF THE TOFT POINT SCIENTIFIC AREA, DOOR COUNTY-WISCONSIN: A PRELIMINARY SURVEY

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ABSTRACT

Live and snap trapping techniques were used to examine the presence and abundance of small mammals at Toft Point. The eleven species found include northern taxa such as *(Lepus, Clethrionomys)* which are typical of boreal forests, and southern forms *(Microtus, Sciurus carolinensis* and *Glaucomys sabrinus).* The southern species, with their main distribution south of Door Peninsula, are probably the most recent additions to the Toft Point small mammal assemblage, indicative of a northward advance after retreat of Wisconsin glaciation.

INTRODUCTION

This project surveyed the terrestrial small mammal community of the Toft Point Scientific Area to determine what mammals were present and whether they were exclusively boreal species. Results are compared to previous studies of Door County mammals (Jackson, 1961; Long, 1974) and to a small mammal study done in similar habitats in northern Michigan (Manville, 1949).

Toft Point lies approximately 2.4 km northeast of Bailey's Harbor, Wisconsin. The history of the Toft Point Natural Area, as related to me primarily by Emma Toft of Bailey's Harbor, is one of a relatively unexploited forest. Miss Toft's parents settled there in the second half of the 19th Century and her father, Kersten Toft, was employed by a Michigan firm interested in the limestone underlying the land. Limestone was mined and ships would dock at the point for a load to take to Michigan. Remnants of this operation can still be found, including dock pilings, rock piles, mine excavations and an old smelter. Mr. Toft gradually accumulated 300 acres as compensation for his labors.

After mining ceased the family operated a resort with half a dozen small guest log cabins. The resort ceased operation in the 1960s and in 1967 the land was given to the University of Wisconsin-Green Bay to be used in a manner compatable with the Wisconsin Scientific Area designation that it also received.

VEGETATION

The Wisconsin Geological and Natural History Survey map of Wisconsin early vegetation codes the area northeast of Bailey's Harbor as boreal forest balsam fir *(Abies balsamea)* and white spruce *(Picea glauca)*.

The Wisconsin Scientific Areas Preservation Council (1973) lists three major plant communities for the Toft Point area:

Northern dry-mesic forest with white pine *(Pinus strobus)*, red maple *(Acer rubrum)*, and red oak *(Quercus rubra)*, and

Northern mesic forest with sugar maple *(A. saccharum)*, hemlock *(Tsuga candensis)*, and yellow birch *(Betula lutea)* and

Northern wet-mesic forest with white cedar *(Thuja occi dentalis)*, balsam fir *(Abies balsamea)*, and black ash *(Fraxinus nigra)*.

This boreal outlier is far south of the only substantial boreal forest stands in Wisconsin which lie along Lake Superior. Curtis (1959) indicates that the influence of on-shore winds off Lake Michigan keep the summer temperatures and evaporation rates relatively low.

A species list of the known flora of the Toft Point Area was compiled during this study as a result of our observations and those made by David B. Lellinger in 1957-59. Dr. Lellinger's collection is in the University of Illinois herbarium in Urbana. An extensive list of plants has also been compiled by Roy Lukes of the adjacent Ridges Sanctuary.

MATERIALS AND METHODS

The quarter method (Curtis and Cottam, 1962) was used to sample vegetation of a 1 ha grid where we were also trapping red squirrels. Importance values were calculated and indicated that white cedar (IV 108.5) and white pine (IV 106.8) were the dominant trees. Species present but of lesser importance were hemlock (17.0), red pine *(P. resinosa)* (28.2), white spruce (13.0), and paper birch *(B. papyrifera)* (24.7). In the sapling category, balsam fir (202.8) accounted for two-thirds of the total importance value with white spruce (29.1), mountain maple *(A. spicatum)* (30.2) and white cedar (26.5) of much lesser importance.

The ground layer species matched closely the published list for boreal forests, (Curtis) (1959). Canada dogwood *(Cornus canadensis)*, bigleaf aster *(Aster macrophyllus)*, twinflower *(Linnaea borealis)*, Canada mayflower *(Maianthemum canadense)* are among the most conspicuous species. The shrub layer is dominated by thimbleberry *(Rubus parviflorus)* wherever sufficient light is available.

Field work began in June, 1971 and proceeded intermittently until April 10,1976. Live and snap-trapping revealed information on the more common (abundant) species. Personal observations and discussions with Ms. Toft and Mr. Lukes yielded information on additional species that were not trapped. The literature was searched and reviewed for previous small mammal records of the region. Two sources have been most useful; Jackson's *Mammals of Wisconsin* (1961) and Long's *Mammals of the Lake Michigan Drainage Basin* (1974).

Longworth and National live traps, and Museum Special snap-traps were used. Most trapping was done with Museum Special traps set out usually in a line of 20 stations at 15.2 meter intervals with three traps per station. This pattern is similar to the type B lines of the North American census of small mammals suggested by Calhoun (1948). All major habitats mentioned above were sampled including a former pasture which is interspersed with low juniper clumps *(Juniperus communis)*. A total of 1366 trap-nights were accumulated in 13 trapping sessions. An additional 321 trap-days were recorded using the National live-traps (22.9 x 22.9 x 60.9 cm) on a grid pattern established to monitor red squirrel populations. Animal calls and tracks were also recorded.

RESULTS

The relative abundance values are of marginal use because equal effort was not expended in trapping each habitat type, i.e. only 13.2 percent of the total 1366 trap-nights were in old pasture, yet *Microtus* accounted for the second highest abundance. Most trap-nights were accumulated in the habitats characteristic of the northern dry-mesic, northern mesic and northern wet-mesic forests. The average trapping success was 3.07 mice per 100 trap-nights.

The results (Table 1) are similar to those Manville (1949) reported in an extensive study of the Huron Mountains region west of Marquette, Michigan. In his study, *Peromyscus maniculatus* replaced *P. leucopus*, but in both cases they were the dominant small mammal.

The meadow jumping mouse *(Zapus hudsonicus)* was a new record for Door County and it apparently maintains as sparse a population as it does over much of its range. It was taken in a northern wet-mesic stand. *Microtus pennsylvanicus*, the meadow vole, the second most abundant species captured, was restricted to the old pasture habitat.

As Manville (1949) previously stated, *Blarina brevicauda* and *Sorex cinereus* are the most common shrews in northern forest habitats and they were the only insectivores caught at Toft Point.

The live-trap grid established for red squirrels in a northern dry-mesic stand yielded numerous captures (120) of approximately 30 individuals. Although this grid was not operated on a regular basis, results indicate a density of red squirrels similar to that reported in other studies in coniferous habitats (i.e. at least 2-5 squirrels per hectare). One gray squirrel *(Sciurus carolinensis)* was trapped during this period, suggesting a sparse population.

Forty-two individuals representing eleven species were trapped (Table I).

Table 1. Small mammal species trapped at Toft Point and their relative abundance.

Species trapped		Individuals	Relative abundance
Sorex cinereus Masked shrew	M	4	11.1
Blarina brevicauda Short-tailed shrew	M	3	8.3
Lepus americanus Snowshoe rabbit		1	*
Sciurus carolinensis Gray squirrel		1	*
Tamiasciurus hudsonicus Red Squirrel	M	32	*
Glaucomys sabrinus Northern flying squirrel	M	2	5.5
Peromyscus leucopus White-footed mouse	M	17	47.2
Clethrionomys gapperi *Red-backed vole*		4	11.1
Microtus pennsylvanicus Meadow vole	M	5	13.9
Zapus hudsonicus Meadow jumping mouse	M	1	2.8
Mustela erminea Short-tailed weasel	M	1	*

These species were not included in relative abundance calculations since the snap-traps were not large enough to effectively capture adults.
M-Specimens in the University of Wisconsin-Marinete mammal collection.

Table 2. Small terrestrial mammals of Door County, Wisconsin.[1]

Species	Jackson (1961)	Long (1974)	Present Study Toft Point
Sorex cinereus Masked Shrew	+	+	+

Blarina brevicauda Short-tailed shrew	+	+	+
Sylvilagus floridanus Eastern cottontail	+	+	–
Lepus americanus Snowshoe rabbit	+	+	+
Tamia striatus Eastern chipmunk	+	+	+
Marmota monax Woodchuck	+	+	+
Tamiasciurus hudsonicus Red squirrel	+	+	+
Sciurus niger Fox squirrel	+	+	–
Sciurus carolinensis Gray squirrel	+	+	+
Glaucomys sabrinus Northern flying squirrel	+	+	+
Peromyscus maniculatus Deer mouse	+	–	–
Peromyscus leucopus White-footed mouse	+	+	+
Clethrionomys gapperi Red-backed vole	+	+	+
Microtus pennsylvanicus Meadow vole	+	+	+
Ondatra zibethicus Muskrat	+	+	–
Rattus norvegicus Norway rat	+	as.	–
Mus musculus House mouse	+	as.	+
Zapus hudsonicus Meadow jumping mouse	–	–	+
Erethizon dorsatum Porcupine	+	+	+

[1] specimens trapped and/or observed.
as.—assumed present.

DISCUSSION

Sub-specific designations were not examined because of the paucity of specimens. However, in-depth examination of Toft Point and Door Peninsula specimens, in general, is warranted and has already been shown to be fruitful by Long's (1971) description of an endemic subspecies (*peninsulae*) of the eastern chipmunk (*Tamia striatus*).

Much more research is needed on Toft Point Natural Area mammals. Longer trapping sessions will undoubtedly account for more uncommon species. Workers should be alert for species previously recorded from Door County (Table 2). The boreal forest remnant represented by Toft Point presumably does not prevent non-boreal species from establishing marginal populations on this tract.

ACKNOWLEDGMENTS

Throughout this study, I have received the cooperation and assistance of Miss Emma Toft and Mr. and Mrs. Roy Lukes. Dr. Keith White of University of Wisconsin-Green Bay and Dr. Charles A. Long of UW-Stevens Point have been helpful with historical information, personal requests and identifications. Three UW-Green Bay undergraduates (Paul J. Kores, John R. Dorney and Robert A. Kahl) provided essential aid in the fieldwork. Part of this work was sponsored by a National Science Foundation Institutional Grant to the University of Wisconsin-Green Bay.

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THE DISTRIBUTION OF FLOODPLAIN HERBS AS INFLUENCED BY ANNUAL FLOOD ELEVATION

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ABSTRACT

Herbaceous plants were sampled in a Chippewa River bottomland forest at Eau Claire, Wisconsin. Spatial dispersion patterns of the herbs were examined in relation to elevation, soil characteristics and flood recurrence intervals. Frequency and magnitude of spring floods appear to be the major influence on the distribution of herbaceous species in this river bottom site.

INTRODUCTION

Herbaceous species in floodplain forests may occur at high densities in some places, although they are sparse in others. Locally, species richness ranges from relatively high to low. Some species appear to occur in distinct bands parallel to the river, whereas others shift gradually in abundance with increasing distance from the river. These patterns of spatial dispersion may be related to soil characteristics, light conditions, topography, drainage, flood elevation and frequency, or other factors. This study examined the spatial distribution of herbaceous plants in a river bottom forest in particular reference to the recurrence interval of floods.

STUDY AREA

The study area is one of several small crescent-shaped floodplains in the middle reaches of the Chippewa River near Eau Claire, Wisconsin (Fig. 1). Two well-defined terraces occur, the first bottom, closest to the river, is flooded to some extent nearly every year while the second bottom, above a rather steep slope, is rarely flooded. The alluvium is primarily sand of Mt. Simon and Eau Claire sandstone origin.

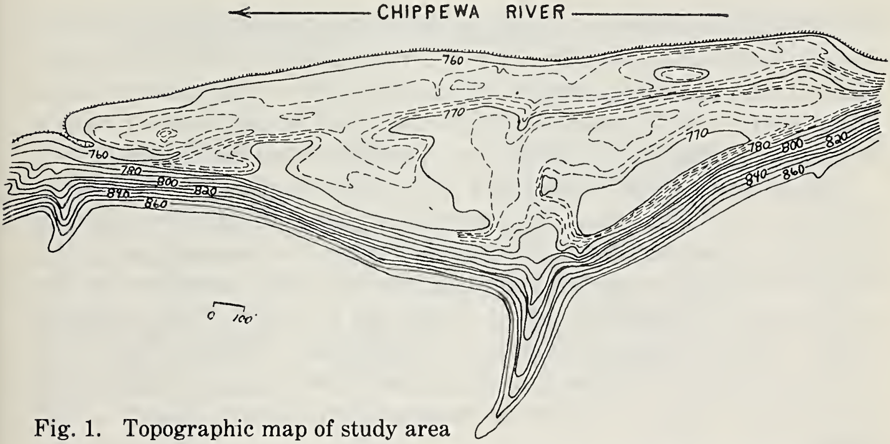

Fig. 1. Topographic map of study area

Many small individuals of *Acer saccharinum* dominate the first bottom and co-dominants, generally larger in size, include *Populus deltoides*, *Betula nigra* and *Salix* spp. *Ulmus americana*, *Fraxinus pennsylvanica*, and *Acer negundo* occur in small numbers. Shrubs are not abundant, although thickets of *Prunus virginiana* and scattered individuals of *Sambucus canadensis*, *Lonicera* X *bella* and *Ribes sp.* are present.

The second bottom is dominated by *Tilia americana*, *Juglans cinerea*, *Ulmus americana* and *Celtis occidentalis*. Individuals of *Ostrya virginiana*, *Carya cordiformis*, *Acer negundo*, and *Fraxinus* occur throughout the stand. Shrub cover is relatively sparse; a rich mixture of spring ephemerals, as well as summer blooming species, forms the understory.

METHODS

Five transects each composed of 300 contiguous 1 square foot quadrats ($0.1m^2$) were used to sample the herbaceous vegetation. The transects were aligned perpendicular to the river and extended from the water across much of the second terrace. Steel stakes, driven into the ground at 100 foot intervals, were used on all transects to expedite relocation. Quadrats were established with a tape and one foot rule and the presence of all herbs was recorded in each quadrat. Vegetation was sampled in late May and again in August.

Elevation profiles were constructed using transit and stadia rod. Elevation readings were taken at one foot (0.31m) intervals along the vegetation transects. A topographic map, with two foot (0.61 m) contour intervals, prepared by the University of Wisconsin-Eau Claire, was used to establish elevation at the water line. A flood stage marker on a nearby bridge was used in conjunction with a surveying altimeter to check the elevation noted on the map.

Soil samples were taken every 6 feet (1.8 m) along the transects. The litter, when present, was scraped away and soil was collected from the upper 6 inches (15.2 cm). Soil texture was analyzed by the Bouyoucos Method, and loss on ignition was used to determine the percentage of organic matter (Wilde et al. 1964). The available water holding capacity (AWC) of the upper 6 inches of soil was estimated from a regression equation based on soil texture and percentage organic matter as independent factors (Salter et al. 1966).

Ozalid paper booklets were used to measure integrated light values (Friend 1961). The booklets, contained in small petri plates, were placed at six foot (1.8 m) intervals along the transects and left for four hours on a sunny August day. The booklets were then collected, developed, and the number of bleached pages counted. The results were compared to a previously prepared calibration curve.

Flood frequency analysis was performed by a U. S. Geological Survey method (Dalrymple 1960). The recurrence interval of flooding was calculated from $T = n+1/m$ where T = recurrence interval in years, n = the number of years of record, and m = the magnitude of the flood, with the highest flood given a value of 1. A recurrence interval is defined as the average interval of the time within which a flood of a given magnitude will be equaled or exceeded once. The mean annual flood is defined by the U. S. Geological Survey as a flood having a recurrence interval of 2.33 years. Flood stage data for the Chippewa River were obtained from Geological Survey Supply Paper 1978 (Peterson and Gamble 1968).

RESULTS

Only the 21 species that occurred in at least 1% (15) of the 1500 quadrats were included in the analysis (Table 1). The frequency of occurrence for each elevation level was calculated for each of these species.

Table 1. Frequency of occurrence in May and August for 21 spring and summer herbaceous species sampled in five transects.

May 1975	Frequency	August 1975	Frequency
Arisaema atrorubens	6.2	Circaea quadrisulcata	3.6
Dicentra cucullaria	3.6	Eupatorium rugosum	17.7
Erythronium albidum	2.1	Glechoma hederacea	7.4
Hydrophyllum virginianum	38.2	Impatiens capensis	3.7
Isopyrum biternatum	16.1	Laportea canadensis	42.3
Leonurus cardiaca	2.7	Oxalis stricta	4.3
Osmorhiza Claytoni	4.5	Parthenocissus inserta	8.7
Osmunda cinnamomea	5.8	Polygonum virginianum	4.4
Phlox divaricata	4.9	Polymnia canadensis	7.8
Sanguinaria canadensis	1.7		
Trillium Gleasoni	1.7		
Viola papilionacea	10.2		

Although the profiles differ somewhat for the five transects all have the same general pattern with a well-defined first bottom, a slope and a second bottom (Fig. 2).

Of the 21 species, five occurred only above the elevation of the mean annual flood, (764 feet) one only below that elevation, and 14 species both above and below mean flood level. Thus 20 species occurred above, and 14 species occurred below the elevation of the mean annual flood.

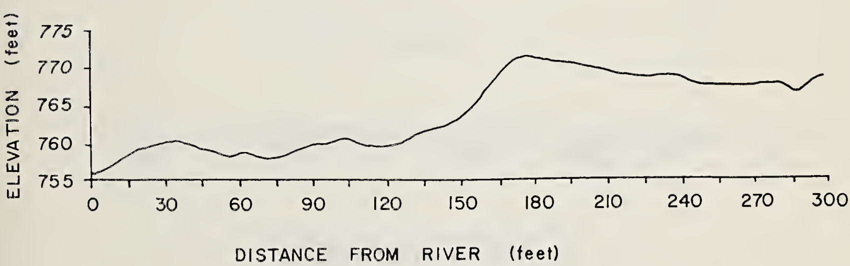

Fig. 2. Elevation profile of a typical transect (Transect #1) from the Chippewa River inland

Frequency of occurrence was calculated by expressing the number of quadrats of occurrence at each one-foot (0.31 m) elevation level as a percentage of the total number of quadrats at that level. The frequency of occurrence of each species was then plotted against elevation and the statistical significance of the relationship was tested.

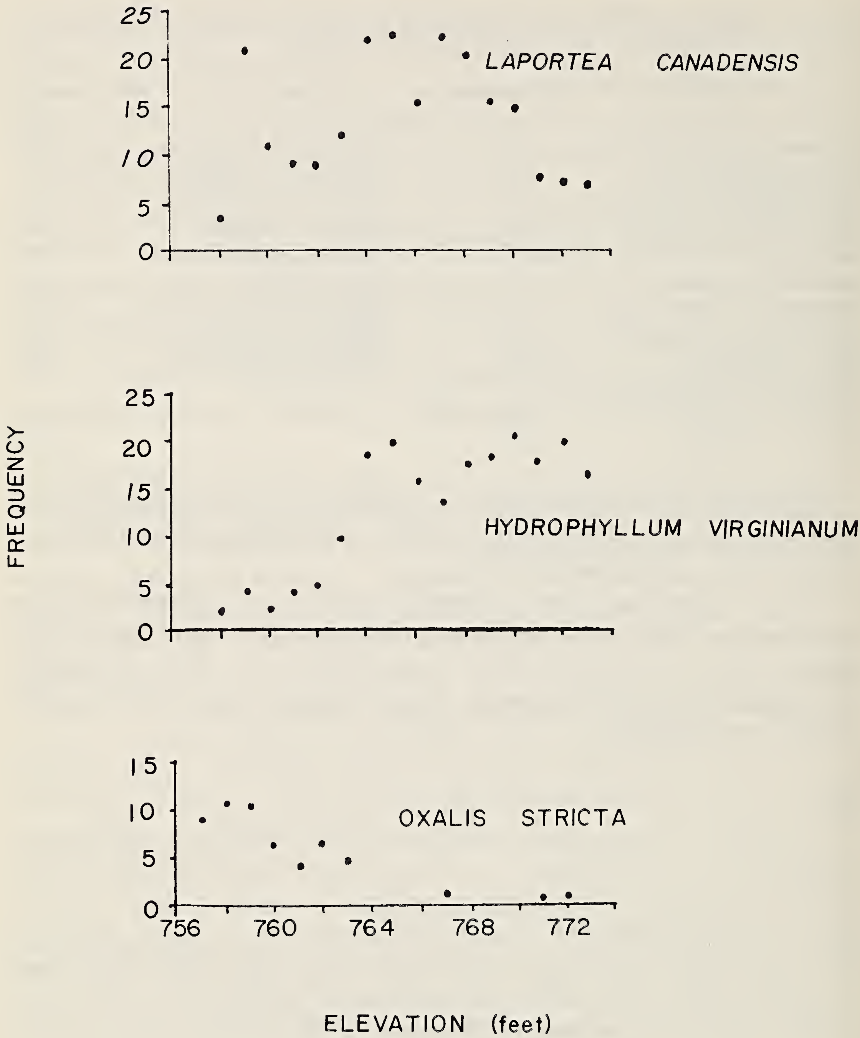

Fig. 3. Relationship of elevation to frequency of three herbs, *Laportea canadensis, Hydrophyllum virginianum* and *Oxalis stricta.*

Distributions of eleven species were found to be significantly (t.05) correlated with elevation (Fig. 3). Six of these, *Arisaema atrorubens, Dicentra cucullaria, Hydrophyllum virginianum, Trillium Gleasoni, Phlox divaricata,* and *Parthenocissus inserta* occur at most elevation levels. Five species, *Osmunda cinnamomea*, *Osmorhiza Claytoni*, *Polymnia canadensis*, *Impatiens capensis*, and *Circaea quadrisulcata* occur almost entirely at higher elevation levels. Occurrence of two species, *Glechoma hederacea* and *Oxalis stricta*, was inversely correlated to elevation; they occur primarily on the first bottom. Occurrence of the remaining eight species was not significantly correlated with elevation.

Soil samples were labeled with the transect distance and elevation level. The mean percentage silt plus clay content was calculated for each one-foot (0.31 m) elevation level and plotted against elevation (Fig. 4). silt plus clay content is very low on the first bottom, highest on the slope, and relatively high on the second bottom.

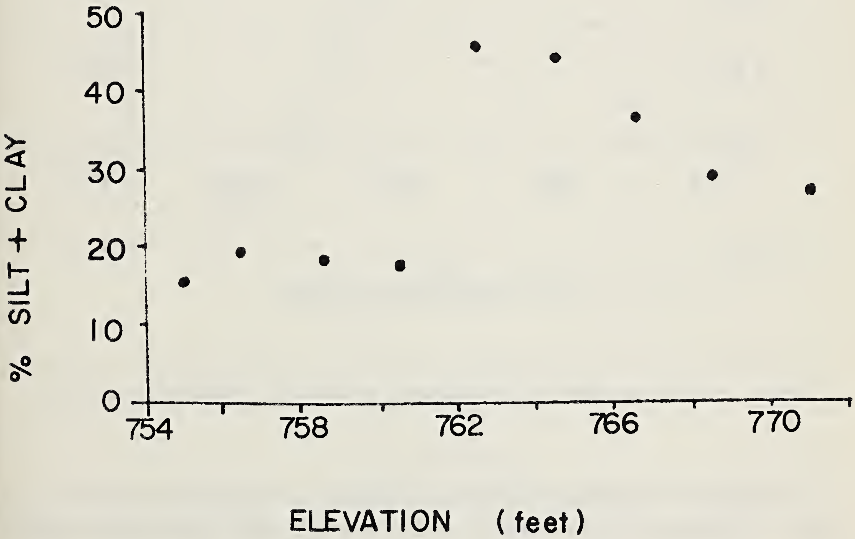

Fig. 4. Soil texture (percentage silt and clay) in relation to elevation

The mean carbon content of the soil was also calculated for each one-foot (0.31 m) elevation level. In general, carbon values of 3% or less were obtained from samples collected on the first bottom, while values of 6 to 7% occurred on the second bottom. Transition from lower to higher levels is abrupt at the slope.

The mean available water capacity of the soil was also calculated for each one-foot (0.31 m) elevation level. Low values of 1.2 to 1.6 in/ft. 10.2 to 13.4 cm/m) occur on the first bottom, while the values on the second bottom are higher, ranging from 2.1 to 2.9 in/ft (17.3 to 24.3 cm/m) (Fig. 5).

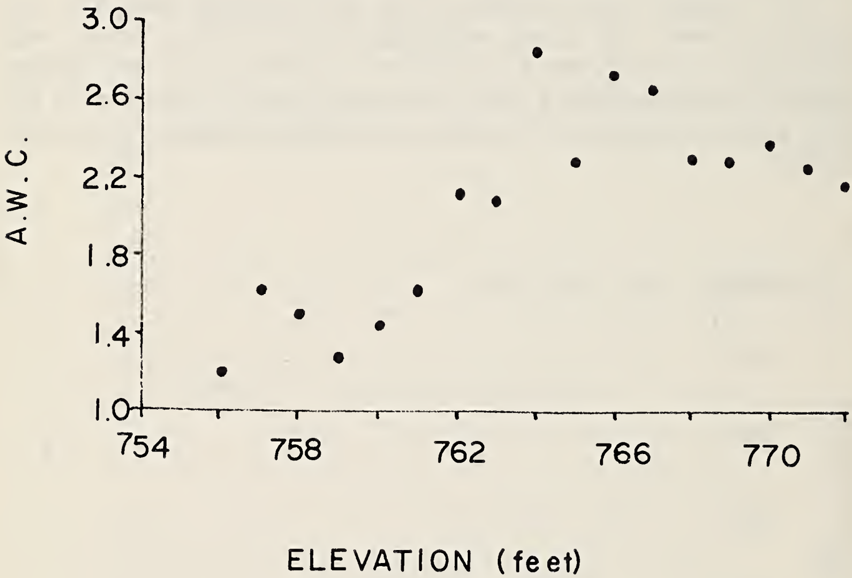

Fig. 5. Available water holding capacity of the soil in relation to elevation

Correlations between integrated values of light and elevation, as well as distance from the river bank were calculated for each of three transects. No clear relationship existed between light conditions and elevation, or light conditions and distance from the river bank. Data were insufficient to compare light intensity and herb frequency of occurrence.

The calculated mean annual flood level is at an elevation of 764 feet (233 m) above sea level. This is approximately midway up the slope. (Fig. 6). Thus most points on the first bottom are flooded nearly every year, and the second bottom is flooded about every 6 to 8 years.

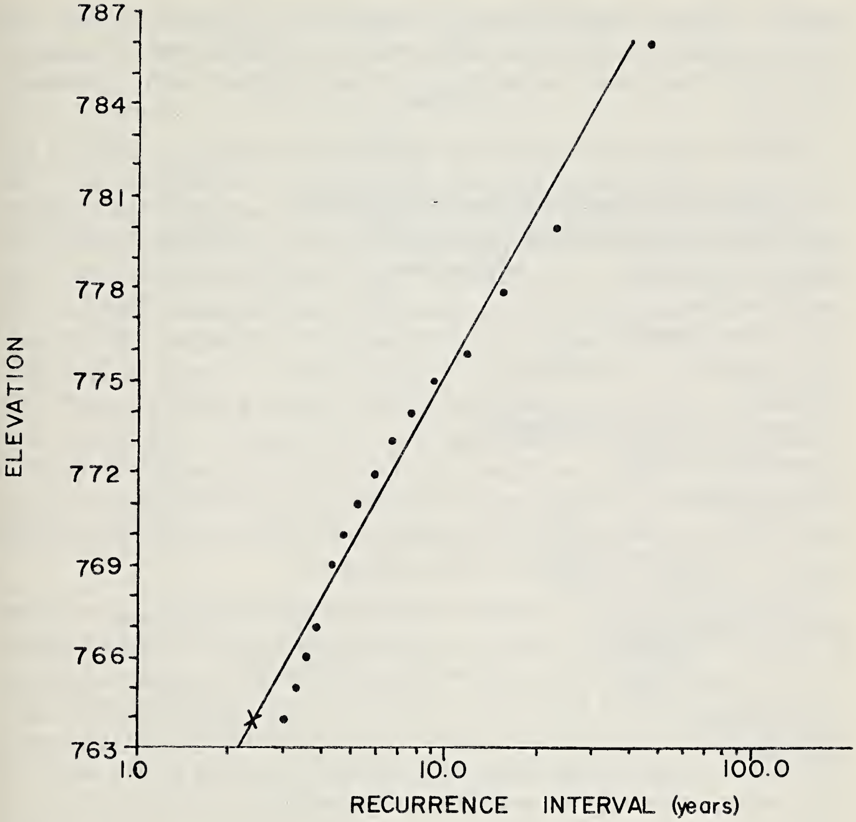

Fig. 6. Flood frequency for various elevations above the Chippewa River

DISCUSSION

The close relationship between several soil properties and topography is directly related to flooding. Changes in soil textures are easily observed. A gradual decrease in sand and a concommitant increase in silt plus clay content of the soil occur with increasing distance from the river as a result of decreasing velocity of the floodwater. Silt plus clay content of the soil is highest on the slope, in most years the line of greatest inland penetration of the floodwater. Floods remove much of the annual increment of litter on the first bottom, resulting in the low carbon content of the soil as compared to the relatively high carbon content on the second bottom. These flood-produced changes in soil texture and soil carbon content result in the differences in available water capacity, generally the lowest near the river and higher with increasing elevation.

Flooding also, influences the vegetation directly, a result of the frequency of occurrence, the duration of inundation, and the velocity of the floodwaters. Most floods that cover the second bottom only last from one to a few days; flood water on the first bottom may remain for weeks. In addition, while the floodwaters may flow swiftly over the first bottom, especially near the bank, there is little current across the second bottom, when it is flooded. Thus plants growing on the first bottom are subjected not only to frequent inundation, but to inundation of long duration, a swift current with attending erosion and damage from floating ice and debris and deposition of coarse sediment. On the other hand, vegetation on the second bottom is flooded only occasionally for brief periods of time, and with little erosion or damaging ice and debris and the deposits consist of small amounts of fine sediment.

Species richness (i.e. number of species) and herbaceous cover are greatest on the second bottom and decrease as elevation decreases. An abrupt change in the number of species occurs near the elevation of the mean annual flood level; most of the spring ephemerals are absent below this elevation. These plants with low shade tolerance survive the shady forest environment by becoming active early in the spring, before the leaves of the trees are fully developed. For this reason, they are at a disadvantage on the first bottom, since flooding often occurs at the time they would be growing most actively.

Total understory abundance does not change dramatically at the slope because a few species, *Laportea canadensis*, *Hydrophyllum virginiana*, and *Polygonum virginianum*, are abundant on portions of the first bottom. Aggregation is common on both terraces. Vegetative reproduction is primarily responsible for aggregation in most species. Flooding may also cause or modify the patchiness of the vegetation, and it appears that many species form clones on the second bottom which are generally larger than those on the first bottom.

The 21 species present were arranged in order of increasing frequency with increasing elevation (Fig. 7). The overall pattern is a gradual and continuous shift in species composition with changing elevation. In many species, there is also a gradual change in frequency with change in elevation. As noted earlier significant

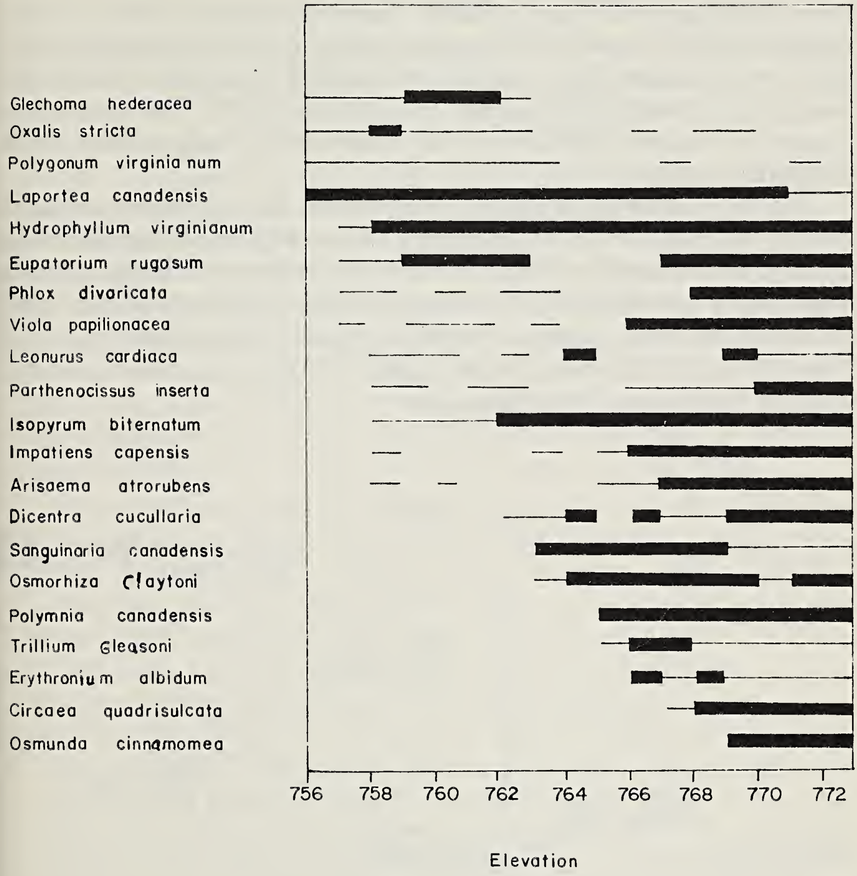

Fig. 7. Distribution patterns of herbaceous species along the elevational gradient. A thin line represents a frequency of less than 10 percent and a thick line a frequency of greater than 10 percent.

correlations exist between frequency and elevation for 13 of the 21 species.

These relationships between flooding, soil properties, and herb distribution lend themselves to examination by multivariate analysis. Accordingly, a polar ordination was performed for eight "stands". A stand is defined as the herbs occurring at each of the eight 2-foot (0.61 m) elevation intervals. The degree of compositional similarity between each of the stand pairs was determined using the 2W/a + b index. Beals' geometric method (Beals 1960) was used to position these eight stands in the plane defined by the first two axes. The stands were labeled A (stand at the lowest elevation) through H (highest elevation) (Fig. 8). The ordination accounts for about 82% of the variability in the original matrix of similarity values.

The first (x) axis appears to represent an elevation gradient which decreases from left to right. The second (Y) axis appears to be related to soil texture (Fig. 4). There is an increase in the amount of sand and a concommitant decrease in the amount of silt plus clay from the bottom to the top along this gradient. The carbon content of the soil and the available water capacity do not appear to be clearly related to either of these two axes.

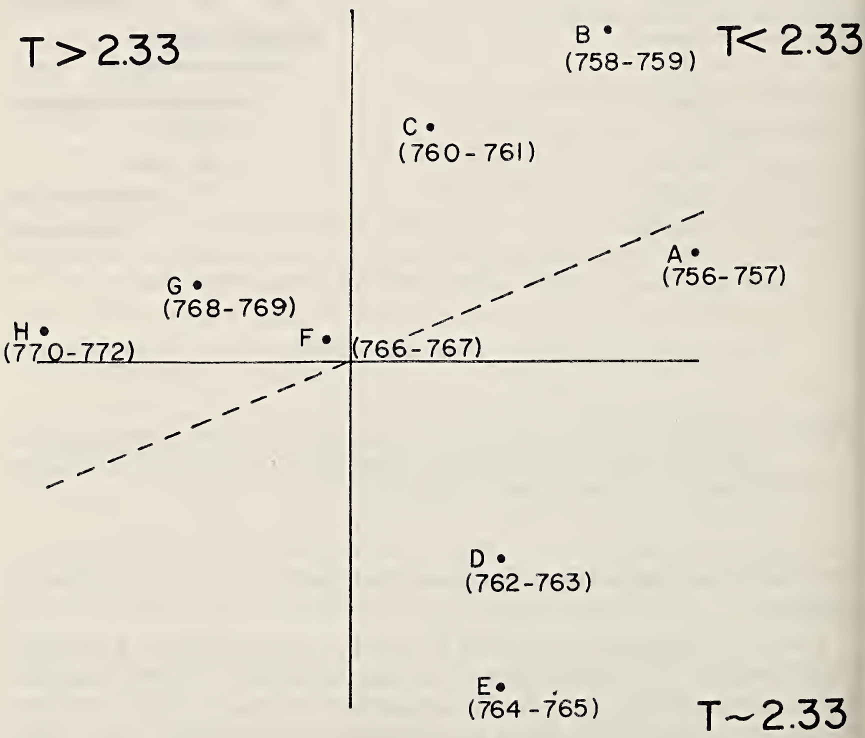

Fig. 8. Ordination of eight "stands" on the plane defined by the xy axis

The dashed line appears to represent the changes in the vegetation that occur with changes in elevation and soil texture (Fig. 8). The upper right end of the line represents the extreme of low elevation and low silt plus clay content, while the opposite extreme occurs at the other end of the line. No stands occur in the lower left quadrant; thus only three conditions are represented, namely: low elevation with low silt plus clay, high elevation with intermediate amounts of silt plus clay, and intermediate elevation with high silt plus clay. The greatest amount of silt plus clay occurs at intermediate elevations, i.e. the level of the mean annual flood.

The recurrence intervals of floods at each of the eight elevation levels were examined. Stands in the upper right quadrant all lie below the mean annual flood level; stands in the upper left quadrant are above this level, while the stands in the lower right quadrant fall approximately at the elevation of the mean annual flood.

Species characteristic of stands occurring below the elevation of the mean annual flood include *Glechoma hederacea, Oxalis stricta, Laportea canadensis, Eupatorium rugosum,* and *Polygonum virginiana.* Species most characteristic of the stands which occur above the elevation of the mean annual flood include *Arisaema atrorubens, Dicentra cucullaria, Erythronium albidum, Trillium Gleasoni, Viola papilionacea, Osmunda cinnamomea, Sanquinaria canadensis, Polymnia canadensis* and *Circaea quadrisulcata.* Despite the fact that stands which occur near the elevation of the mean annual flood are well separated from the other stands in the ordination, there are no species characteristic of this elevation level. Species which occur at both higher and lower elevation levels are absent here, or at least occur at much lower densities. This elevation also represents a transition zone in patterns of species abundance.

There is a direct relationship between elevation and soil texture, carbon content and available water capacity. There is also a direct relationship between elevation and the frequency of occurrence, or the presence or absence, of many herbaceous species. Moreover, there is a close correlation between the several soil properties and the relative frequency of many of the herbs. It is not clear whether the herbs are responding directly to flooding, directly to soil influences, or to some combination of both. It is clear however that the frequency and magnitude of flooding is, either directly or indirectly, responsible for the aforementioned relationships, and thus for the distribution patterns of the herbaceous species growing on this river bottom site.

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A LEGACY OF PARADOX: PURITANISM AND THE ORIGINS OF INCONSISTENCIES IN AMERICAN VALUES

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Paradoxes and contradictions within the American value system have been perceived by social observers dating as far back as Bryce and Tocqueville. Robin Williams, in his description of the major value orientations in American culture, notes the curious co-existence of such values as external conformity, racism and related group-superiority alongside the more frequently extolled values of individualism, freedom and equality (Williams, 1963: 466-68). Williams' analysis, while valuable, fails to probe the historical origins of such internal contradictions. To use modern American culture as an example of an ambivalent or even schizoid culture is to exaggerate its uniqueness among world societies, past and present. Such temporocentrism, unfortunately, lends credence to the oft-repeated criticism that American sociology is anti- or at least ahistorical in its approach. This paper is an attempt to move beyond the time perspective common to American sociology, and to search for same historical clues that might help explain the existence of seemingly logical contradictions in the American value system. It is not my purpose to consider Myrdal's "American Dilemma"—i. e., the gap between the real and ideal in American culture—but to examine instead certain discrepancies within the ideal culture itself.

Consensus among contemporary sociologists on the definition of values is yet to be attained. One of the more popular definitions has been Kluckhohn's classically simple one of values as "conceptions of the desirable." Milton Rokeach offers a more elaborate definition: "A value is an enduring belief that a specific mode of conduct or end-state of existence is personally or socially preferable to an opposite or converse mode of conduct or end-state of existence (Rokeach, 1973: 5-7). He also distinguishes between "instrumental" values (desirable modes of conduct) and "terminal" values (desirable end-states of existence). As standards which guide conduct, values influence the person to take a particular stand on social issues, shape his presentation of self to others, help him to decide if he is as moral and competent as others, and serve as criteria by which he may rationalize his beliefs or actions that otherwise would be viewed as clearly unacceptable (Rokeach, 1973: 13).

It is important to recognize that values are "malleable," in that they can be utilized to justify a wide range of personal goals and behavior—even courses of action which to an outsider might appear blatantly contradictory. Unlike instincts, values do not lead in some unthinking, inevitable fashion toward a predetermined pattern of gratification-behavior. Values render certain courses of social action more likely or more feasible than alternate courses of action. To some degree, however, values receive their essential formulation *after* the fact—as an explanation stemming from the need felt by a person or a group to "account" for certain attitudes or behavior. Therefore, internal consistency within any value system must be seen as a highly precarious condition.

In the case of the American value system, there seems ample empirical evidence supporting Williams' assertion about the co-existence of one set of values centering on equality, freedom, and individualism, and another set which focuses upon inequality, ethnocentrism, and authoritarianism. The question of how these inconsistencies came to exist poses a problem which will require many more years to unravel. A part of the answer, I submit, might be found in that complex, misunderstood network of beliefs and values known as Puritanism, which reigned supreme in New England during much of the seventeenth century. Of all the various "heritages" adorning the rhetoric of the Bicentennial, none is more far-reaching in its consequences than Puritanism. Robert Bellah, in fact, recommends that we look at the ways in which Puritans dealt with their problems "since American culture and even American counter-culture remain Puritan to this day" (Bellah, 1975: 64). While many social scientists might not agree completely with Bellah's statement, few would deny that Puritanism has had an extremely powerful impact upon the formation of American culture.

My goals in this study are (1) to determine whether there were, in fact, value inconsistencies within New England Puritanism; (2) if so, to determine whether such inconsistencies were similar in any important respects to those now existing within modern American culture; and (3) to investigate the social and cultural factors which appear to have been associated with such inconsistencies in Puritanism. The problem of piecing together, in some sort of "causal chain," all of the ideas, people and events that comprise the historic linkage between Puritanism and the modern American value system represents a task of monumental proportions— one which I will happily leave to the social and intellectual historians. I hope that my research will provide some "leads" towards an answer to this broad question; however, this study is an exploratory probe into the use of historical data for sociological purposes.

THE EMERGENCE OF THE PURITAN MIND

With a few noteworthy exceptions like Bellah, Merton and Erikson, American sociologists have contributed little to an understanding of the linkages between Puritanism and "Americanism." Historians, on the other hand, have produced a wealth of studies and are currently engaged in a lively debate over the very definition of Puritanism. Some think of it as a "mood" or "thrust;" others see it as a special theological emphasis or a certain kind of religious language (Simpson, 1955; Hall, 1970; Kammen, 1973; Lockridge, 1970). David Hall portrays the Puritan as a "man in motion, a man possessed by a peculiar restlessness, a man who may attack the idea of a gathered church while still a minister in England, yet form such a group within his English parish and publicly defend the practice once he reached America" (Hall, 1970: 331). Perry Miller, whose writings on Puritanism remain unsurpassed, defined Puritanism in very forthright terms as "that point of view, that philosophy of life, that set of values which was carried to New England by the first settlers in the seventeenth century" (Miller and Johnson, 1963: 1). Some of the difficulty in conceptualizing Puritanism stems from the curious amalgamation of seemingly divergent, opposing elements which comprise it. On this point, McLoughlin once remarked that "historians are still wrangling over whether the Massachusetts Bay Colony was a theocentric, totalitarian society, a Christian utopia or a seedbed of the American democratic system, because it was all three" (McLoughlin, 1968: 52).

One must be wary of "Americanizing" the Puritans, for as Miller pointed out, 90 percent of the Puritan Mind was really the English Mind, and actually what come to be "American" came mainly from this 90 percent. The 10 percent remaining, he argued, is what made the Puritan pick up stakes and emigrate. This difference consisted of the drive to achieve purity within the Church of England, and also to attain a social purity through a social order dominated by saints.

The English Puritans, unlike the Anglicans of their day, viewed the Bible as the whole Word of God, a guide not only to theology, but also to ethics, law, art, military tactics and all of social life. From the perspective of their contemporaries, English Puritans were arrogant literalists, but were not "fundamentalists" in the popular sense of that term, since they saw no intrinsic conflict between science and the Bible (Miller and Johnson, 1963: 43). Puritanism in its original form in England must be understood in the context of the status of its practitioners as an out-group with virtually no power. The greater the powerlessness of the Puritans became, the more heightened their conviction that the church must be freed from the world in order to bring about the coming Kingdom of God (Hall, 1970: 340-41). The heavily millenarian emphasis of the movement provided many Englishmen with a new identity, just as crusades and cultic movements in all periods of history have bestowed radically altered identities upon their converts. Puritans shared the belief of their fellow English Protestants that God extended His special providence toward England, and that eventually God's children would march to war against anti-Christ and his hosts. The Puritans found ample opportunity to use this rhetoric later, applying it in numerous ways to their "holy cause" in North America.

PARADOXES IN PURITANISM

Examination of a wide range of primary and secondary source material, such as sermon literature, missionary correspondence, court records, descriptions of community life, and interpretations of Puritan experience by both insiders and outsiders makes it clear that Puritanism was not a static, monolithic ideology. It was instead a highly complex and dynamic movement filled with inner tensions and contradictions not unlike those observed in American culture today. There are many spheres of Puritan thought which can be identified as containing contradictory internal strains, but those areas of Puritanism most germane to the purposes of this paper may be identified under the following topical headings: (1) individualism and "free will"; (2) freedom and equality; (3) democracy; (4) deviance and dissent; and (5) racism.

Individualism and Free Will

Although Puritan theology emphasized Man's original sinfulness and helplessness before an autocratic God, Man was regarded as having been created a rational, autonomous and responsible being who was "good" to the degree that God's will guided the affairs of the "regenerate." Even the regenerates, however, had to be vigilant in seeking out signs of sin in themselves.

On the doctrine of predestination, often considered the hallmark of Puritan theology, the Puritans were ambivalent. Their theology unquestionably contains many elements of predestinarian doctrine, but their social behavior seems to have been marked much more clearly by voluntarism. They most assuredly did not resign themselves to fate, waiting for some inexorable divine plan to mysteriously unfold. A form of theological individualism was clearly evident in their belief that every individual must assume an active role in working out his own salvation. He could not rely upon group membership, community participation or the mediating functions of a priest. His religiosity, to use Allport's term, was to be "intrinsic," as he sought to appropriate God's grace through a vivid and highly individualistic religious experience. "Even the poor soul condemned to Hell," comments Ralph Perry (1949: 39), "received God's personal attention."

In social relations, however, Puritans were expected to form one united front. "The lone horseman, the solitary trapper are not figures of the Puritan frontier" (Miller, 1969: 42). Puritans moved about in whole groups or towns. Individuals acting outside the bounds of their communities, they believed, personified the very essence of sin. The apparent inconsistency between individualism and external conformity was reconciled, in the Puritan mind, by the concept of "collective individualism" (Perry, 1949: 37). Privacy and individualism were accorded some degree of respect, therefore, but only within the context of external discipline and public accountability.

Freedom and Equality

The notions of liberty and equality, which were to spark the fires of revolution a century later, were not alien to Puritan culture, although both terms were hedged with careful qualifications. Puritans allowed for *Christian* liberty and an equality of *believers*. "Natural" (i.e., unregenerate) man had no such privileges, as was evident in Nathaniel Ward's remark: "All Familists, Antinomians, Anabaptists and other Enthusiasts shall have liberty to keep away from us" (Riemer, 1967: 72). Freedom was thus inextricably bound to conversion in the Puritan mind. Even the freedom of the believer, however, was subject to the controlling influence of the "convenant," a contract which set out a whole series of obligations governing the relationships between God and Man and between Man and Man. God was fully expected to hold up His end of the agreement. The Puritan interpretation of freedom and equality was visibly shaken as a result of the Great Awakening, which left in its wake a pronounced shift toward pietism with its "emotional excesses" and an anarchistic conception of liberty as "liberty from any laws whatever."

The very mention of the popular sociological term "social inequality" would have produced deep frowns or expressions of utter bewilderment from the Puritans, who accepted without question the basic goodness of the social class system as part of the natural order of Creation. The reality of a social hierarchy in New England towns was in no way an embarrassment to the Puritans: to the contrary, heirarchy was incorporated into the ideals of community-builders. In an excellent historical study of the Puritan community of Dedham, Massachusetts, Lockridge asserts that there was nothing in the Puritan understanding of Christian love which necessarily implies anything like absolute equality. "This commune," he wrote, "was not about to practice communism" (Lockridge, 1970: 11). Residents of Dedham fully accepted the idea that obedience to men of superior rank was necessary to the foundation of an orderly society, and that some persons were simply "fated," to be incompetents and laggards. They saw no contradiction, according to Lockridge (1970: 17), between "mutuality to the point of collectivism and a recognition of a hierarchy of wealth and status," since both were seen as inevitable and desirable in the harmonious functioning of society.

Democracy

On the subject of democratic government, the Puritans were much more ambivalent than their authoritarian image would suggest. If we look at only the official statements of two of their leading spokesmen, there would seem to be no ambiguity in their position. John Winthrop, for example, is quoted as saying that "a democracy is, among most civill nations, accounted the meanest and worst of all formes of Governmt . . . and History does recorde that it hath been allwayes of least continuance and fullest of troubles" (Rossiter, 1953: 53) John Cotton added to this: "Democracy, I do not conceyve that God did ordeyne as a fitt government eyther for church or commonwealth. If the people be governors, who shall be governed?" (Rossiter, 1953: 53). Despite these official protestations, circumstances over the course of the seventeenth century served to open the doors to the evolution of democracy as it is popularly regarded today. In their concern to maintain a pure community, many Puritans vigorously endorsed freedom from England. Their desire to maintain religious independence had placed them in the position of desiring political independence as well.

The government of the Puritan commonwealth could be described as a modified theocracy, though it embodied elements of monarchy, aristocracy and democracy as well. The agreed-upon ruler of the commonwealth was God, but He ruled through an aristocracy—the spiritual elect. His rule, however, needed constitutional limitations on absolute power, and allowed for certain constitutional freedoms to increase the number of God's freemen and their rights. This in turn led to a dispersion of power. The oligarchy gradually changed into a near-democracy. As certain liberal elements in Puritanism (such as congregational church polity) prevailed at the expense of its more restrictive characteristics, government "of the people"—including the protection of certain basic individual rights—came into being (Riemer, 1967: 75).

Glimpses of Puritan pragmatism are evident in the development of the congregational church polity during the 1630s, a time when changes in church organization clearly *preceded* changes in the theoretical rationale for such innovations. Replying to inquiries from their Puritan brethren back in England, who were quite concerned about this radical change in church organization, leaders of the Massachusetts Bay Colony simply argued that it "worked," and provided descriptions of how it operated. Not until a decade later, in the 1640s, did any formal ecclesiastical treatises on church polity begin to appear (Ziff, 1973: 51).

Gaer and Siegel conclude that "even New England's limited republicanism allowed greater general participation in church and political matters than had been possible for centuries in Europe. For the elect, at least, even theocracy was an assertion of liberty and democracy" (Gaer and Siegel, 1964: 30).

Deviance and Dissent

The notion of free will, as was mentioned previously, was a constituent part of the Puritan Mind. The deviant was held fully accountable for his deviance. Publicly, the Puritans expressed hope that the deviant, through the chastening experience of harsh punishment, would acknowledge and renounce his waywardness. It appears improbable, however, that such punishment was in any real sense "reform-oriented." The criminal was held up to public view as a bad example, and the harsh treatment accorded him was mainly intended to prevent the re-appearance of that form of behavior within the community (Erikson, 1966: 197).

The possibility that any honest differences could exist among the saints was not seriously entertained by the Puritan fathers. To act in accordance with one's conscience was a hallmark of Puritan thought, but precisely what constituted a valid or authentic "act of conscience" was invariably defined in terms of "official" Puritan theology and policy. Any dissent was likely to be seen as an attempt to shatter the unity of the body, thus jeopardizing the convenant. Sin was not simply a form of deviance occurring within the group; it was seen as a deliberate attack on the very integrity of the group (Owens, 1974: 17-18). Roger Williams consequently found himself in the rather curious position of being informed by his Puritan brethren that the reason they were persecuting him was because he was acting in violation of his own conscience!

From a Durkheimian perspective, one might argue that New England Puritanism defined itself by constantly defining deviancy *from* it, and therefore it "needed" its quota of sinners. The saint vs. sinner dichotomy seemed always uppermost in the Puritan mind. During the seventeenth century more and more groups—both real and imaginary ones—came to know the opprobrium of Puritan labeling. Some implications of this behavior are suggested by Robert Bellah: "When the allegedly sinful group was external to the society, the dialectic of saint and sinner could fuse with the notions of chosen people and holy war to justify extraordinary hostility and aggression against the despised group" (Bellah, 1975: 101).

Racism

A consideration of the history of Puritan-Indian relations seems germane to the present discussion, because of the intricate ways in which racial attitudes were linked to virtually all the Puritan values, and also because of the ways in which racial attitudes serve to highlight the many tensions and contradictions within those values. Certainly the history of Puritan racial beliefs carries with it some distinctively modern overtones. From the beginning, the Puritans held contradictory images of the Indian. Before embarking on their Atlantic crossing, Puritans had been exposed to the hostile images of the Indian as circulated by Spanish and

Portuguese explorers (as "naturally vicious, lazy, inclined toward bestiality and heathen worship"), but these were countered by Hakluyt's description of the Indian as "simple and rude, but by nature gentle and tractable, and most apt to receive the Christian religion" (Taylor, 1935; 164).

Another theory growing in popularity at that time held that the Indians were in fact the descendents of the Lost Tribes of Israel, and were actually white people whose skin had simply darkened by the sun. During the first few years of the Puritan settlement, the Indian was not viewed as an enemy to be driven out, but instead as an unfortunate heathen in need of saving grace and anglicization. Indians were, in Puritan eyes, obviously inferior, culturally speaking, but this defect was remediable.

Problems were to arise, however, as the expansionist goal of the Puritan community came to the fore. Theologians lent their support to expansion by reasoning that if the Indians had been intended to hold this vast land all for themselves, why would God have shown the English the way to the New World? After the smallpox epidemic in 1633, which claimed the lives of several thousand Indians, Winthrop surmised that God must be clearing the way for the Puritan occupation (Vaughan, 1965: 104). In addition, Puritans began interpreting their Bible to mean that only if Man subdues the land through agriculture does he have the right to legitimate possession of the land (Owens, 1974: 179).

Puritan-Indian relations deteriorated during the 1630s. The mounting economic interests of the Puritans seem to have led to situations in which the Indians were given little choice but to react with violence. This in turn activated the "self-fulfilling prophecy" by reinforcing the distinctly unfavorable image of the Indian in the Puritan mind. By 1659, Puritans were identifying the Indians unequivocally as Satanists. In fact, as Owens observes, "the Indian could now be used as a standard against which Puritans could measure other groups suspected of being in league with the Devil" (Owens, 1974: 128). Besides the pressures felt from the increasing land interests of the Puritans, the Indians also came to feel—at least indirectly—the effects of an internal religious problem within the Puritan community. This was the problem of "declension."

It is perhaps unfortunate that the New England Puritans did not have a Max Weber in their midst to warn them of what to expect during the transformation from sect to church. For having become established on Massachusetts soil, the Puritans were no longer the persecuted minority, but the reigning majority. Their preachers, Hall writes, "who had whetted their fiery preaching on targets that the Church of England had to offer, underwent an agonizing adjustment to a new life style" (Hall, 1970: 342). There were also some inherent conflicts in their dual mission to create (a) a moral covenanted community, and (b) a genuinely reformed church *within* this community (Pope, 1969: 261). The numerous social functions of Puritan churches served to draw them into the community, whereas the stress on pietism and "visible sainthood" served to *separate* church and community.

The tide of declension was strong. Spontaneity was lost, piety became formalized, charisma became routinized, and visionaries became organizers. It was simply not possible for Puritan children to recapture the vivid religious experiences of their elders, whose identities had been forged by continual assault upon enemies the children could not know. In a furious counter-attack on what the Puritan divines believed to be the work of Satan in their midst, the churches shook with Jeremiad sermons, consisting of lamentations, desperate calls for repentance, and predictions of impending doom.

As the Puritan leaders bemoaned the continued declension in their ranks, they seem to have resorted to the now-familiar tactic of "scapegoating." The Indian, predictably enough, was selected for the role of scapegoat. As an external, highly visible, relatively powerless and already unpopular group, Indians came to bear much of the brunt of the collective failings and frustrations of the commonwealth. After the Puritans had clearly identified their scapegoat, the implication was both simple and urgent: destroy that enemy and things will return to normal. Perceiving the Indian as one of the "shapes of the devil," to use Erikson's phrase, represented an attempt to regain Puritan group solidarity and to strengthen a rather shaky identity.

By 1675, Cotton Mather and other Puritan writers were referring to Puritan-Indian conflicts in genuinely racial terms—i.e., as a confrontation between White and Red. It was not that the situation had developed into a *purely* racial confrontation, however. The Indian was simply one among many despised classes of deviants, including Quakers, witches, Papists and such "wayward Puritans" as Roger Williams and Anne Hutchinson. No longer was there any talk about Indians as a lost tribe of Israel: they were now seen as Philistines, and therefore as arch-enemies of God's New Israel. By the 1690s, the Indian came to assume great psychological importance for the Puritan. For, as Nash and Weiss point out, the failure to control the Indian "would mean the loss of control over one's new environment, and ultimately, of oneself" (Nash and Weiss, 1970: 8).

Three hundred years have passed since the Puritan experiment but only recently have Americans begun to ponder the criminality of their treatment of Indians. Why has it taken so long? The answer, according to Bellah, "lies in the ambiguities of chosenness. There are similarities between John Winthrop and John Foster Dulles' easy identification of the free world with those nations willing to do the bidding of the American government" (Bellah, 1975: 37).

PURITANISM AND THE AMERICAN VALUE SYSTEM

One of the most consequential ideas within the entire American cultural tradition is what has come to be called Manifest Destiny. The roots of this doctrine are deeply embedded in Puritan thought. No society was ever more convinced of being God's elect than were the New England Puritans. As saints in covenant with God, their identity was supported by the unshakable conviction that history was moving rapidly toward the establishment of God's Kingdom, and that they were to be His agents who would usher it in. This belief, I suspect, functioned to anesthetize the Puritan Mind— and later the American Mind—to any sensitivity to value inconsistencies.

The history of religious interpretations of American destiny has been thoroughly documented by such scholars as Conrad Cherry, Sydney Ahlstrom and Sidney Mead, to cite only a few. Cherry, for example, has traced the idea of a divinely-sanctioned American destiny through Puritanism, the Great Awakening, the birth of the American Republic, the westward expansion, the Civil War, the Spanish-American War and the Philippine acquisition, the massive industrialization and immigration of the late nineteenth century, World War I and II (as well as the "limited" wars that followed), the struggle of minority groups for equal rights, and the whole "communitarian impulse"—a movement which has a long and rich history of its own in this country (Cherry, 1971). Manifest destiny has been subject to varying definitions and varying degrees of popularity throughout American history. It seemed to reach a peak of intensity in the latter part of the nineteenth century, at least among "mainstream" Protestants. For that segment of America's populace, Ahlstrom contends, “a denial of America’s manifest destiny bordered on treason” (Ahlstrom, 1972: 845).

Puritanism in its original form was not to survive long. Perhaps this utopian experiment, demanding such absolute commitment and unswerving conformity, and riddled with so many internal tensions and logical inconsistencies, was doomed from the start. Kammen has noted that the Puritans shared with other colonial societies a strong tendency toward value contradictions, since such societies are inheritors of old inconsistencies as well as creators of new ones (Kammen, 1973: 20-26). English society in Puritan times was torn by internal conflicts, such as Catholic vs. Protestant, Mary vs. Elizabeth, and other tensions related to an age of colonization. These were compounded, in the case of the Puritans, by the uprooting influences of movement, migration and mobility—Pierson’s “M-Factor” (Pierson, 1962). Such influences are conducive to social and cultural change by forcing accommodation, hence increasing the likelihood of conflict, compromise and modification of values. It would be naive to maintain (as some have) that such influences have some innate power to “cause” certain types of social values to emerge inevitably. “Wilderness” and “frontier” are really cultural constructs which are amenable to a remarkably diverse variety of definitions and resultant behavior.

The survival of Puritanism as a viable tradition may be accounted for by its robust ideological offspring, who oftentimes resemble their parent very little, and each other even less! Fundamentalistic revivalism, rationalism, enlightenment philosophy, transcendentalism, the social gospel, rugged individualism and communitarianism can all legitimately trace their ancestry back to Puritanism. Its pervasive influence can be explained not only by its “primacy,” its idealism and its aggressiveness, but also by its extraordinarily literate and educated tradition, which sent out its roots in the form of a vast and rich literature. Motived by the conviction that reason and faith are natural allies, Puritans founded Harvard University in 1636 for the express purpose of providing their prophets with the best available education in the sciences and humanities.

A great many “heroes” of American history, each in his/her own way, played some part in the Americanization of Puritanism. If any one of them could be singled out as having been the key link connecting Puritanism with modern American culture, there would be no better candidate than Benjamin Franklin. His famous autobiography has been described as "the record of what Puritan habits detached from Puritan beliefs were capable of achieving in the eighteenth-century world of affairs. The diary technique of soul-searching for signs of the presence of grace was adapted to a review of the day's external accomplishments, and the boundless belief in salvation through fellowship in a community of the saved adapted to schemes of social betterment through association" (Ziff, 1973: 218). Franklin said, in effect, that if one wishes to succeed, he must hold to the classic Puritan values as the necessary means to achievement. Qualities like temperance, frugality, resolve, industry, justice and sincerity are—to put it bluntly—"useful." Franklin could be described as an eighteenth-century man of affairs as well as a Puritan in his austere moralism—even though he found Calvinistic theology distasteful. Schneider sees Franklin and Jonathan Edwards as representing the two opposite poles of Puritan thought: "It was Edwards who attempted to induce New England to lead a godly, not a sober, life; it was Franklin who succeeded in teaching Americans to lead a sober and not a godly life . . . ." (Schneider, 1969: 153). To employ Rokeach's constructs Franklin could be said to have laid heavy emphasis upon the *instrumental,* not the *terminal,* values of Puritanism, thus furthering the cause of pragmatism in American culture. Despite Franklin's unique and enormously influential interpretation of Puritan values, Puritanism's influence in America was not restricted to sure-fire formulae for worldly success. "Puritanism had become a reflex way of perceiving reality: of how to engage in social intercourse, interpret the implications of daily events with a disciplined conscience, and retain a consciousness of one's own identity as an individual and as a member of a people" (Ziff, 1973: 218-19).

Can the modern American value inconsistencies—freedom, individualism and equality on the one hand, with racism, group-superiority themes and external conformity on the other—really be traced back to similar inconsistencies in Puritanism? The similarities are striking. Puritans valued freedom, individualism and equality—with qualifications, of course. As understood within the context of their whole ideology and culture these values were by no means "unpuritan." Similarly, modern Americans hedge these same values with elaborate sets of customs, taboos, rules and qualifications. It is widely accepted by modern Americans that individuals are "equally" individual—that persons ought to be judged on the basis of their achievements or failures as individuals. Members of minority groups are not exempt from the demands of individualism. "After all," the saying goes, "should minority groups be treated any differently from anyone else? Why should a person blame anybody but himself for his own failures?" It is true that Americans overwhelmingly reject theories which speak of the innate biological superiority or inferiority of racial groups. Yet all too frequently one hears questions like: "Isn't it too bad that blacks, Indians or Chicanos don't have the motivation to get ahead?" "Why don't they want to be more like us?" "Why don't those foreigners just accept our superiority and model themselves after us?" "Why are they so ungrateful when we try to help them?"

These are very modern American questions indeed—but they have an unmistakably Puritanical ring.

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PREDICTION OF BLOOM IN WOODY PLANTS

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INTRODUCTION

The science of phenology is concerned with the timing of natural events in plants and animals and the relationship of these events to the calendar, weather and climate. Phenological events include the emergence of a particular insect, the appearance of the first robin or earthworm or the first bloom of the lilac. Any natural recurring phenomenon could be recorded as a phenological event.

For each of the last fifteen years the blooming dates of trees and shrubs in the University of Wisconsin-Madison Arboretum and campus have been recorded by a selected student in Horticulture 264-*Landscape Plants.* The senior author made and recorded these observations during the spring of 1977.

The year 1977 was unusual when compared to the previous fourteen years. After a cold dry winter, temperatures increased dramatically in early spring and plants set records for earliness of bloom (within the last fourteen years). Early blooming continued through May and June, confirming the results of previous investigations that the spring flowering of trees and shrubs is dependent on the accumulation of a certain number of temperature units. These units, termed degree days, were calculated from temperature records.

This paper is an analysis of the blooming records and their relationship to the temperature prior to bloom. The feasibility of predicting time of bloom was investigated as was the practical use of such predictions by the home landscaper.

METHODS

Field

A flowering tree or shrub was considered "in bloom" when the observer determined that 50% of the flowers were completely open. In plants without showy flowers, the bloom date was determined as the date when the anthers released a small cloud of pollen at a slight touch of the branch. Examples of such plants are *Corylus americana* (American Filbert) and *Betula papyrifera* (Paper Birch).

Data Compilation

The number of calendar year days to bloom (i.e. from January 1) was determined from the bloom dates, and the mean was compiled by summing the days per year and dividing by the number of years for which there were data. The number of degree days (DD) and modified degree days (MDD) to bloom was determined using temperature data from the National Weather Service at Truax Field in Madison. Degree days were obtained by summing for each calendar day the excess of the mean daily temperature above a threshold value. Forty degrees F. was used as the threshold value and March 1 was used as the starting point for determining degree days. In determining the number of modified degree days the low temperature is always considered 50° F. (when the high temperature exceeds this amount), and the high temperature is considered 86°F. when the actual temperature exceeds this value. The mean between the high temperature (86°F. maximum) and the low (or 50°F., whichever is higher) minus 50°F. gives the number of modified degree days. Table 1 lists the plants used in this study, the mean number of year days, DD and MDD to bloom and the number of years on which the data are based.

Sources of Error

The blooming dates used in this study were collected over a fifteen year period; data for each year were collected by a different student. This has no doubt led to some degree of error. Since the same plant was not specified for observation, it is possible that a different tree or shrub could have been observed in each of the fifteen years. Genetic difference alone could account for a slight difference in bloom date (as in the case of *Acer plantanoides* cultivars), but hybridization in some species could account for major differences, as is the case for *Acer saccharinum* and *Crataegus mollis.* Age of the plant may also be a factor. Nienstaedt (1974) observed that buds open later as the tree matures. Of greater significance, though, is the temperature difference created by microclimate. While most of the data were collected from the UW-Madison Arboretum, some data were collected on campus and in the city, where microclimates created by buildings could produce great differences in development of flower buds. The senior author observed that *Buxus microphylla koreana* (Korean Littleleaf Box) bloomed on April 3 next to a campus building but did not reach anthesis until April 10 in the arboretum. Similar observations were made on other species.

TABLE 1. Mean year days, degree days and modified degree days of tree and shrub species based on the 15-year study.

Plant	Year Days to bloom	Degree Days to bloom	Modified Degree Days to bloom	Years of record
Acer ginnala	142.9	641.1	28.8	11
Acer rubrum	99.8	93.2	67.7	13
Acer saccharinum	89.3	46.3	36.8	12
Acer saccharum	114.5	271.6	194.3	8
Aesculus hippocastanum	137.9	543.9	366.0	10
Amelanchier arborea	119.9	294.9	205.6	13
Berberis thunbergii	128.5	399.1	274.1	10
Betula papyrifera	112.5	240.3	173.1	10
Cercis canadensis	125.4	371.5	253.4	13
Cornus alternifolia	145.5	669.6	447.6	11
Cornus mas	104.3	162.5	120.2	13
Corylus americana	943.1	59.7	42.0	10
Cotoneaster multiflorus	138.1	555.8	375.0	10
Crataegus crus-galli	149.8	760.5	507.5	8
Crataegus mollis	130.5	432.8	295.6	11
Diervilla lonicera	161.5	1026.0	683.2	6
Euonymus alata	141.0	591.1	398.0	9
Forsythia x intermedia	109.0	163.7	116.5	10
Forsythia ovata	102.1	115.7	86.7	14
Forsythia suspensa	110.3	179.9	131.3	12
Lonicera tatarica	131.4	456.6	316.6	9
Magnolia x soulangiana	113.7	236.4	169.9	11
Magnolia stellata	110.3	180.1	131.9	14
Malus baccata mandshurica	125.5	365.0	248.4	12
Malus ioensis	133.2	506.7	346.0	10
Prunus americana	120.3	304.0	212.6	12
Prunus serotina	138.7	571.0	389.6	9
Prunus tomentosa	112.0	193.3	141.4	14
Prunus triloba	122.5	327.8	218.6	12
Ribes alpinum	115.2	244.8	177.3	13
Robinia pseudoacacia	148.2	801.7	527.8	9
Rosa hugonis	137.0	545.5	366.3	12
Rosa rugosa	154.4	870.1	572.3	8
Sambucus canadensis	177.7	1509.3	1013.2	6
Sorbus aucuparia	135.0	553.8	372.3	8
Spiraea thunbergii	114.6	231.6	166.8	13
Spiraea x vanhouttei	140.1	589.3	393.6	12
Viburnum carlesii	122.4	328.6	230.0	14
Viburnum lantana	131.2	452.7	307.7	13
Viburnum lentago	141.3	609.8	408.1	12
Viburnum prunifolium	137.8	552.9	371.9	12
Viburnum rafinesquianum	147.5	724.3	481.7	12
Viburnum trilobum	146.1	706.8	471.2	10

Another source of error is the difficulty and subjectivity in determining when the plant has actually reached 50% bloom. *Ribes alpinum* (Alpine Currant), *Larix decidua* (European Larch), *Chaenomeles japonica* (Japanese Floweringquince), *Rhus aromatica* (Fragrant Sumac) and others were especially difficult to determine, and hence most of these were eliminated from evaluation for this paper (*Ribes alpinum* being the exception). Other species, like *Cornus mas* (Corneliancherry Dogwood) and *Magnolia* x *soulangiana* (Saucer Magnolia) have unreliable bloom due to winter injury and late spring frosts, thus making it difficult to determine when they are at 50% bloom. This subjective interpretation could account for three to four days difference in bloom date or up to 100 degree days error in the case of later blooming species. The fact that different persons have taken the data over the years makes errors from this source probable.

The minimum threshold temperature upon which the calculation of degree days to bloom is based varies with different plants. The minimum temperatures required for development according to Chang (1968) are 40° for peas, 50° for corn and 55° for citrus fruit, *Syringa vulgaris* (Common Lilac) initiates growth in spring when the mean daily temperature reaches about 31°F. (Caprio, 1974). Since this threshold varies among plants of different species, the degree day concept for predicting bloom should be based on threshold temperature for each species. The 40°F. threshold temperature used in this study probably is too high for some plants, particularly the early blooming species but may be too low for the later developing species.

Most researchers agree that temperature is of major importance in the flower development of plants, but many note that this factor may be overemphasized. Chang (1968) said that too much weight is given to the high temperature and not enough to the minimum temperature. Bassett et al (1961) believe that in some cases the minimum temperature is more closely related to developmental rate. Lindsey and Newman (1956) pointed out that the mean temperature may be misleading because it fails to take temperature duration into account.

Other factors which may account for the flowering date of plants are sunlight, solar radiation, wind, moisture, light duration, diurnal temperature fluctuations and soil temperature. Caprio (1974) placed major emphasis on sunshine. He said that more degree days are required to bloom in areas with less spring sunshine. His solar thermal unit theory states that the number of degree days to bring lilacs to bloom is inversely related to the amount of solar radiation.

No doubt these factors are interrelated, and controlled experiments would be required to determine the requirements of each individual species. Within the scope of this study, and the purposes for which it is intended, we can consider temperature to be a major factor contributing to the flowering of trees and shrubs and assume that 40°F. is a useful threshold temperature.

RESULTS AND DISCUSSION

Effect Of Temperature On Date Of Bloom

There is a direct relationship between the weather in a given spring and the earliness or lateness of plant development. Species which on the average bloom about the same time seem to be affected to the same degree. *Magnolia stellata* (Star Magnolia), *Forsythia suspensa* (Weeping Forsythia), *Prunus tomentosa* (Manchu Cherry) and *Forsythia* x *intermedia* (Border Forsythia) all have an average bloom date of about April 20 in the Madison area (Fig. 1). The deviation from the mean date of bloom follows the same pattern over the fourteen year period.

It is believed that the accumulation of a certain number of degree days is a major contributor to reaching anthesis. An almost linear relationship is shown between average degree days to bloom and number of days to bloom (Fig. 2). This relationship does not seem to apply in early spring or late in the blooming season, when year days lag behind degree days. Early blooming species may have a lower threshold temperature which would account for the early season discrepancy. The difference in temperature between the Truax Field weather station and the UW-Madison Arboretum in early spring may also affect the linear relationship. Late in the season the number of degree day accumulation per day is much greater than early. Perhaps there is a maximum critical temperature above which plant development is suppressed. Degree days would continue to accumulate rapidly, but plants would not develop at a similar rate. Those plants blooming between April 19 and May 25 seem to have a direct relationship between year days to bloom and degree day accumulation. This is further shown by the almost parallel curves of degree days to bloom and calendar days to bloom between days 109 (April 19) and 145 (May 25) (Fig. 3). After May 25, degree day accumulation is more rapid than plant development.

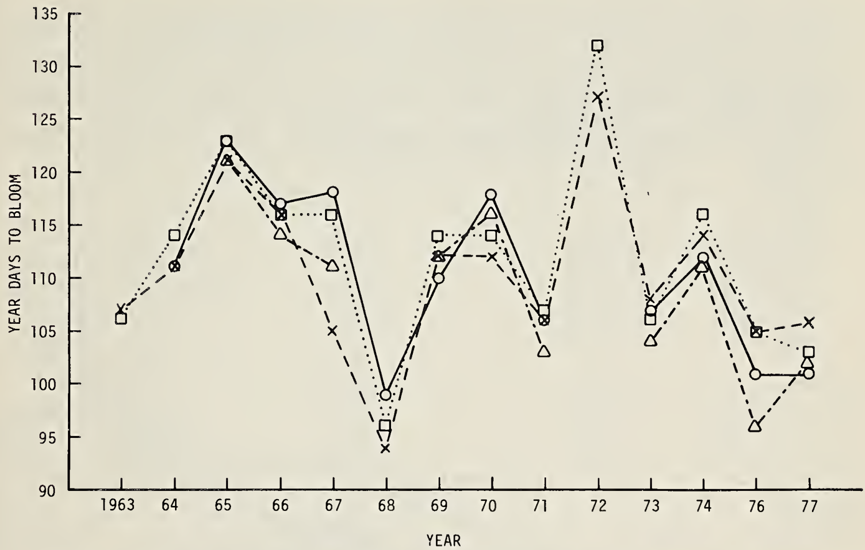

FIGURE 1. Number of days to bloom for plants of similar mean bloom date
Plant Key: X— — —X *Magnolia Stellata*
O———O *Forsythia suspensa*
□.............□ *Prunus tomentosa*
— - — - — *Forsythia x intermedia*

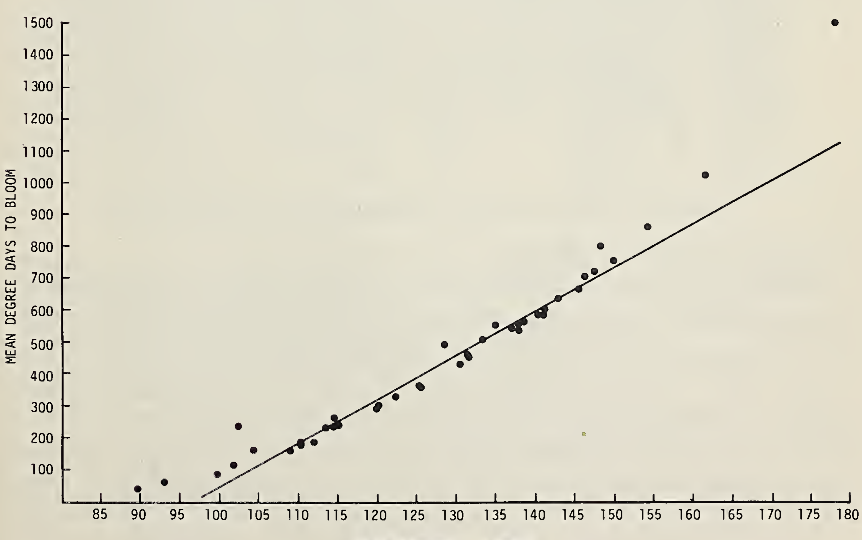

FIGURE 2. Mean number of degree days and year days to bloom for the plants listed on Table 1.

This may have been the case in 1977 when many of the later blooming plants showed a much higher number of degree days to bloom than the average. Plant development could not keep pace with the rate of temperature increase in the unusually warm spring.

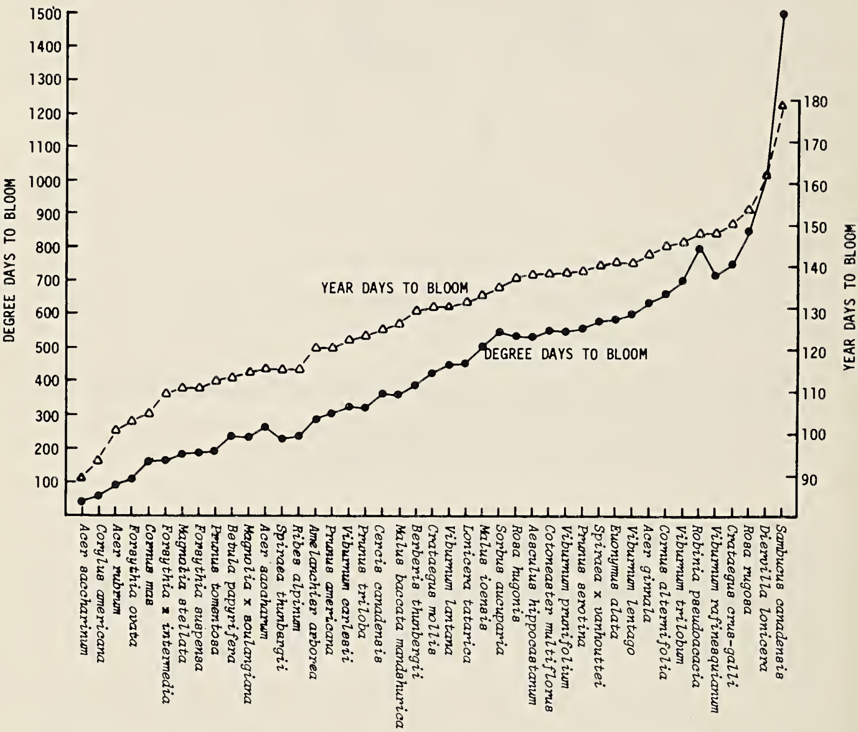

FIGURE 3. Mean number of degree days and days to bloom.

Predicting Date Of Bloom

The uncertainty of Wisconsin spring weather and degree day accumulation rate makes it extremely difficult to predict when a certain tree or shrub will bloom. Some species are more predictable than others, based on degree days to bloom. The average of degree days to bloom through 1976 was calculated for all species used in this study, and their bloom dates predicted for 1977 based on degree day accumulation. The more predictable species tend to be plants which normally bloom in late April through mid May (Table 2). The more unpredictable species in general are earlier bloomers which are influenced by prolonged winters, late frosts and other factors which may delay or virtually eliminate bloom (Table 3). *Diervilla*

TABLE 2. Plants that had predictable bloom in 1977 based on the mean degree days for all years through 1976.

Plant	Mean degree days through 1976	Bloom date prediction based on 1977 degree days	1977 Bloom date
Acer saccharum	271.6	April 14	April 15
Betula papyrifera	240.3	April 12	April 13
Forsythia x intermedia	163.7	April 8	April 12
Forsythia ovata	115.7	March 28	April 1
Forsythia suspensa	179.9	April 10	April 11
Malus baccata mandshurica	365.0	April 18	April 19
Prunus tomentosa	193.3	April 11	April 13
Sorbus aucuparia	553.8	May 1	May1
Viburnum rafinesquianum	724.3	May 12	May 13

TABLE 3. Plants which had unpredictable bloom in 1977 based on the mean degree days for all years through 1976.

Plant	Mean degree days through 1976	Bloom date prediction based on 1977 degree days	1977 Bloom date
Acer rubrum	93.2	March 26	April 10
Chaenomeles japonica	273.4	April 14	April 20
Cornus mas	162.5	March 30	April 19
Corylus americana	59.7	March 12	April 3
Crataegus mollis	432.8	April 20	April 28
Diervilla lonicera	1026.0	May 18	June 10
Magnolia x soulangiana	236.4	April 12	April 21
Ulmus americana	71.5	March 15	March 29

lonicera (Dwarf Bushhoneysuckle), one of the latest blooming species used in this study, is an exception. The bloom of this plant may be day-length dependent, rather than temperature dependent, since all recorded bloom dates fall within twelve days, and the standard deviation is only 4.1 days.

Since it is impossible to predict how many degree days will accumulate by a given calendar day, predicting full bloom in trees and shrubs cannot be based on the accumulation of degree days alone. With careful recording of degree day accumulation, one can predict that bloom is imminent, but long range prediction is impossible.

By noting the bloom date of an early blooming species, one may get a fair indication of when later blooming species will reach anthesis. This is especially true for species which normally bloom within a short time after the observed species. The correlation between the bloom dates of different species decreases as the time between the mean bloom dates increases, due to the unpredictability of the weather during this time. The correlation of bloom dates was calculated between *Forsythia ovata* (Early Forsythia) and nine other species over a ten year period to illustrate this point (Fig. 4). *Acer rubrum* (Red Maple) and *Cornus mas* (Corneliancherry Dogwood) both have mean bloom dates within four days of *Forsythia ovata* and have correlation coefficients of 0.85 and 0.87, respectively, while *Spiraea* x *vanhouttei* (Vanhoutte Spirea) which blooms over a month after *Forsythia ovata* has a correlation coefficient of only 0.43[1] Perfect correlation is represented by a value of 1.00; 0.70 indicates a good correlation, whereas 0.30 is on the threshold of significance. To a degree, one can be reasonably accurate in noting the bloom of one plant and predicting the bloom of another based on the difference of their average days to bloom

As mentioned earlier, later blooming species tend to be more predictable than earlier blooming species. Earlier species face inconsistent weather and other variable factors. A heavy frost may delay or destroy imminent bloom.

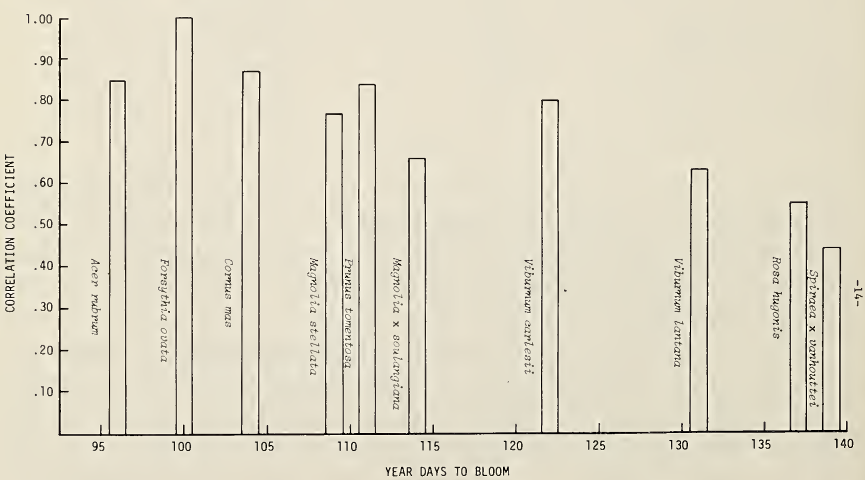

FIGURE 4. Relationship of bloom of various species to the bloom of *Forsythia ovata*. Based on 10 years of data (1966-1973, 1976-1977)

In the spring of 1977 a heavy freeze occurred on May 9 and destroyed the bloom of *Weigela* sp. and *Deutzia* x *lemoinei.*

The fact that later blooming species are more predictable is supported by the decrease in standard deviation (SD)[2] as days to bloom increase (Fig. 5). Early blooming species have an SD of 10 to 12 whereas most of the later blooming species have an SD falling between 6.5 and 8.5. Similarly, the percent standard deviation of the mean decreases as the mean degree days increase (Fig. 6).

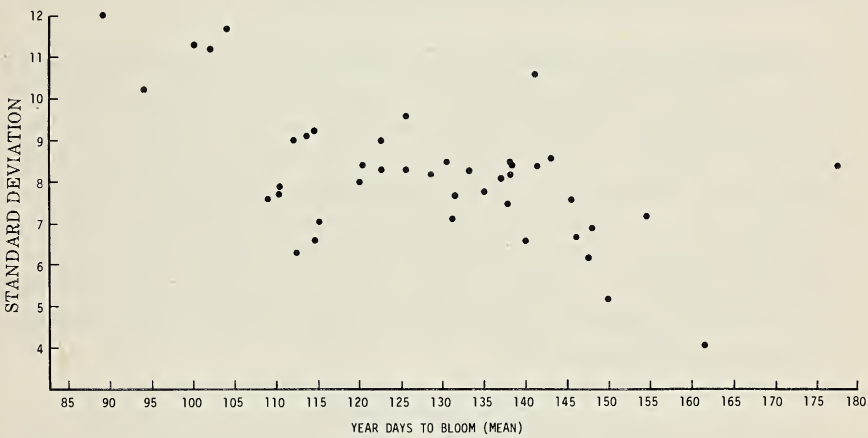

FIGURE 5. Standard deviation and mean number of days to bloom for the plants listed on Table 1.

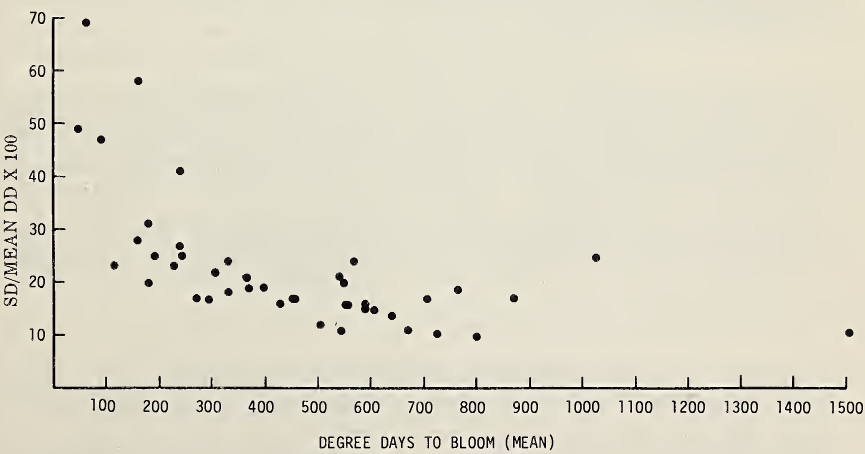

FIGURE 6. Relationship between mean degree days to bloom and standard deviation as a per cent of the degree days to bloom.

PRACTICAL APPLICATIONS

Although the flowers of most trees and shrubs are shortlived if the temperature is high, as was the case in 1977, most home landscapers select plants on the basis of their flower display. Often little thought is given to color coordination of the various elements in the landscape setting. If the landscaper knew the color of the flowers of various plants and when they would bloom, he could be much more innovative in his landscape planting design.

Knowing the blooming sequence allows the landscaper to design a garden with continuous bloom and appropriate color coordination. He can plan the landscape with plants to begin blooming in early April (or earlier in a warm spring) and to last until fall, if roses, *Potentilla fruticosa*, and *Hammamelis virginiana* (Common Witchhazel) are used. If the blooming times and flower colors of annuals and perennials are known, these can also be used to blend with the flowers of woody plants. Thus, whereas most trees and shrubs bloom in spring, proper plant selection can result in summer and autumn bloom as well.

By knowing when plants will bloom, one can also choose those species which have more reliable bloom year after year. Plants which bloom late in the spring often avoid the late season frosts so common in Wisconsin.

In species which bloom in early spring, flowering is often the first sign that the plant is breaking dormancy. Daubenmire (1959) suggested that this may be useful in determining when a species should be transplanted. By keeping a record of degree day accumulation, a nurseryman or landscape contractor may be able to determine the optimal time to plant new stock or transplant established stock.

Despite the inconsistency of Wisconsin springs, most plants bloom regularly and the sequence of blooming is predictable. This information will allow landscape architects and homeowners to be more creative in developing landscape planting schemes which will exhibit color throughout the year.

NOTATIONS

[1]Correlation coefficient (r) = $\Sigma (x_i - \bar{x})(y_i - \bar{y}) / \sqrt{\Sigma (x_i - \bar{x})^2} \sqrt{\Sigma (y_i - \bar{y})^2}$

= the sum of the products of the differences between yearly date and mean date, divided by the product of the square roots of the summed squares of the differences.

[2]Standard deviation (SD) = $\sqrt{\Sigma (x_i - \bar{x})^2 / n - 1}$

= a measure of scatter of spread in a series of observations

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SQUIRRELS ON THE HOWARD POTTER RESEARCH AREA

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ABSTRACT

The average home range estimated for 21 gray squirrels was 2 acres (0.9 ha). Over half the marked population dispersed beyond the study area; in 1973 dispersal began in August and extended through January, 1974. In 1974 and 1975, dispersal began in March. This early spring dispersal may have been triggered by poor mast carry-over from the previous fall. Three patterns of daily activity emerged during the study. The first was a summer pattern with two peaks, one from 2 to 5 hours after sunrise, and another from 1 to 3 hours before sunset. The autumn activity pattern showed few diurnal fluctuations; gray squirrels were equally active through most of the day during September, October, and November. Winter activity peaked at midday. Weather conditions that had the greatest inhibiting effect on gray squirrel activity were high summer temperatures and spring precipitation. Cloud cover stimulated winter activity. Indices to gray squirrel abundance on three Potter Area study grids showed squirrel density to be lowest on Trap Area III where oaks produced fewer acorns than the same species on the other grids. Red, gray, and fox squirrels occupied all trap areas. Red squirrels were the least common of the three species but most common on Trap Area I. The fox squirrel was least common on this area. Competition between these two species may have limited local fox squirrel densities. Only six agonistic encounters among the three species were observed during the study. In these encounters, the red squirrel was most aggressive and the fox squirrel least aggressive.

The Potter Research Area is a 400-acre (162 ha) tract on the southern ridge of the Baraboo Range in Sauk county, south-central Wisconsin (Fig. 1). It was obtained by the University of Wisconsin in 1969. The area has two major soil types, Pecatonica silty loam, a light-colored forest soil lying on weathered glacial till, and Baraboo silty loam, a similar forest soil containing some quartzite outcrops from 2 (61 cm) to 8 feet (244 cm) high, lying on the northern and southwestern borders of the area.

Red Oak *(Quercus rubrum)* is the dominant tree species in the 263 acres (106 ha) of woodland. Other common tree species include red maple *(Acer rubrum)*, white oak *(Q. alba)*, and occasionally sugar maple *(A. saccharum)* and big-toothed aspen *(Populus grandidentata)*. There is a 12-acre (5.0 ha) apple orchard on the eastern side of the area and 69 acres (27.9 ha) of crop land in the center. When the study began, these fields supported an extensive stand of brome grass (*Bromus* sp.). The northeastern quarter of the fields was planted to corn in May 1974. The two western fields were plowed for corn in May 1975.

The objective of the squirrel research on the Potter area was to gain additional insight into the timing, magnitude, and cause of gray squirrel *(Sciurus carolinensis)* movements in southern Wisconsin. The relation of gray squirrel density to woodlot mast production was also investigated.

Effort was concentrated in three woodlots. The first, Trap Area I, was a 12-acre (5.0 ha) plot in the ravine of an intermittent stream in the southwest corner of the preserve. Roughly half of this grid was on a south-facing slope; the other half faced north or was relatively flat. This woodlot contained the greatest variety of tree species of the three woodlots. The understory varied from a dense layer of

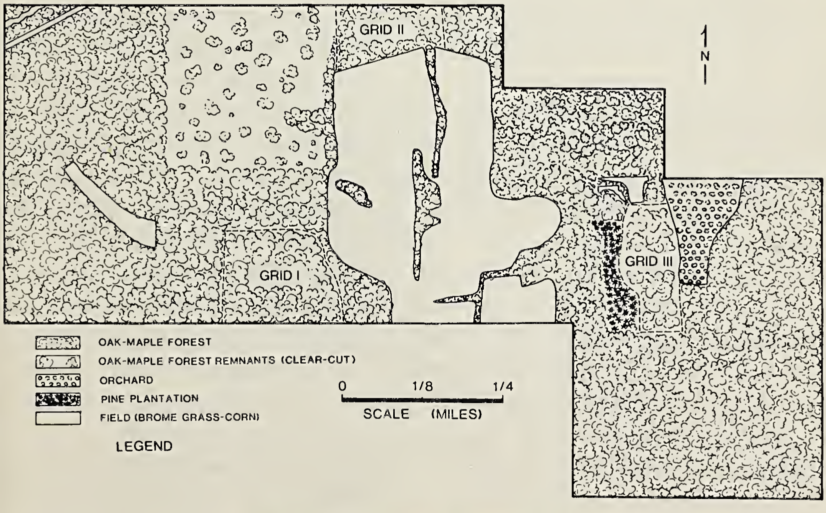

Figure 1. Potter Research Area.

shrubs and saplings on the north-facing slope to a sparse shrub layer with sedge ground cover on the more xeric south-facing slope.

Trap Area II was a 12-acre (5.0 ha) tract on a north-facing slope north of the agricultural fields. Red oaks on this grid were slightly larger than those on Area I (Table 1). White oaks were less common on Area II than on either Areas I or III, but they were generally larger. Red maple was common but occurred primarily as an understory species. Several species of *Cornus* were also common in the understory.

Trap Area III covered 11 acres (4.5 ha) along Ringling Creek just west of the orchard and lay chiefly on west-facing slope. The timber was mixed red oak, white oak, red maple, sugar maple, and big-toothed aspen. The understory had scattered stands of young red and sugar maple saplings, separated by large open areas with a grass and sedge ground cover. The shaded ground was covered with leaf litter and an assortment of herbaceous species.

METHODS AND MATERIALS

Trapping and marking of squirrels began in March 1973 on Area I, in May on Area II, and in June on Area III. The traps used were 9 inches (23 cm) x 9 inches (23 cm) x 32 inches (81 cm) National Live Traps which were placed 50 yards (46 m) apart. They were arranged in rectangular networks with 26 traps on Area I, 30 on Area II, and 28 on Area III.

Four marking methods were used during the study: dye marking, tail trimming, toe clipping, and collaring. The effectiveness of the Nyanzol D dye varied and dye marks on the body were lost twice a year as seasonal pelage was molted. Collars were lost at an unknown rate and were difficult to put on the squirrel in the field. Two gray squirrels died while they were being collared, and four others showed signs of moderate shock. Because of these difficulties, dye marking and collaring were abandoned and all squirrels were marked with a toe clip and tail clip pattern. The toe clip provided a permanent mark, while the tail pattern allowed an observer to distinguish between marked and unmarked squirrels at a distance. The tail clip code did not identify the individual (there were not enough possible patterns), but it did provide a common mark for all individuals captured on the same grid. This grid code made it possible to detect movements of marked squirrels between grids.

To gain access to juveniles prior to weaning, 29 nest boxes were installed on the three grids. Barkalow (pers. comm.) and Bakken

(1952) have stated that juvenile gray squirrels can be identified by their small size for two to three months after they have been weaned. Barrier and Barkalow (1967) described a technique for assigning age of gray squirrels in winter pelage that relied on coloration of rump fur. These techniques for aging were applied in this study; when they were not applicable, an attempt was made to use Sharp's (1958) method involving tail pelage characters.

The animals aged as adults were certainly adults and animals identified as juveniles according to their size during the summer were indeed juvenile. The group classified as subadults in this study, however, may include an undetermined number of early-born juveniles and misclassified adults. Extensive use of age data has been avoided because of the unknown incidence of errors in aging.

Observations on the three trap areas were made between September 1973 and June 1975 to determine proportions of marked squirrels in the populations and possibly to locate marked squirrels that had disappeared from other grids. The main observation effort was made between June 1974 and June 1975. Usually daily observations began one-half hour before sunrise to one hour after sunrise and lasted 6 to 8 hours. The observation period was shortened to 4 or 5 hours during extreme winter weather. The numbers of squirrels seen per day were used to make time-area estimates of the study area populations according to Goodrum (1940). These estimates differed from Goodrum's method in that they were based on data from a somewhat larger area and over a longer observation period.

During the observations, I wore camouflage clothing and moved approximately 300 ft (91 m) per hour. These movements, confined to trails on the grids, were silent except during periods of crusted snow cover. In most cases, I could approach to within 15 yds (14 m) of a gray squirrel without flushing it.

Each trap area was divided into 100 foot (30 m) squares to map squirrel sightings and timber. Location, species, basal area, and the presence or absence of tree dens or leaf nests were recorded for every tree with over 0.8 square decimeters of basal area. The number of quadrats in which each species occurred was recorded, then divided by the sum of the quadrats of occurrence for all species and multiplied by 100: this "percentage frequency" index indicates the uniformity of distribution for each species. The sum of the basal area for each species was divided by the total basal area for all species and multiplied by 100: this is a measure of the relative size of the trees of each species and is the "percentage dominance." The number of trees of each species was divided by the total number of trees and multiplied by 100: to give the relative number of each species present, the "percentage density". These three indices were averaged to describe the overall importance of each species in the woodlot (Table 1). This average is the "Importance Value" of Curtis and McIntosh (1950).

To obtain an estimate of oak mast production on the three grids, the number of acorn caps were counted on 94 circular quadrats, each with an area of one square yard (0.836 m^2). Caps were assumed to decompose at the same rate on all grids.

TABLE 1. Composition of tree layer on trapping Grids I, II, and III, Potter Research Area

Species	Grid	Trees/acre	Avg. basal area[1] (dm^2)	Percentage Frequency	Percentage Density	Percentage Dominance	I.V.[2]
Quercus rubrum	I	44	13 (8.7)	18	38	60	39
	II	26	15 (7.4)	23	38	71	44
	III	58	11 (6.7)	18	45	58	40
Q. alba	I	24	7 (5.5)	16	21	18	18
	II	13	10 (7.7)	20	8	10	13
	III	33	6 (4.2)	18	24	17	20
Acer rubrum	I	9	4 (6.7)	10	8	4	7
	II	78	3 (2.9)	23	47	16	29
	III	14	6 (4.7)	12	11	7	10
A. saccharum	III	12	8 (6.0)	15	9	8	11
Tilia americana	I	8	6 (5.1)	8	6	5	6
	II	0.3	12 (0.0)	2	0.2	0.3	0.7
	III	2	9 (7.1)	4	1	1	2
Ulmus sp.	I	10	3 (4.5)	11	8	3	7
	II	2	6 (5.9)	7	1	1	3
	III	2	12 (6.1)	4	1	2	2
Fraxinus americana	I	5	7 (5.6)	8	4	3	5
	II						
	III	2	11 (6.2)	4	2	2	3
Carya ovata	I	7	3 (2.3)	7	6	2	5
	II	0.6	4 (6.0)	3	0.4	0.2	1

Species	Grid	Trees/acre	Avg. basal area[1] (dm^2)	Percentage Frequency	Density	Dominance	I.V.[2]
Carya cordiformis	I	1	3 (2.5)	3	1	0.3	2
	II	1	4 (3.6)	3	0.3	0.1	1
	III	0.2	1 (0.0)	0.7	0.1	0.0	0.3
Juglans cinerea	I	2	8 (6.0)	5	1	1	3
	II	2	6 (4.9)	7	1	1	3
	III	1	8 (5.7)	3	1	1	2
Prunus serotina	I	1	5 (3.2)	4	1	1	2
	II	4	3 (2.1)	9	2	1	3
	III	0.7	6 (1.7)	2	1	0.4	1
Populus tremuloides	I	3	2 (0.9)	3	2	1	2
P. grandidentata	I	2	5 (3.8)	4	2	1	2
	III	3	11 (3.5)	7	2	3	4
Corylus americana	I	0.3	1 (0.0)	1	0.2	0	0.4
Betula papyrifera	I	2	3 (2.6)	3	2	1	2
Celtis occidentalis	II	0.2	5 (0.0)	1	0	0	0.3
Acer negundo	II	1	1 (0.6)	3	1	0	0.3
Juglans nigra	II	2	2 (0.0)	0.8	0	0	0.3
	III	4	4 (0.0)	0.7	0.3	0.1	0.4
Ostrya virginiana	III	6	1 (0.4)	12	4	1	6

[1] Standard deviation in parentheses.
[2] Importance Value.

RESULTS AND DISCUSSION

Squirrel home range

Of 268 gray squirrels captured and released during the study, 49% were captured once, 19% twice, and only 8% five times or more (ave. 7 times). Two estimates of home range, a minimum polygon estimate (Hayne, 1949) and a home range index estimate (Metzgar and Sheldon, 1974), were made for each of these squirrels. The average minimum polygon estimate was 3 acres (1 ha); the average home range index estimate was 2 acres (0.9 ha) (Table 2).

Gray squirrel investigators differ on the squirrel's typical home range size. Flyger (1960) estimated home ranges for Maryland squirrels at 0.2 to 7 acres (0.1 ha to 2.8 ha). Robinson and Cowan (1954) estimated home ranges of 50 to 55 acres (20.3 to 22.3 ha) in a Vancouver Island woods. For Indiana gray squirrels, Allen (1952) estimated a daily activity radius of 100 yards (91 m).

TABLE 2. Home ranges of 21 gray squirrels on the Potter Research Area

				Home Range Estimates	
Grid	Individual Squirrel	Sex	Locations	Home Range Index (acres)	Minimum Polygon (acres)
I	22	m.	11	5	8
	43	m.	5	2	4
	2	f.	5	1	0.3
	40	m.	5		1
	32	f.	5		3
II	5	m.	5		1
	7	f.	10	3	1
	16	f.	6	1	0.4
	2	f.	9	1	1
	23	m.	5		2
	24	m.	6	3	1
	27	f.	8	3	1
	31	m.	5		0.4
	32	m.	5	1	0
	80	m.	11	3	3
	102	m.	6		3
III	41	f.	7	4	4
	58	f.	5		7
	47	f.	5		3
	36	f.	8	2	8
	40	f.	6	1	2
Mean (all grids)		males	6	3	2
		females	7	2	3
		all sexes	6	2	3

Tester and Siniff (1974) pointed out that home range estimates based on recapture data grow progressively larger with an increasing number of recaptures. The small number of recaptures for the 21 animals (for which estimates were made) in my study limits the size of calculated home ranges. Our estimates therefore represent minimum sizes.

Hayne (1949) remarked on another difficulty in using recapture data for home range estimation — the ranges of many animals do not conform to the size and shape of the trap grid on which they are captured. My observations show that 16% of the gray squirrels sighted were using timbered areas adjacent to the trap grids as well as the grids themselves. These sightings included animals that were unmarked or marked only with grid codes. Because these animals could not be individually identified, their movements could not be used for home range estimation. Their movements do show, however, that the estimates made above may be somewhat smaller than the true home ranges for these squirrels.

The agreement of home range estimates from this study with Flyger's 1960 figures indicates that home ranges for some gray squirrels may not exceed 7 acres (2.8 ha). In my study, however, it was not possible to make any home range estimate for the 182 squirrels caught only once or twice. Thus the home range estimates here reported do not apply to these mobile animals. It appears that there were certain small cohorts of the trap grid populations that are quite conservative in their movements and other larger cohorts that ranged more widely.

Dispersal

Size of Dispersing Cohort. The 8 squirrels observed on grids other than the ones on which they were originally marked are only a small proportion of the 268 marked squirrels that could have dispersed to other areas. However, the time of observation of dispersing animals was only a small proportion (12%) of the time during which they could have dispersed. In addition, the observation areas represented only 36% of the total area available to dispersing squirrels. The observation sample, then, represents only 4% of the combined time and area available for sampling. In theory, 8 squirrels observed during a 4% sample yield an estimate of 200 squirrels dispersing at least as far as a new study grid. Actually, the small sample size limits the dependability of this estimate, but these data indicate that a large proportion of all marked squirrels dispersed at least 0.4 miles (0.64 km) (the distance between the grids) at some time during the study. One advantage of this estimate is that it considers only squirrels that actually dispersed rather than lumping squirrels that dispersed with those that died.

Trapping records show that 68% of all gray squirrels trapped were captured only once or twice. Mortality probably did not play a significant role in those disappearances. For squirrels that were captured more than twice, the average period between first and third captures was 35 days. The upper 95% confidence limit on this mean is 57 days. Average mortality over a 57-day period should have been between 7 (Mosby 1969) and 10% (Barkalow et al, 1970). According to these estimates of mortality, between 90 and 93% of the disappearances after one or two captures were due to dispersal rather than mortality. Only 26% of 384 gray squirrels observed on the grids were marked, indicating that marked squirrels were actually dispersing and not simply avoiding traps.

These independent estimates of the number of dispersing squirrels demonstrate that a large proportion (probably well over half) of the squirrels on the Potter Area undertook movements of half a mile (0.8 km) or more during the study.

Barkalow et al. (1970) estimated that 15% of squirrels marked on his 200-acre (81 ha) study plots moved into other areas. Mosby (1969) studied two woodlots separated by 800 feet (244 m) of cultivated land. He detected 45 movements between the woodlots or from the woodlots into surrounding areas, a 6% dispersal rate. Flyger (1960) saw no movement between two woodlots 600 yards (549 m) apart. Longley (1963) felt that ingress of dispersing squirrels had an important effect on local populations on his Minnesota study areas. He estimated the fall population on one woodlot at 33 and observed 6 new squirrels (not including young of the year) in the following summer. He also observed 6 instances of 0.5 mile (0.8 km) movements and described 0.25 mile (0.4 km) movements as "not uncommon." Sharp (1959) observed the majority of gray squirrels moving out of his Pennsylvania study areas in anticipation of a mast failure. He also cited Schorger's 1949 statement that squirrels abandoned areas before mast failure manifested itself. This implies that most, if not all, squirrels in an area with low food reserves may disperse to other areas.

Transient Squirrels on Trap Areas. Time-area estimates of fall population densities on the trap areas ranged from 0.4 to 1.0 squirrels per acre (1 to 3 squirrels per hectare) with a mean of 1 squirrel per acre (2.5 squirrels/ha) (Table 3). This density estimate

TABLE 3. Time-area estimates of study area populations on the Potter Area

Census period	Study Grid	Observation time days	hours	Gray Squirrels observed marked	unmarked	Largest no. seen on a single day	Estimated density/acre
Sept.	I	7	45	9	75	16	1
To							
Nov.	II	9	52	22	37	15	1
1974	III	7	40	3	12	4	0.4
Total		23	136	34	124	35	1
March	I	9	84	16	14	7	1
To							
May	II	9	69	17	19	9	1
1975	III	9	64	3	12	5	0.4
Total		26	216	36	45	21	0.6

compares favorably with Moulton and Thompson's (1971) estimate of 2 squirrels per acre (4.0 squirrels/ha) in Iowa County, Wisconsin and finds support in other literature estimates of squirrel density (Barkalow et al., 1970—1.35 squirrels/acre (3.34/ha); Brown and Yeager, 1945—1/acre (2.50/ha). Applying a liberal estimate of slightly more than 1 squirrel/acre to the area of the trapping grids, the combined populations of all grids should have been no more than 36 in the fall of 1973.

Population indices during the 25-month study indicated that local squirrel populations remained stable (trap success: 1973—0.4 squirrels/grid day, 1974—0.4 squirrels/grid day; observation success; 1973—0.4 squirrels/hour, 1974—1 squirrel per hour). In addition, there is no evidence of an unusually successful breeding season during the study. The stability of the population in 1973-1974 indicated that the annual recruitment was no more than that required to compensate for mortality. An estimate of the mortality among the original 36 squirrels on the study grids, thus, should estimate the number of new squirrels recruited to the population and available for trapping.

Time-area population estimates for September 1974 and May 1975 showed a 40% mortality. If most losses occur in winter, this estimate probably includes the bulk of the year's mortality. If this is not the case and mortality is uniform throughout the year, the 40% in 8-month estimate is equivalent to a 60% annual mortality. The 40% estimate agrees closely with Mosby's 1969 estimate of average annual mortality (42%); the 60% estimate approaches Barkalow et al.'s 1970 estimate of 64% annual mortality. Because both estimates find support in the literature, both were used in these computations in order to provide a broader estimate of the number of squirrels available for marking. Forty to 60 percent mortality operating on a stable fall population of 36 squirrels should have been compensated by recruitment of 14 to 22 young annually. The total number of squirrels available for marking during the study should have been between 50 and 66, the sum of the 1973 spring population (36 fall squirrels reduced by 40% over-winter mortality) and the recruitment from two years of breeding. In fact, 268 squirrels were trapped. The difference of 202 to 218 probably resulted from the appearance of dispersing squirrels.

Dispersal Peaks. In this study, the proportion of unmarked squirrels in the total catch was taken as an index to the rate of dispersal in the population (Fig. 2). After the initial marking period, increases in this proportion always reflected movement onto the trapping area. There is only one occurrence that could cause an

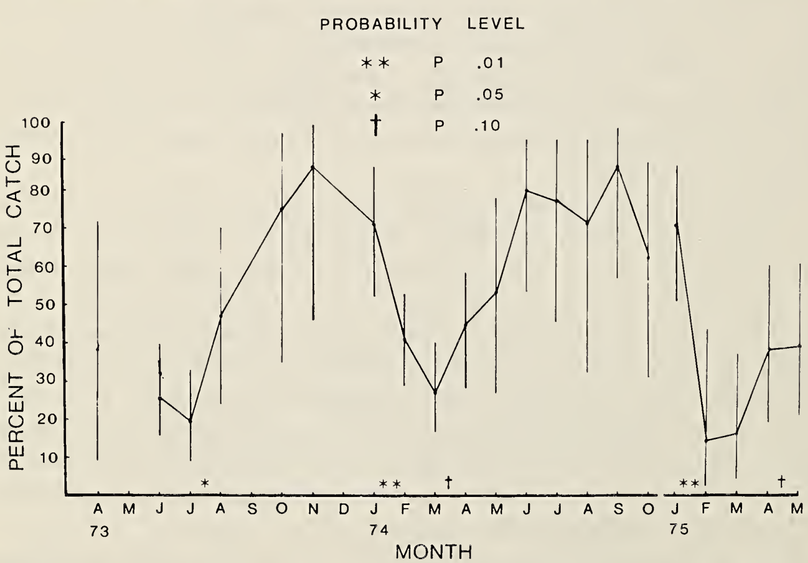

Figure 2. Changes in the proportion of unmarked gray squirrels in the monthly catch on the Potter Research Area. (Vertical lines represent 95 percent confidence intervals).

increase in this proportion in the absence of actual movement, and that is the appearance of young of the year in the traps at a time when they are no longer recognizable as juveniles. This situation, if it ever existed, was probably confined to a brief period in the fall or early winter and was of little consequence in the interpretation of seasonal dispersal during this study.

Sharp (1959) stated that 80 to 90% of a local gray squirrel population could be trapped in a 3-week period. Data from Potter Area trapping also indicated that nearly all of the resident squirrels on the trapping areas were marked by the end of the first month's trapping. Therefore, the data from the first month on each grid were discarded to avoid spurious peaks in the proportion of unmarked squirrels. The remaining data for late spring and early summer showed that there was little or no spring dispersal in the spring of 1973. The low proportion of unmarked squirrels in the July catch indicated that dispersal remained low through mid-summer. The low June and July proportions also demonstrated that the appearance of first litter juveniles which probably occurred at this time (Barkalow and Shorten, 1973) did not affect the utility of the proportion as a barometer of dispersal. Only 5 squirrels of the 42 captured during this summer were juveniles.

There was a sharp increase in the proportion of unmarked squirrels in the catch from July to August, 1973 ($X^2 = 5.43$, $P < .05$). Using the small size of the summer juvenile along with Sharps 1958 tail pelage characters, I identified only two juveniles during this period. The other 16 unmarked squirrels that appeared were adults or subadults dispersing from other areas. This influx was probably the beginning of the fall shuffle.

Rates of dispersal remained high from September 1973 through January 1974 (Fig. 2). Movement in the first half of the period can be explained as a manifestation of the fall shuffle. Most investigators, however, have observed the end of the shuffle sometime in November. Barkalow and Shorten (1973) mentioned that gray squirrels on one of their study areas moved into adjacent habitat between December and April apparently driven by a lack of food. Allen (1952) stated that Indiana gray squirrels refused to abandon a woodlot in winter even when food resources dwindled. Both researchers seemed to consider winter movements as unusual. Nonetheless, movement to and from the trapping areas on the Potter Area continued through January in each of two consecutive winters.

The proportion of unmarked animals in the catch dropped (X^2 = 15.15, P < .01) between January and February 1974 (Fig. 2). Activity seemed to decline during periods of deep, fluffy snow but was not inhibited by compacted or crusted snow. The absence of long-distance movements on the Potter Area in late winter may have resulted from a cover of loose snow. The difference between squirrel activity on winter days with and without snow was significant (t = 2.75, P < .01). The level of significance might have been even higher if the difference in activity on varying types and depths of snow had been taken into account.

The proportions of unmarked squirrels in the catch rose steadily from March to June 1974 (X^2 = 14.21, P < .01) (Fig. 2). This spring movement occurred well before the weaning of first-litter juveniles. Barkalow and Shorten (1973), Shorten (1954), and Sharp (1959) all mentioned similar spring movement in gray squirrel populations.

The high proportion of unmarked squirrels trapped between June 1974 and January 1975 was due to a repetition of the kind of dispersal that occurred in late summer and fall 1973. Of 54 squirrels taken in the last half of 1974, 29 could be aged accurately; 10 were juvenile, and 19 were adult. These data indicate that fall movements were undertaken by members of all age cohorts in the population.

The significant decline (X^2 = 12.44, P < .01) in the proportion of unmarked squirrels in the catch between January and February 1975 reflected the same pattern of restricted late winter movement that occurred during this period in 1974 (Fig.2).

The difference between the proportions of unmarked squirrels in March and April 1975 was not significant (X^2 = 3.29, P < .10). However, the pattern of increasing dispersal in early spring was similar in both 1974 and 1975. In 1975, as in 1974, the beginning of the dispersal was too early to be attributed to the appearance of weaned juveniles.

The proportion of unmarked animals trapped was uniformly high in the autumns and winters of 1973 and 1974. Spring and summer patterns varied. The proportions of unmarked squirrels in April and June 1973 were low indicating that there was little dispersive movement during this period. In the corresponding periods of 1974 and 1975, however, the proportions of unmarked squirrels in the traps were high, indicating a high level of spring and summer dispersal. The differences in successive spring dispersals implied that spring gray squirrel movements on the Potter Area were a response to varying environmental conditions rather than a consistent immutable behavioral trait.

Effect of Mast Crop Variations on Spring Dispersal. Weather records for Madison, Wisconsin show a 3-week period in January and February 1973 in which temperatures averaged 42°F (5.6°C.) (high) and 25°F (-3.9°C.) (low). A second warm period occurred in mid-March during which temperatures rose as high as 67°F (19.4°C.). These early warm periods accelerated local phenology. Ice break-up in Lake Mendota in Madison occurred on 14 March 1973, the second earliest break-up since 1852 when break-up dates were first recorded. Then, on 9 April 1973, a 14-inch snow storm moved through southern Wisconsin. The low temperature on 11 April 2 was 7°F (-14°C.). Freezing temperatures alternated with high afternoon readings until 18 May, the date of last frost for that spring.

The early warm periods followed by snow and late spring frosts damaged the flowers of many early-blossoming trees. A representative of the Wisconsin Phenological Society (Lettau, 1975, pers. comm.) stated that a stand of burr oaks *(Quercus macrocarpa)* she observed in Madison had no fruit in the fall of 1973, apparently because of spring frost damage. I have no record of mast abundance for 1973 on the Potter Area, but I believe that these weather records and observed weather effects on trees in surrounding areas are good indications that mast producing trees on the study area suffered a considerable loss of blossoms in 1973.

As a result of flower damage, the trees that produce seeds from the flower of the same year such as red and sugar maple, shagbark *(Carya ovata)* and bitternut hickory *(C. cordiformis)*, and all members of the white oak group probably bore much-reduced mast crops in 1973. Oaks of the red oak group probably bore a normal crop because their fruit develops from the previous year's flower (Allen, 1943; Allen, 1952; Fowells, 1965; Rosendahl, 1955), but for that reason their crop declined in 1974. Thus, the unseasonal 1973 frost probably affected mast production for 2 consecutive years.

These years of reduced mast crop probably had greatest impact on the squirrel population in the late winters and early springs of 1974 and 1975. Without normal mast carry-over from the previous fall, food would become scarce, encouraging spring dispersal.

Movement Distances. During 1974 and 1975, I observed or trapped 10 gray squirrels that had moved from one trapping grid to another. These movements averaged 0.4 miles (0.6 km), they ranged from 0.2 to 0.5 mile or 0.3 to 0.8 km. It is not likely that these movements were within the normal home ranges of these squirrels because if they had been, average home range area (assuming that they were circular) would have been 125 acres (50 ha), roughly twice the size of any home range estimates found in the literature. Apparently these movements were part of a population dispersal.

Goodrum (1940) stated that gray squirrels in Texas seldom moved more than 5 miles (8 km). Brown and Yeager (1945) in Illinois thought that squirrels might move 2 to 3 miles (3 to 5 km) in the course of a year's foraging. Sharp (1959) reported that one Pennsylvania gray squirrel moved 62 miles (100 km) over a 6 month period.

There are indications that some of the movements on the Potter Area might have been longer than the 0.5 mile (0.8 km) observed maximum. Three of the 10 squirrels that moved to new areas were frequently observed on their new grids after the initial movement. The other 7 did not stay on their new areas. Four of these 7 squirrels were marked with a grid code alone, so they could have returned unnoticed to their original grids. The other 3 squirrels, however, were individually marked, and if they had returned to their original grids, the movement would have been detected. The disappearance of these squirrels was most probably due to mortality or continued movement away from their original grids.

The dispersing squirrels were not easy to trap. Of the 10 squirrels that were recorded on new grids, 8 were observed and only 2 trapped. This low trapping rate probably stemmed from the rapid movement of these squirrels through the trap grids.

Daily Activity

Daily fluctuations in gray squirrel activity on the Potter Area showed three seasonal patterns from June 1974 to May 1975. The summer pattern had two peaks of activity, one from 2 to 5 hours after sunrise, and the other, 1 to 3 hours before sunset.

During the 3-month autumn pattern, activity was constant throughout the day, probably because the squirrels were caching recently fallen mast. Twilight observations in September and October indicated activity long after sunset, but it was too dark to count these squirrels accurately.

The winter pattern was most prominent during January. Activity peaked at noon, apparently in response to midday warmth. February activity resembled the spring patterns of March and

April, probably because of the relatively mild weather during most of the late winter in 1975.

Goodrum (1940), Allen (1952), and Packard (1956) all reported that the gray squirrel was most active during the early morning and late afternoon. Donohoe and Beal (1972) noted that squirrels carrying radio transmitters showed activity peaks at 10:00 A.M. and 2:00 P.M. Bakken (1959) probably took the most reasonable position, stating that there was an early morning and late afternoon activity peak during mild seasons, with an early afternoon peak often occurring in late spring. In the extreme cold of midwinter, Bakken found these peaks were replaced by a single peak in the late morning or early afternoon.

Effect of Weather on Activity

Using daily observation success as an index to squirrel activity, I tested the correlation between activity and the following weather conditions: maximum daily temperature, minimum daily temperature, daily precipitation, maximum wind velocity, average wind velocity, and the degree of cloud cover. Estimates for the last three weather conditions were made for the Potter Area from records for Madison, Wisconsin, 40 miles (64 km) to the south, and Lone Rock, Wisconsin, 30 miles (48 km) to the west. There was close agreement of data from the two stations. All other weather data were obtained from records for Baraboo, Wisconsin, 6 miles (10 km) west of the study area. There was a negative correlation between summer observation success and maximum ($r = -.36$, $P = .08$) and minimum ($r = -.34$, $P = .11$) temperature. Most gray squirrel researchers (Barkalow and Shorten, 1973; Brown and Yeager, 1945) have stated that squirrels are not active in midafternoon during the summer. In a multivariate analysis of squirrel activity and weather conditions. Doebel and McGinnes (1974) indicated that only 5% of all variation in gray squirrel activity could be accounted for by changes in temperature.

There was also a negative correlation ($r = -.42$, $P = .08$) between observation success and spring precipitation. The squirrels understandably seek shelter from cold rains in early spring.

The only other correlation approaching significance was between observation success and winter cloud cover ($r = .34$, $P = .10$). Overcast skies usually accompany warm temperatures in winter. For this reason, I thought initially that the squirrels were responding to high winter temperatures and that the correlation with cloud cover was accidental. However, the lack of significant

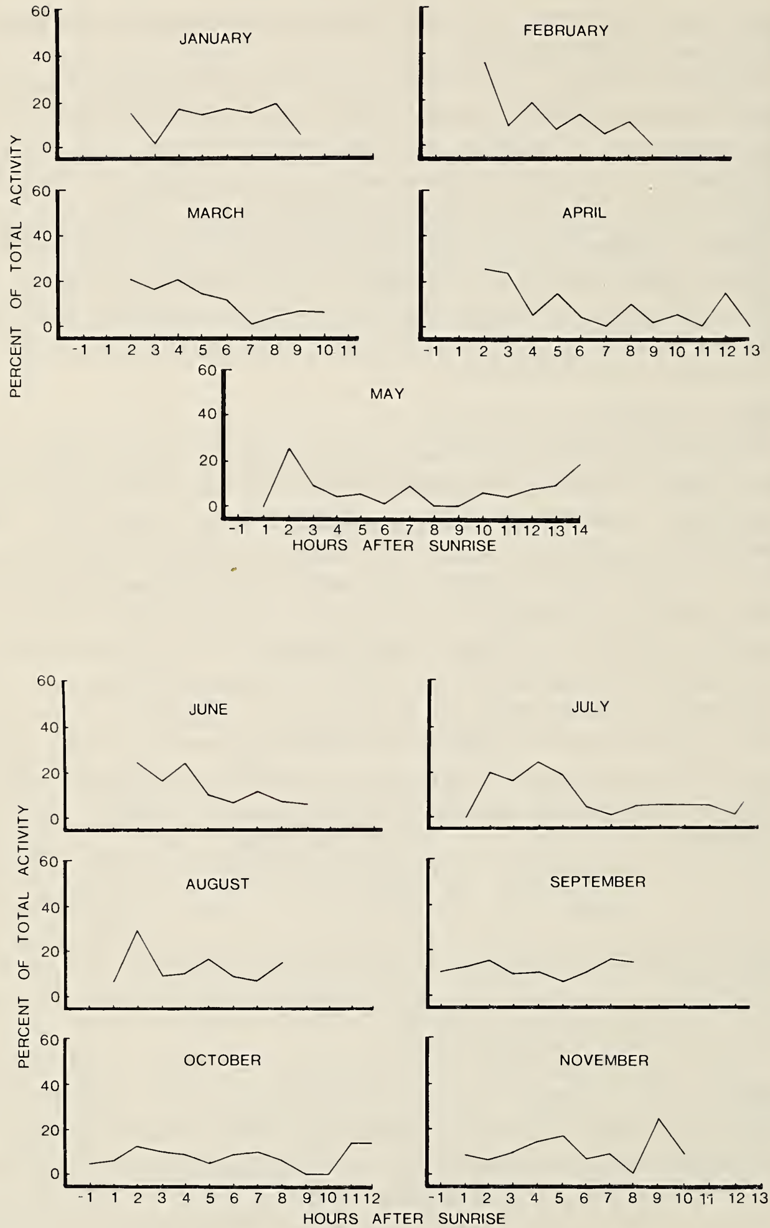

Figure 3. Average hourly activity rates for the gray squirrel on the Potter Research Area.

correlation between observation success and winter temperatures indicated that the squirrels were responding to some feature of cloudy winter days other than high temperature, possibly light intensity. Packard (1956) in Kansas found a direct relationship between gray squirrel activity and low light intensity. He did not to suggest a physiological or behavioral explanation for the relationship, and I have none. Barkalow and Shorten (1973) stated that the gray squirrel's retina contains only cone cells and that the lens has a yellow pigmentation for filtering strong light. As a result, light sensitivity of the gray squirrel eye is similar to that of man. Any observer who has been afield can attest to the effect of snow glare on the human eye. A similar impact on the gray squirrel might explain the animal's lower activity on sunny winter days.

I found no correlation between observation success and wind velocity, although Goodrum (1940), Packard (1956), and Bakken (1959) all reported that heavy wind generally inhibits gray squirrel activity. Goodrum gave two explanations for the effect of wind. He thought that the squirrel might be less sure of its footing in wind-swept branches and that its sight and hearing might be impaired by movements and noise among blowing trees.

The first explanation does not seem likely. The gray squirrel is well-suited visually and physically for arboreal movement and can survive a 50-foot (15.2 m) fall without apparent injury. Gray squirrels on the Potter Area did not seem hesitant about climbing during heavy wind. Wind may interfere with the efficiency of the squirrel's senses, but it interferes with an observer's as well; correlations in previous stdies may have resulted as much from observer inefficiency as from actual reduction in squirrel activity. Doebel and McGinnes (1974) found a very low correlation between wind and activity probably because their use of radio collars made it possible to monitor activity while avoiding error from observation inefficiency or disturbance.

Habitat Preferences

Population differences on three trapping areas. Data from 88 days of observation (averaging 6 hours per day) were tested by analysis of variance and the three trap grids were found to be significantly different ($P < .01$). The average number of observations per day were: Trap Area I—6 squirrels per day, Trap Area II—6 per day, and Trap Area III—2 per day (Table 4). Time-area density estimates for the three areas in the fall of 1974 were 1 squirrel per acre (3.2/ha), 1 squirrel per acre (3.0/ha), and 0.4 squirrel per acre (1.0/ha), respectively (Table 3).

TABLE 4. Observation success for three grids, Potter Research Area

	Length of observation period		Number of squirrels seen			
Grid	Hours	Days	Gray	Fox	Red	Acres
I	154	25	146 (6)[a]	16 (1,[a]	52 (2)[a]	12
II	223	37	206 (6)	73 (2)	53 (1)	12
III	166	27	47 (2)	29 (1)	6 (1)	11
Total	543	89	399	118	111	36

a = observations per day.

A second index to gray squirrel abundance was obtained from trapping data. The numbers of squirrels on each grid per week were compared by analysis of variance. To avoid bias from varying trap success at different times of year only weeks in which all grids were trapped were used. The differences in average grid success (I—6 squirrels per week, II—5, 7, III—3) were not significantly different ($P < .10$). However, when these two independent estimates of the populations were considered together, they indicated that the Area III squirrel population was significantly smaller than the populations on the other two grids.

Differences in Den Density. Two efforts were made to assess the effect of den density on the squirrel populations. The numbers of possible tree den cavities and nests on each grid were counted (from the ground), and nest-box use was assessed under the assumption that the boxes would be more attractive to squirrels in areas where natural den densities were low.

Tree den numbers on the three grids were similar: Trap Area I—4 cavities per acre (10/ha), Trap Area II—3 per acre (8/ha), and Trap Area III—5 per acre (11.6/ha). Leaf nest densities showed more variation. There was 1 nest per acre (2.2/ha) on Area I, 2 (5.4/ha) on Area II, and 1 (2.2/ha) in Area III. The large number of nests on Area II may have resulted from the small number of den cavities present on this grid.

Only 4 of 29 nest boxes installed on the 3 trap areas were consistently used by gray squirrels. These boxes were filled with leaves and shredded bark and some gray squirrel hair. Two of them contained well-built inner nests of shredded leaves and grape bark, indicating use by breeding females. Only one juvenile squirrel was found in the boxes.

Three other boxes contained flying squirrel *(Glaucomys volans)* nests; one was used by a fox squirrel *(Sciurus niger)*, and one was used by a pair of red squirrels *(Tamiasciurus hudsonicus)*. Most of the boxes that did not contain nest material showed signs of being used as feeding platforms by squirrels, chipmunks *(Tamias striatus)*, flying squirrels or mice. The low rate of nest box use on all grids indicates that den density was not one of the factors that held Area III gray squirrel density below densities on the other two grids.

Effect of Mast Crop on Squirrel Population. Variation in size and abundance of each mast-producing tree species on the Potter Area trap areas was not in itself sufficient to explain the observed differences in squirrel population. There were, however, significant differences in oak mast production on the three areas.

Quadrat samples of acorn caps on the three areas yielded an estimate of oak mast production over the previous 2 to 3 years. The length of time covered by this estimate depends on the rate of acorn cap decomposition which varies with the amount of litter and dampness on the quadrat. All 3 areas had similar ground conditions so it was probable that the rate of cap decomposition was similar.

Area II produced significantly more red oak acorns ($F = 4.83$, P .01) than the other two grids (Table 5). A similar analysis for white oak mast indicated a significant difference ($F = 8.60$, $P < .001$) in white oak production among all three areas. Area I led in white oak production followed by Area II, while Area III had the lowest production (Table 5).

Low white oak mast production on Area III apparently resulted from interactions among white oak and maple that did not occur to the same extent on the other two grids. Because there is a direct relationship between the basal area and the height of the tree, ratios between basal areas of species (Table 6) represent a comparison of the average heights of the dominant species on each grid. These ratios indicate that competition for light between white oak and the maples on Area III was more intense than on grids I and II (Table 6).

According to Allen (1943), increased access to light causes mast-producing species in the open to produce more nuts than those in woodlots. Similarly, increased competition for light may be related to a decrease in mast crop. This effect is probably most extreme when competition for light involves relatively xeric, light-requiring

TABLE 5. Mast production, estimated by acorn cap count, of red oak and white oak on three grids in the Potter Research Area

Grid	Number of $0.836m^2$ samples	Mean number of caps Red oak**	White oak***
I	30	26.7	22.1
II	30	50.2	12.0
III	34	28.6	2.6

** 4.83 F value
*** 8.60 F value

TABLE 6. Relationship between oak and maple basal area on trapping grids.

Ratio of basal area	Trapping grid I	II	III
white oak basal area / red oak basal area	0.54	0.65	0.55
white oak basal area / red maple basal area	1.61	3.39	1.07
white oak basal area / sugar maple basal area	-- [a]	-- [a]	0.80
white oak basal area / all maple basal area	1.61	3.30	0.93

[a] No sugar maple on grid.

species such as white oak and mesic, shade-tolerant species such as red and sugar maple. In such a situation, white oak would suffer a reduction in mast crop as the shade from maples increased. White oak mast production on the three grids varied with the amount of light available to the white oaks. Area I was the peak producer because recent logging had opened up the stand. Area III white oaks were forced to contend with the shade from a stand of maples and did not produce well.

The difference in red oak mast production on the three grids resulted largely from the variation in average red oak size among the grids. Goodrum et al. (1971) found a linear relationship between southern red oak mast production and bole diameter. With each 2-inch (5 cm) increase in bole diameter, he found a 2 (0.746 kg) to 3-

pound (1.2 kg) increase in mast production. Southern red oak acorns average 316 per pound. The average bole diameter of the red oaks on Area II was 30 inches (68 cm) while on Area I it was 29 inches (65 cm) and on Area III, 26 inches (59 cm).

The Area III mast crop suffered from a lack of large red oak producers and from low white oak protection due to shading. This area also lacked appreciable numbers of non-oak seed producers (shagbark, hickory, elm, butternut) that were present on the other grids. These habitat deficiencies resulted in a poor food supply and a low squirrel population.

Red and Fox Squirrel Populations

Red and fox squirrels also inhabited the Potter Area, although neither species was as common as the gray squirrel. Rates of observation and trapping were used as indices to the populations of red and fox squirrels on each grid.

An analysis of variance of fox squirrel observations on the three grids showed the number observed to be significantly different ($F = 12.55$, $P < .01$) among trap areas. Area II had the greatest number of observations (2 per day) followed by Area III (1 per day) and Area I (0.6 per day). An analysis of variance for trap success on the 3 areas showed no significant differences.

Analysis of variance of red squirrel observation success revealed a significant difference ($F = 6.87$ $P < .005$) among all means. Area I success was greatest (2 per day) followed by Area II (1 per day) and Area III (0.2 per day). A test of trap success differences was not appropriate because of the small number of animals captured.

Low red squirrel population on Area III was related to the consistently poor mast crop on that grid. Observation records showed red squirrels to be most abundant around concentrations of butternut trees on Area I and 150 yards north of Area I. Butternuts were eaten extensively when they were available.

The apparent low fox squirrel population on Area I does not seem to be related to any floral element of the habitat. This area has good mast production, a large number of potential dens, northern and southern exposures, and the open aspect supposedly preferred by fox squirrels. A possible explanation is that the fox squirrel populations do not compete well with red squirrels.

In three agonistic encounters I observed between red and fox squirrels, the red squirrel always prevailed. In the absence of other data, the red squirrel's aggressive behavior may partially explain the scarcity of fox squirrels on Area I.

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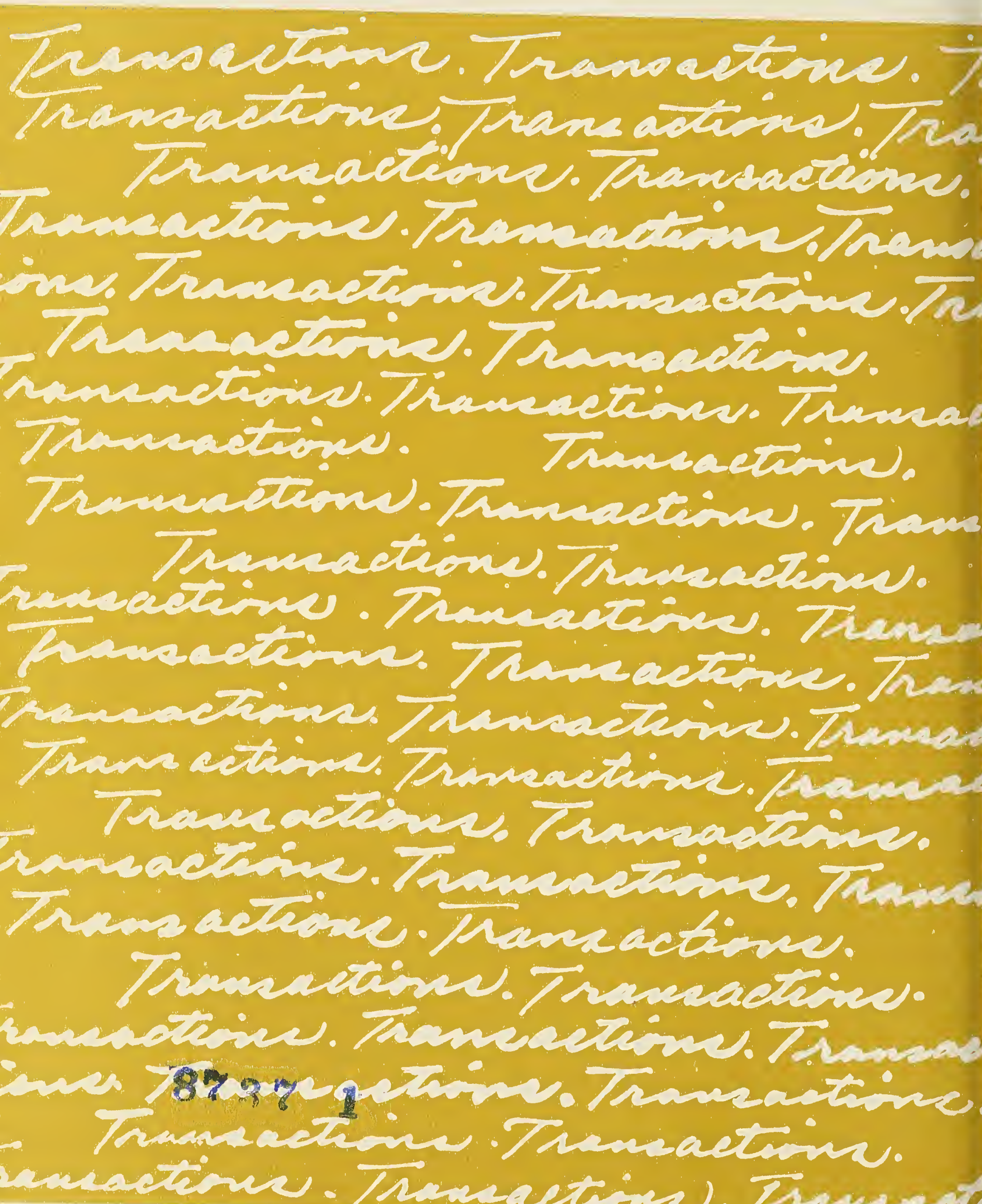

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