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THE CALIFORNIA-WISCONSIN AXIS IN AMERICAN ASTRONOMY

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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).

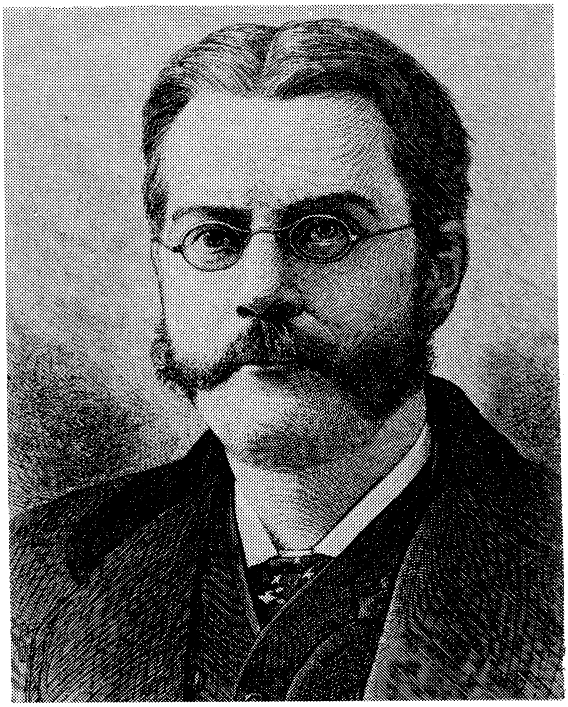

Figure 1. — Edward S. Holden 1846-1914. He was successively Director of the Washburn Observatory of the University of Wisconsin, President of the University of California, and Director of its Lick Observatory, Mount Hamilton, California. Lick Observatory Archives.

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

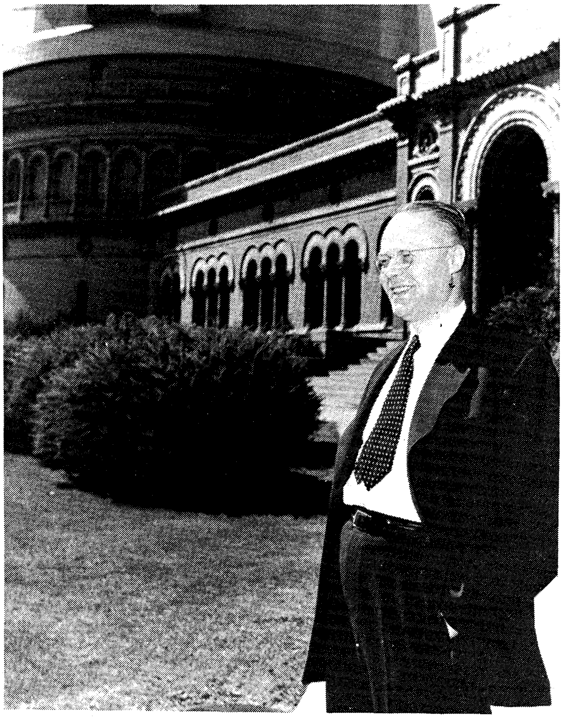

Figure 2. — Otto Struve 1897-1963. He was successively Director of the Yerkes Observatory of the University of Chicago, Williams Bay, Wisconsin, and Chairman of the Berkeley Astronomy Department of the University of California. Here he is shown standing outside Yerkes Observatory. Yerkes Observatory 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.

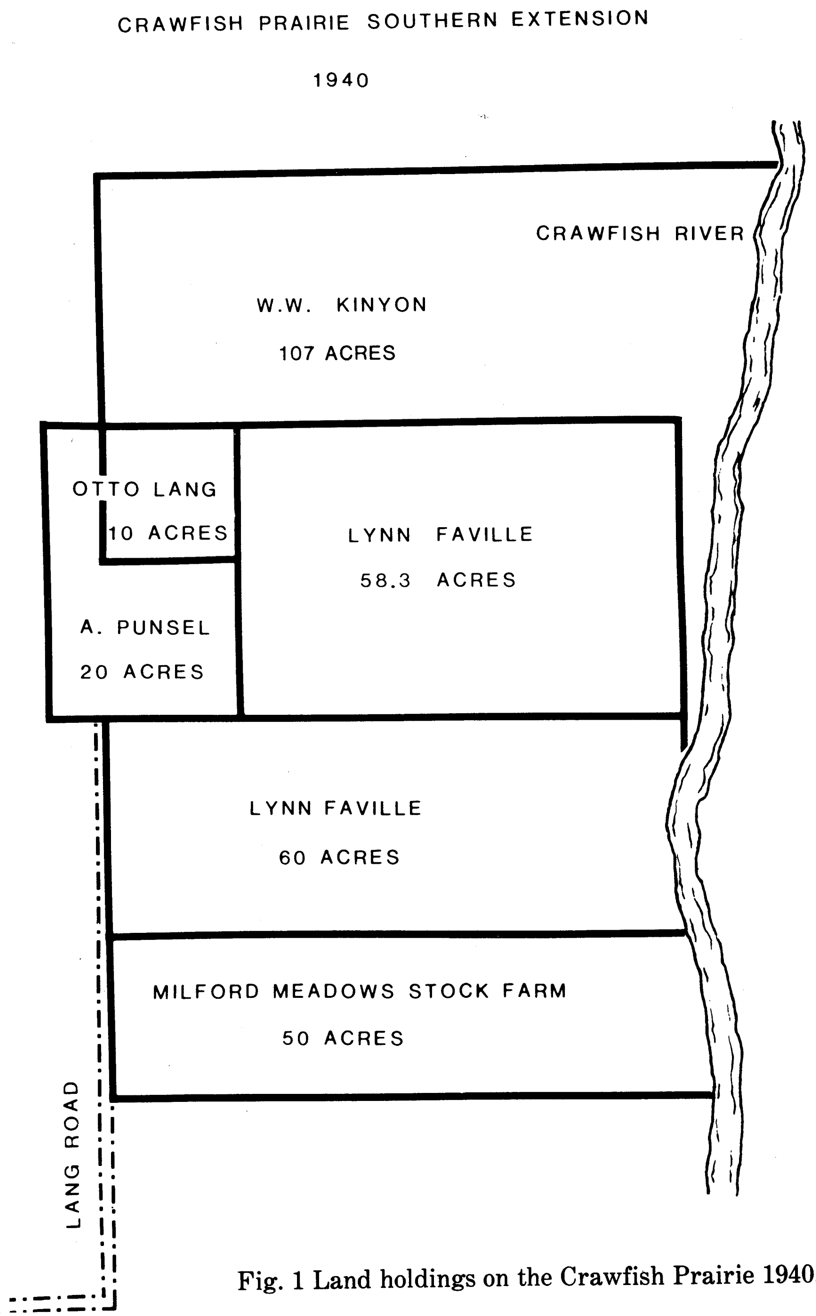


Fig. 1 Land holdings on the Crawfish Prairie 1940.

"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

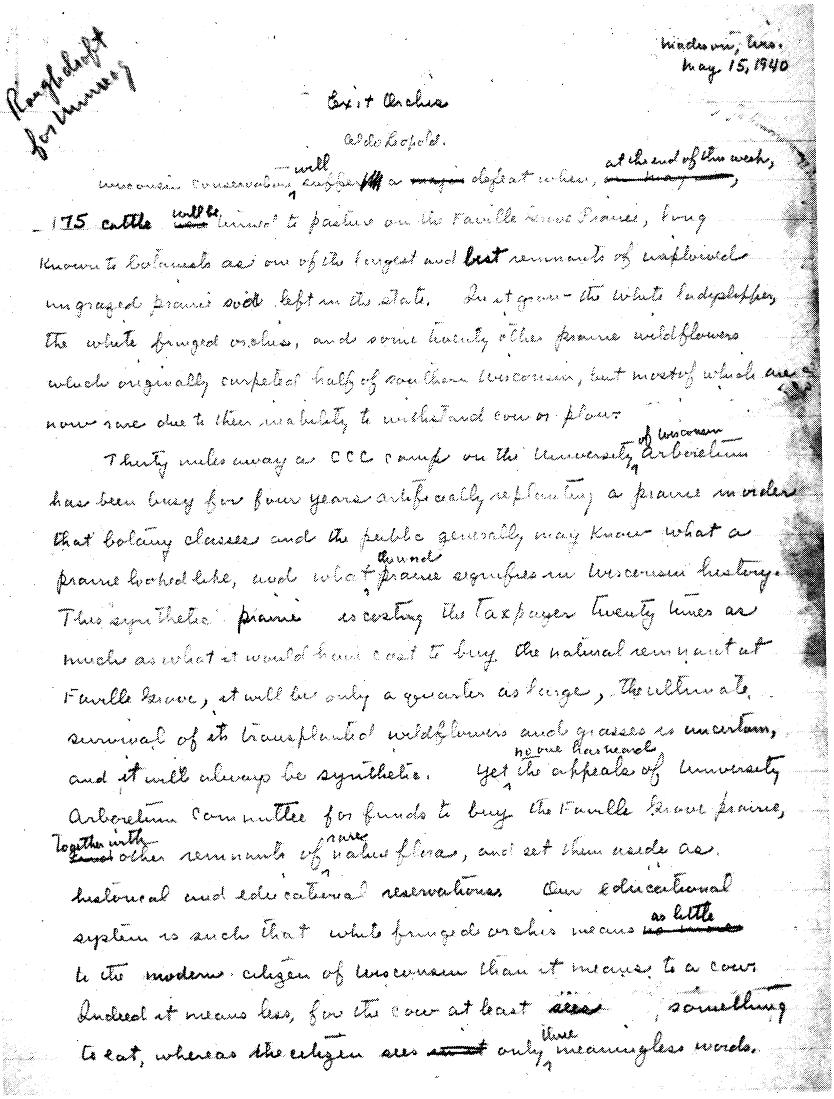
"On May 15, 1940, cattle were turned to pasture on the Faville prairie, long known to botanists as one of the largest and best remnants of unplowed, ungrazed prairie sod left in Wisconsin. In it grow the white ladyslipper, the white-fringed orchis, the prairie clover, prairie fringed gentian, Indian 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 Prairie, long known to botanists as one of the largest and best remnants of unplowed ungrazed prairie sod 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."

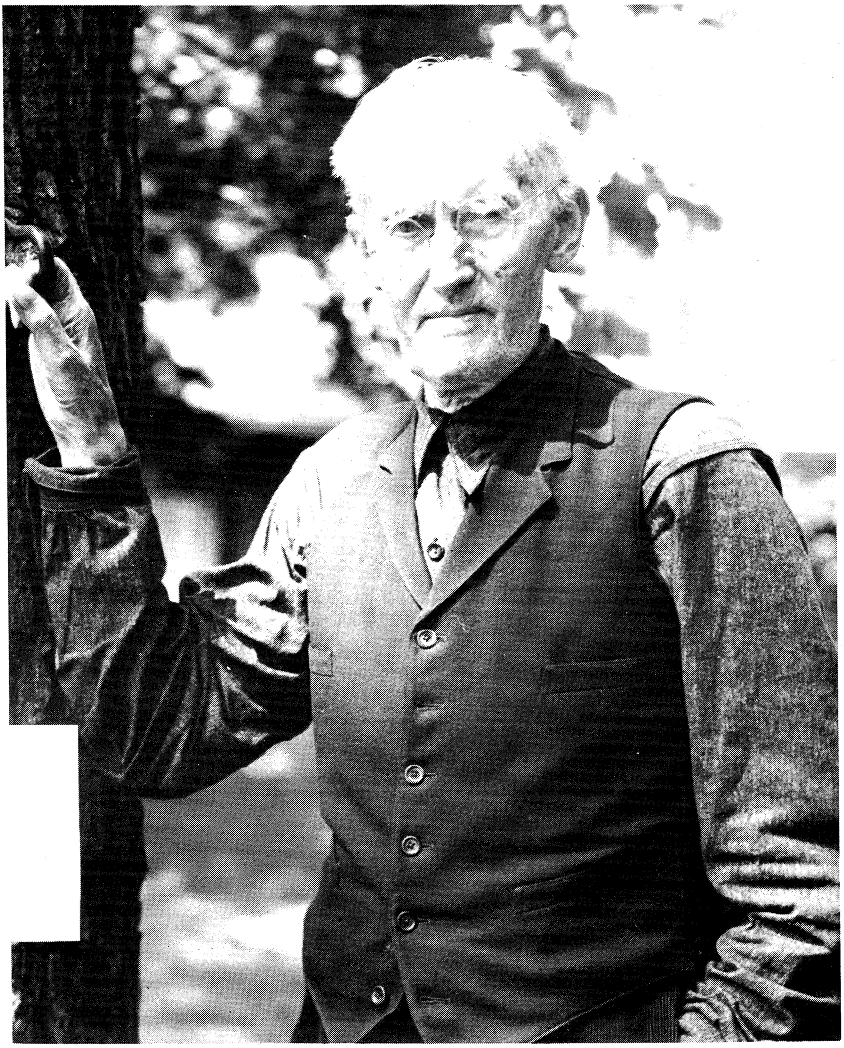


Fig. 5 Stoughton Willis Faville (1852-1951) taken at the Faville Homestead farm 1941. (Milwaukee Journal photo)

"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.

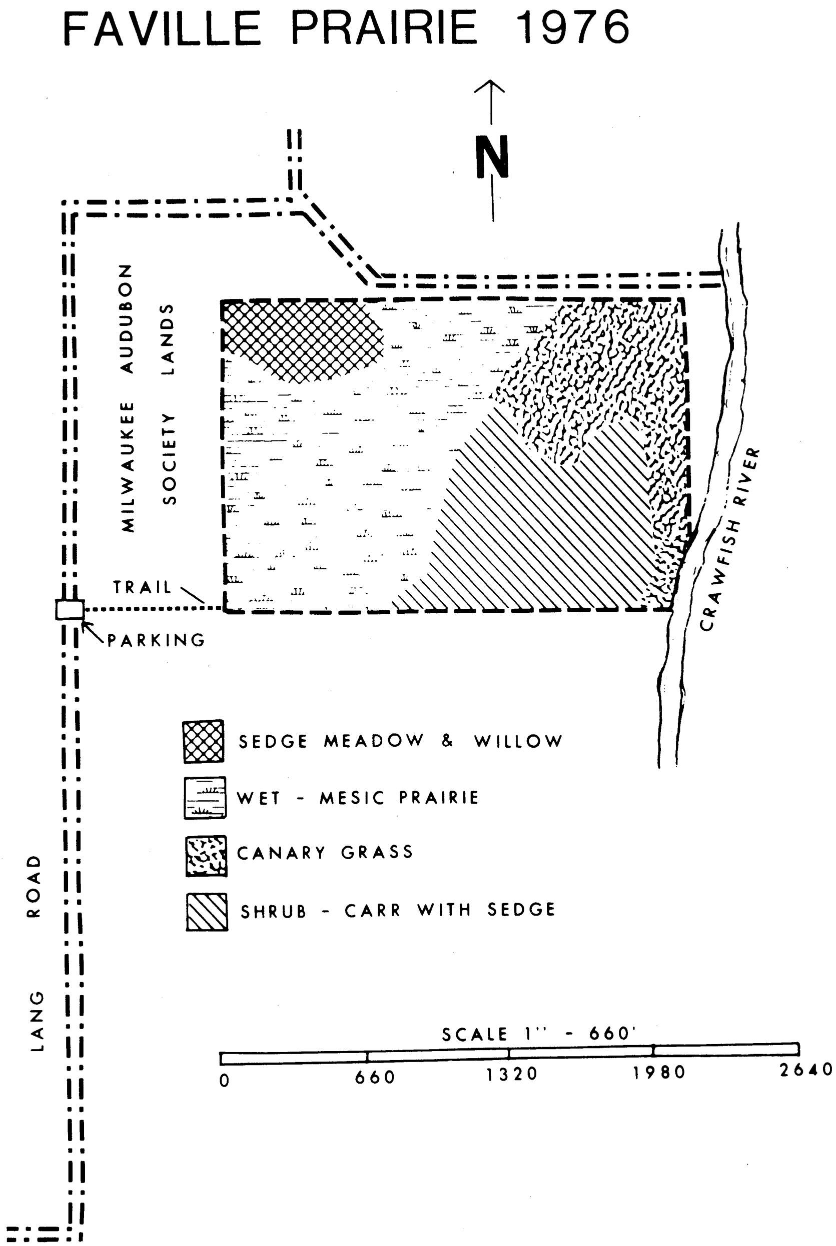


Fig. 6 The Stoughton Faville Prairie Preserve 1976.

"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

In the course of data gathering and manuscript preparation I had aid from several sources. For helpful suggestions and constructive criticism grateful appreciation is given to Arthur S. and Bettie T. Hawkins, David Tillotson, and Max Partch. Mrs. Philip Miles provided information on the initial land purchase. Thanks also to my student assistant, Kay Mullins, for checking plant names and Jim Liebig, University archivist, for the unencumbered use of source material. Special thanks to my wife, Marie, who shared some of the field experiences with me and who gave editorial counsel.

LATE PLEISTOCENE (WISCONSINAN) CARIBOU FROM SOUTHEASTERN WISCONSIN

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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 midpoint 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

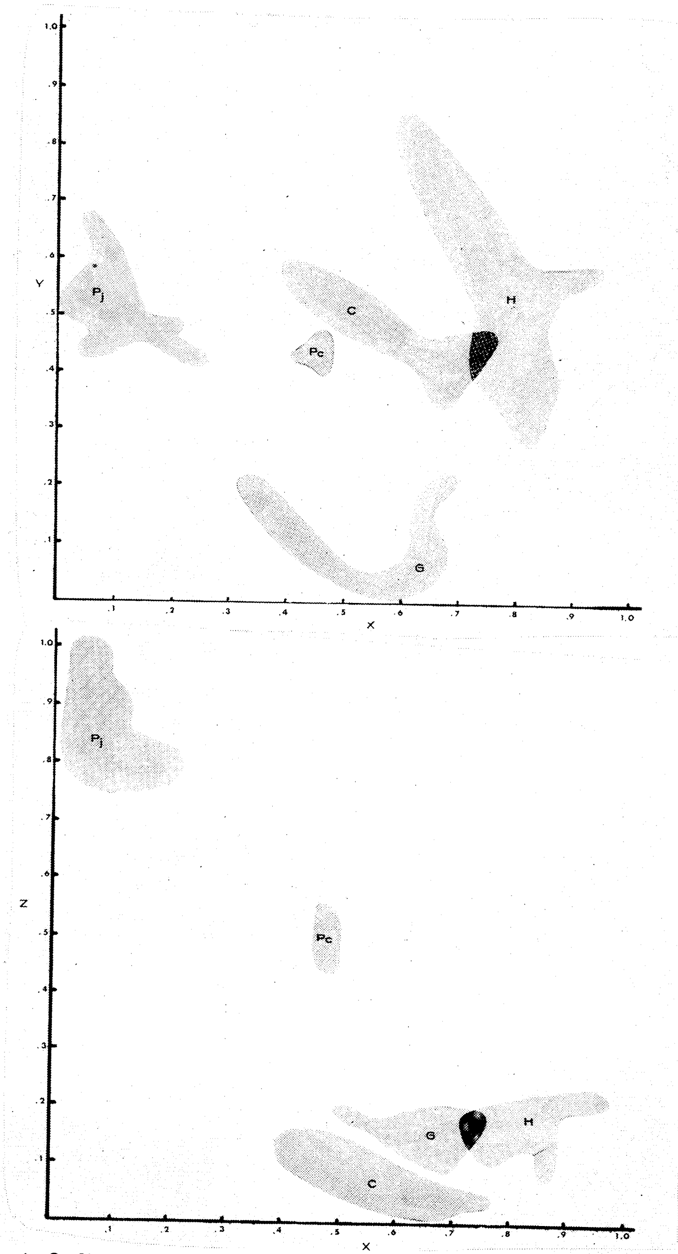

Figure 1. Ordination of the bryophyte stands at Cactus Rock. Letters indicate dominant moss species (C: *Ceratodon;* G: *Grimmia;* H: *Hedwigia;* Pc: *Polytrichum commune;* Pj: *Polytrichum juniperinum*) (a), XY plane. (b) XZ plane.

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 (3.7-5.3 x 10^3 lx, 5.3-7.5 x 10^3 lx) 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.

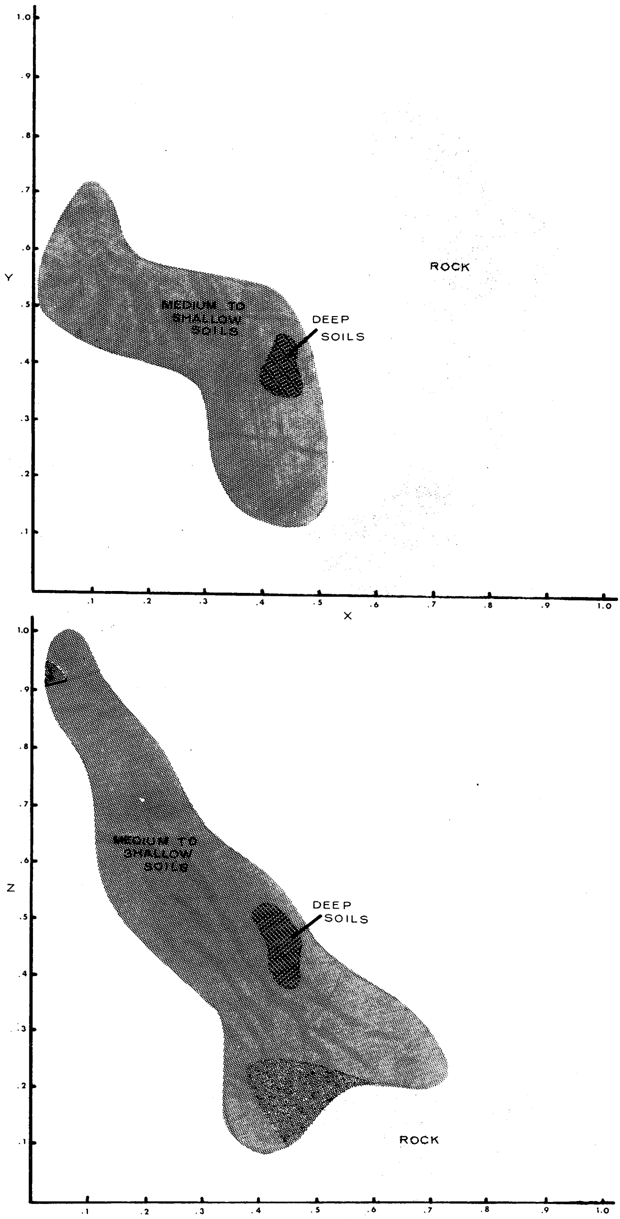

Figure 2. Grouping of the study-stands at Cactus Rock as a function of their maximum soil depths.
(a) XY plane. (b) XZ plane.

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 lx). 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

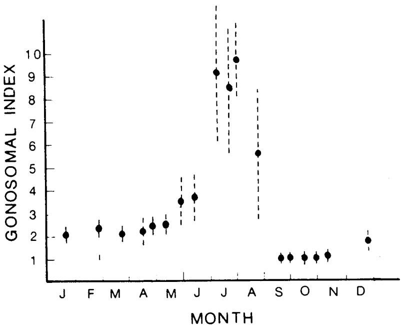

Fig. 1. Seasonal changes in the gonosomal index of the female alewife in Lake Michigan [dashed line indicates 1 standard deviation].

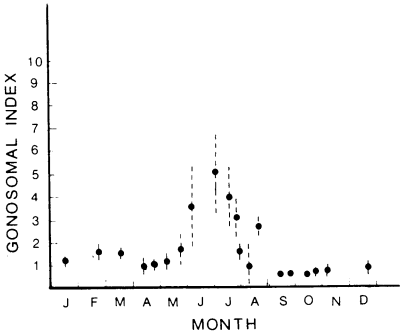

Fig. 2. Seasonal changes in the gonosomal index of the male alewife in Lake Michigan [dashed line indicates 1 standard deviation].

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)

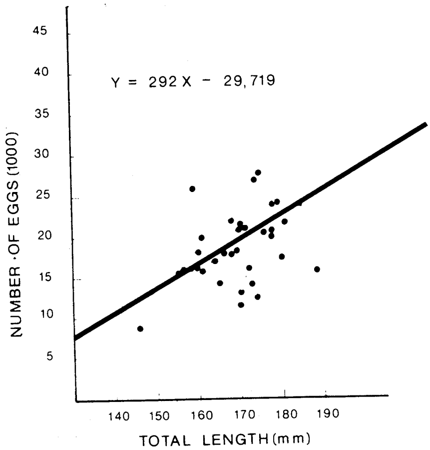

Fig. 3. Linear relationship between total length and fecundity of the alewife in Lake Michigan.

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

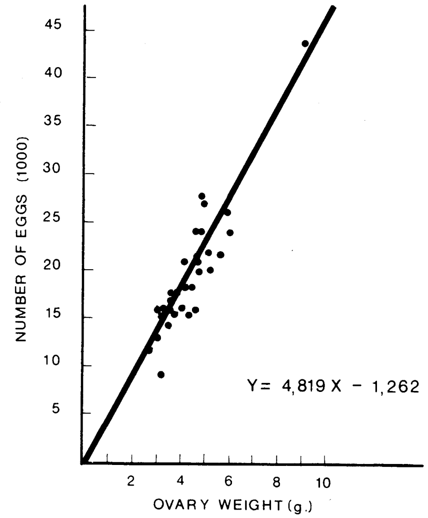

Fig. 4. Linear relationship between ovarian weight and fecundity of the alewife in Lake Michigan.

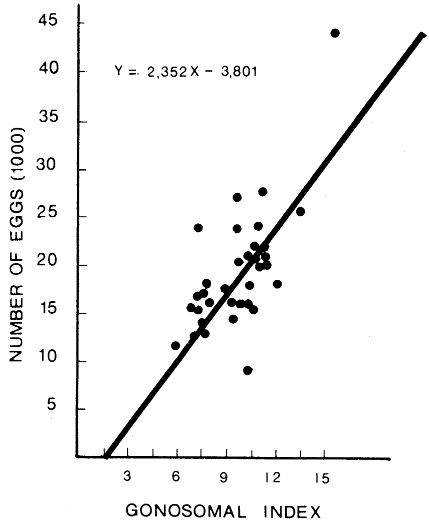

Fig. 5. Linear relationship between gonosomal index and fecundity of the alewife in Lake Michigan.

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.

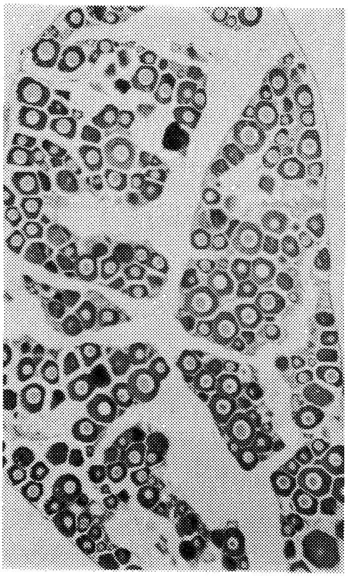

Fig. 6. Section of an immature alewife ovary showing typical cystovarian configuration, with ovigerous lamellae containing primary and secondary oocytes protruding into the central lumen. TL 130 mm. Wt. 19 grams (40x)

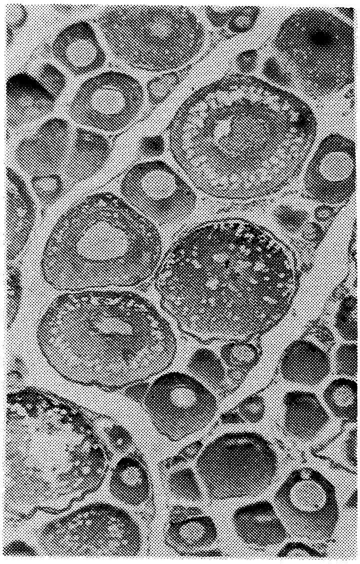

Fig. 7. Section of a maturing alewife ovary showing peripheral vacuolization of the ova. TL 183 mm. Wt. 53 gr. (100x).

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

Mark E. Kraemer
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University of Wisconsin—Madison

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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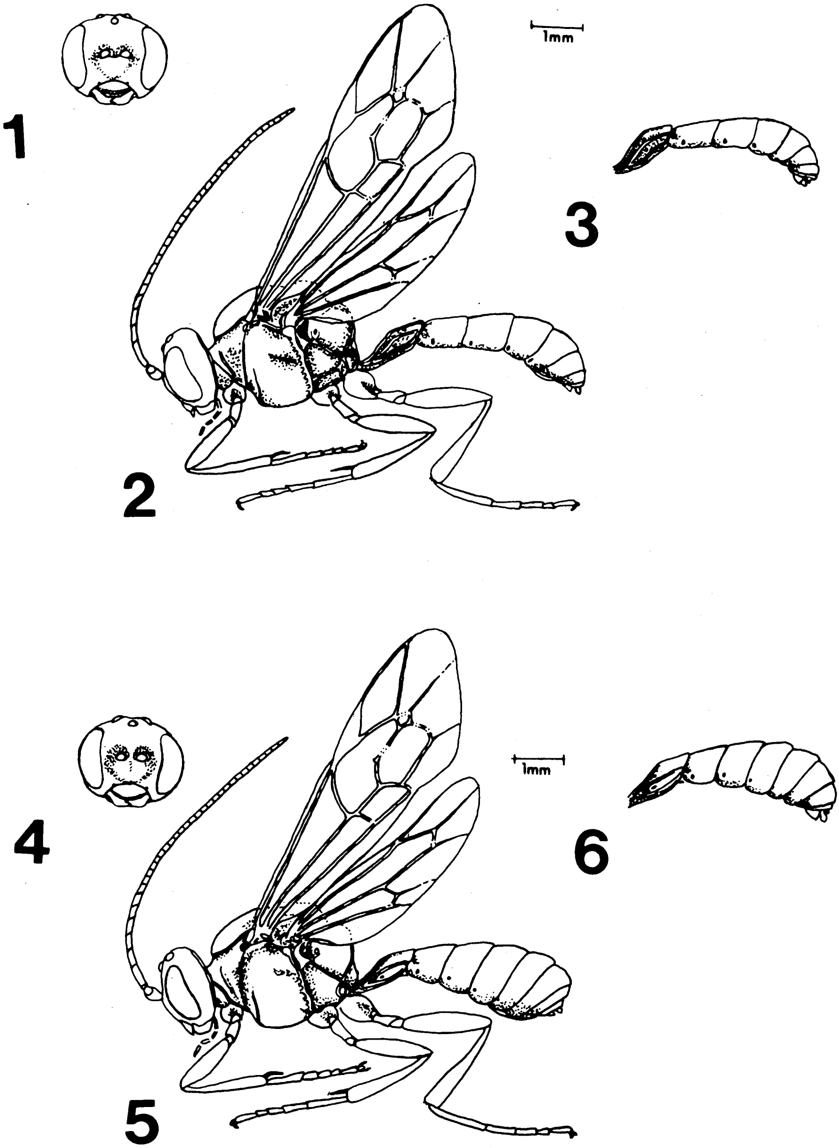
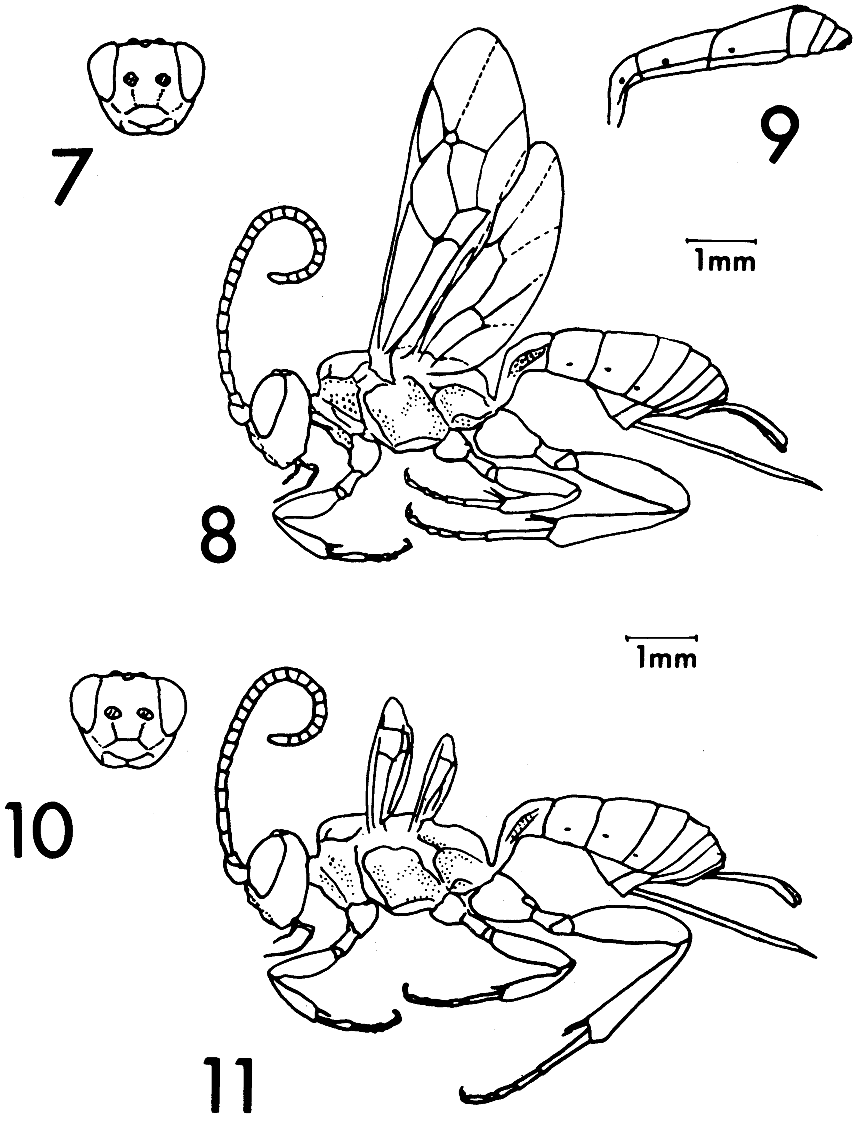
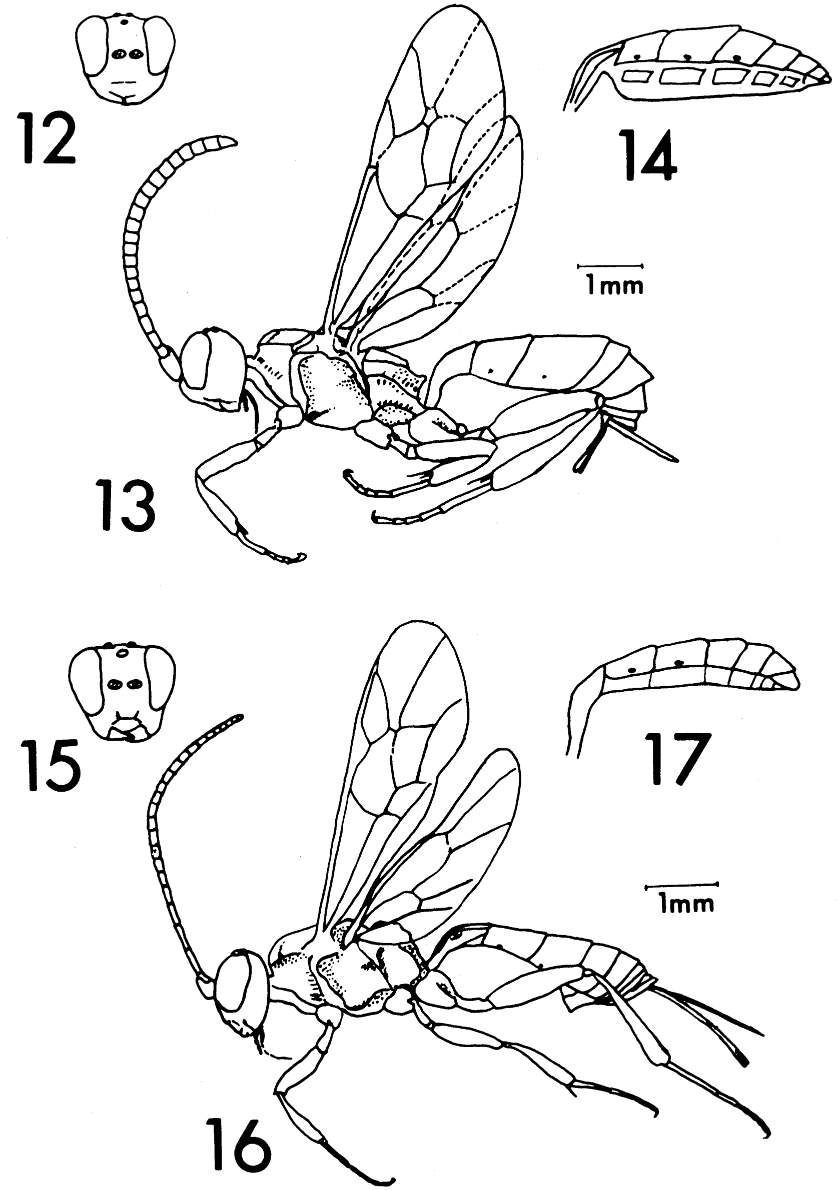


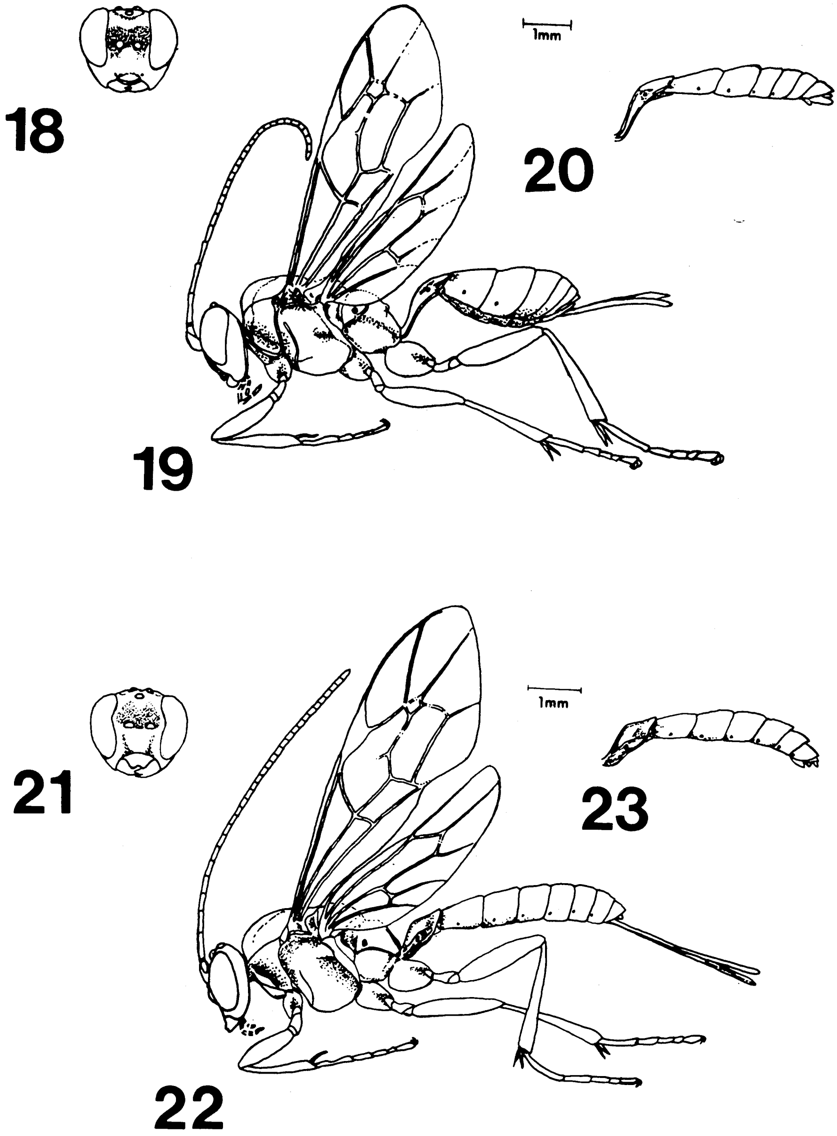
Figures 1-6. Adult hymenopterous parasitoids of *N. sertifer.* 1-3, *Exenterus amictorius;* 1, head capsule, frontal view; 2, female, lateral view; 3, male abdomen, lateral view. 4-6, *Exenterus nigrifrons;* 4, head capsule, frontal view; 5, female, lateral view; 6, male abdomen, lateral view. Courtesy of J.W. Mertins, U. W.-Madison.



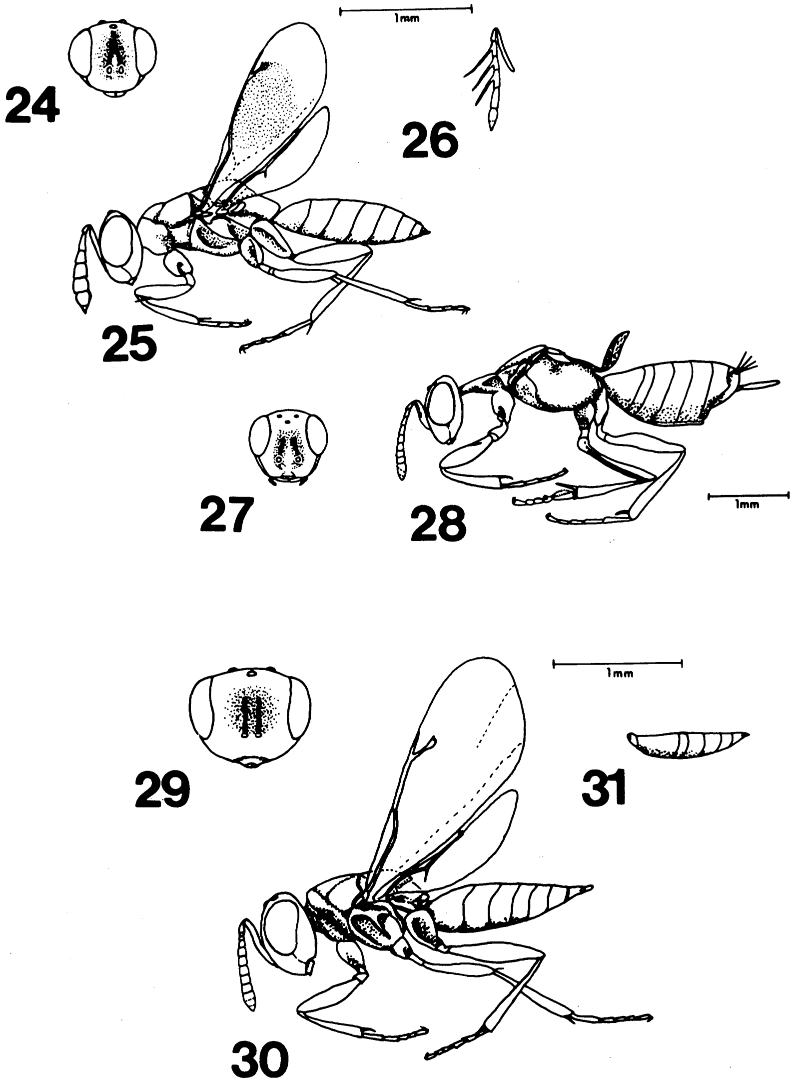
Figures 7-11. Adult hymenopterous parasitoids of *N. sertifer.* 7-9, *Pleolophus basizonus;* 7, head capsule, frontal view; 8, female, lateral view; 9, male abdomen, lateral view. 10, 11, *Pleolophus indistincta;* 10, head capsule, frontal view; 11, female, lateral view. Redrawn from Townes (1969).



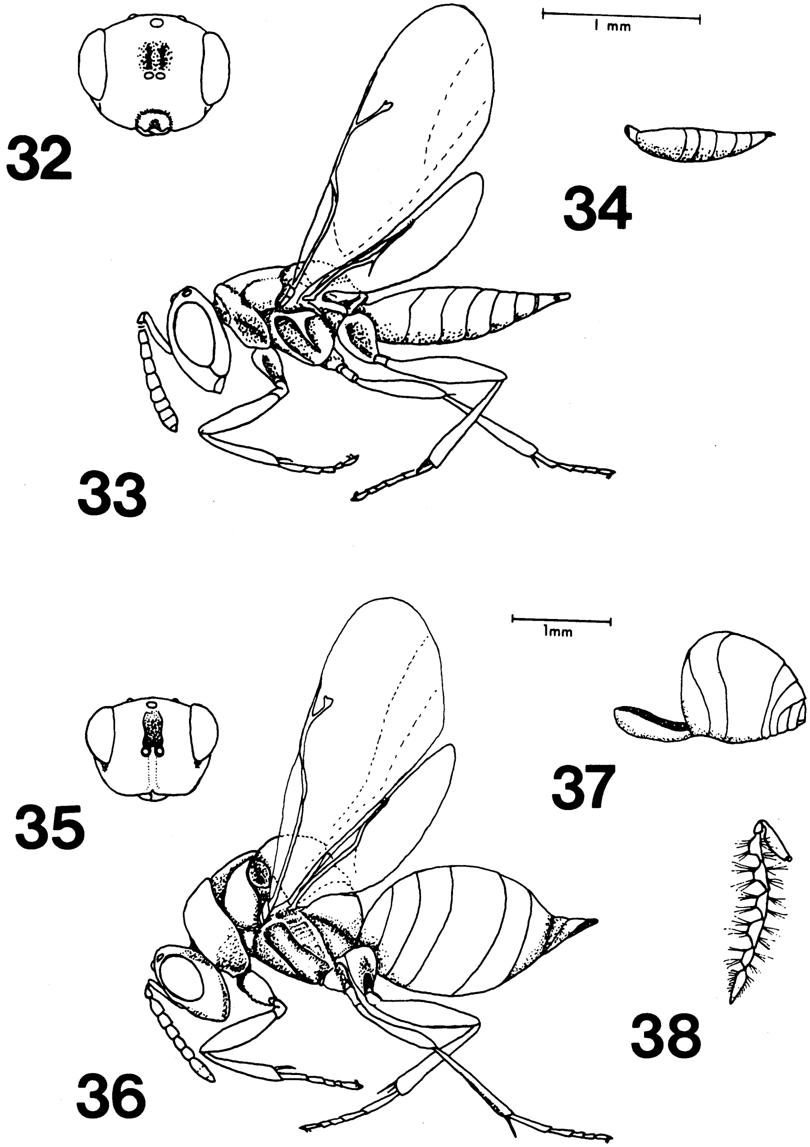
Figures 12-17. Adult hymenopterous parasitoids of *N. sertifer*. 12-14, *Endasys subclavatus;* 12, head capsule, frontal view; 13, female lateral view, 14, male abdomen, lateral view. 15-17, *Mastrus aciculatus;* 15, head capsule, frontal view; 16, female, lateral view; 17, male abdomen, lateral view. Redrawn from Townes (1969).



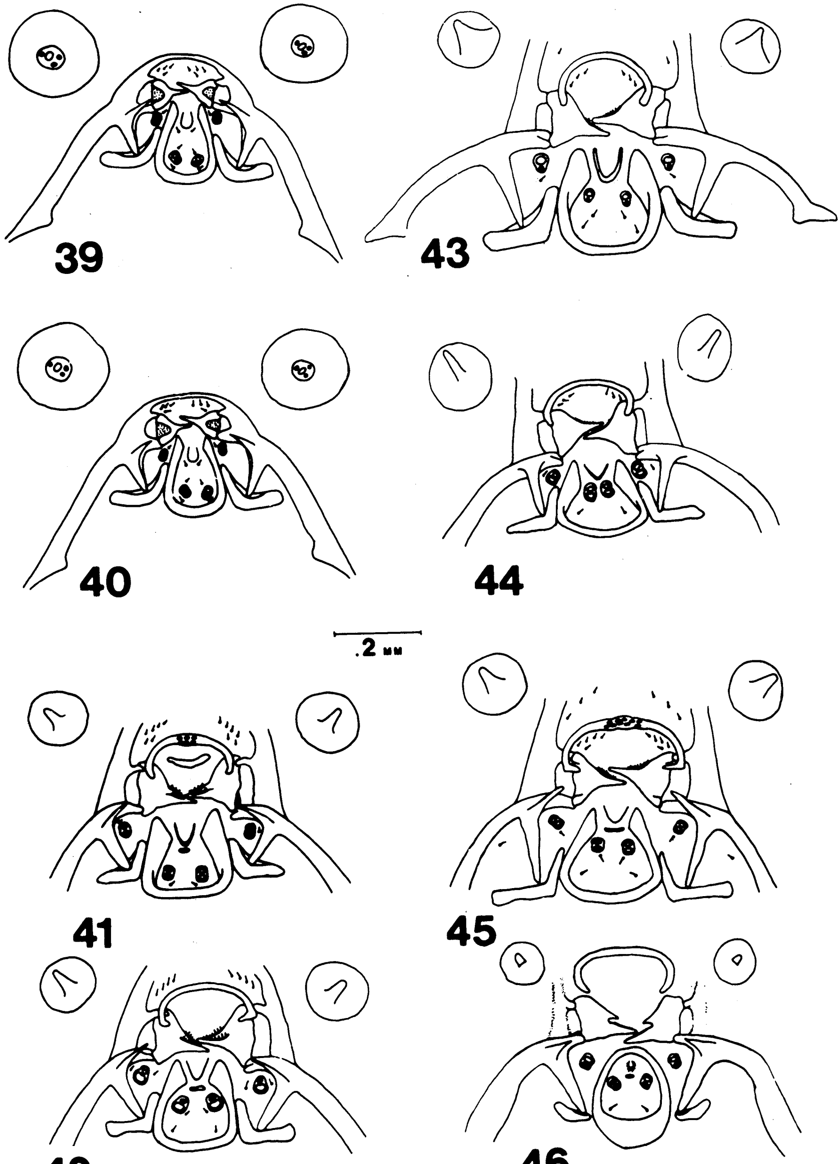
Figures 18-23. Adult hymenopterous parasitoids of *N. sertifer*. 18-20, *Agrothereutes lophyri;* 18, head capsule, frontal view; 19, female, lateral view; 20 male abdomen, lateral view. 21-23, *Delomerista japonica diprionis;* 21, head capsule, frontal view; 22, female, lateral view; 23 male abdomen, lateral view. Courtesy of J. W. Mertins, U.W.-Madison.



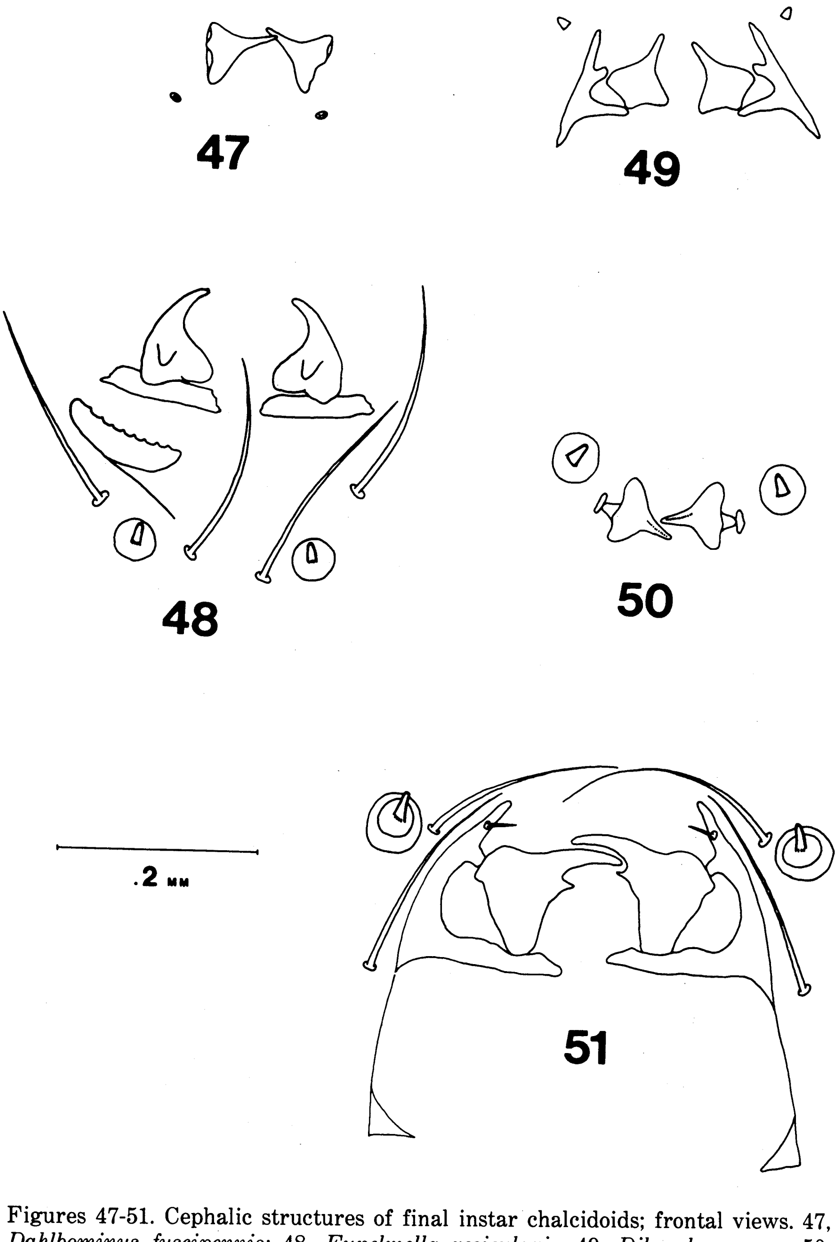
Figures 24-31. Adult hymenopterous parasitoids of *N. sertifer*. 24-26, *Dahlbominus fuscipennis;* 24, head capsule, frontal view; 25, female, lateral view; 26, male antenna, lateral view. 27-28, *Eupelmella vesicularis;* 27, head capsule, frontal view; 28, female, lateral view. 29-31, *Dibrachys cavus;* 29, head capsule, frontal view; 30, female, lateral view; 31, male abdomen, lateral view. Courtesy of J.W. Mertins, U.W.-Madison.



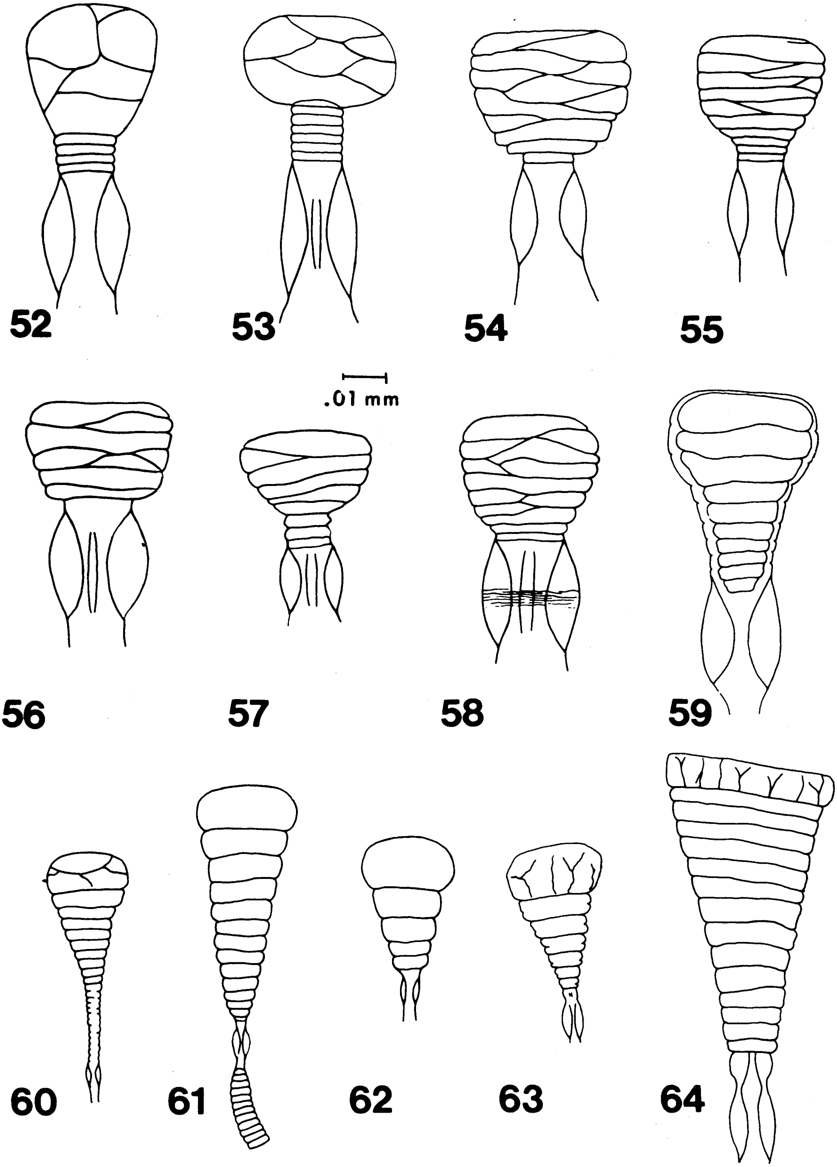
Figures 32-38. Adult hymenopterous parasitoids of *N. sertifer*. 32-34, *Habrocytus thyridopterigis;* 32, head capsule, frontal view; 33, female, lateral view; 34, male abdomen, lateral view. 35-38, *Eurytoma pini;* 35, head capsule, frontal view; 36, female, lateral view; 37, male abdomen, lateral view; 38, male antenna, lateral view. Courtesy of J. W. Mertins, U.W.-Madison.



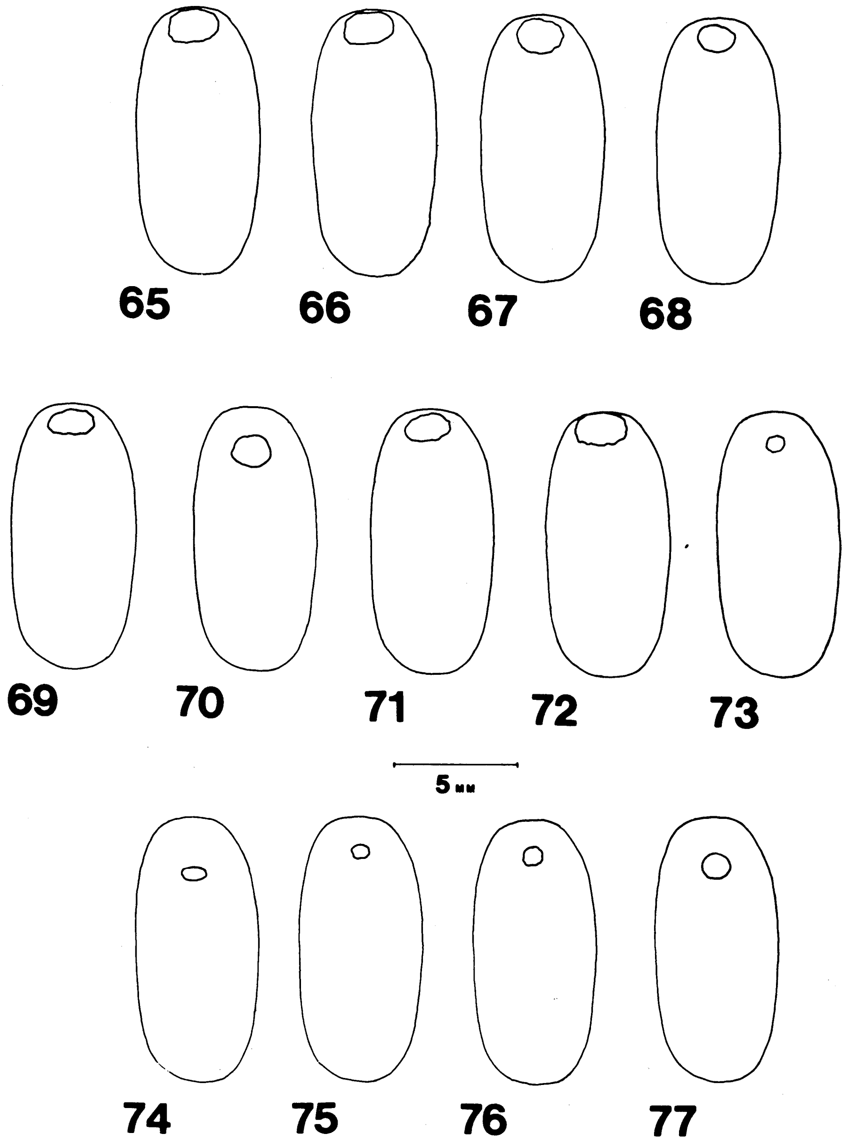
Figures 39-46. Cephalic structures of final instar ichneumonids; frontal views. 39, *Exenterus amictorius;* 40, *Exenterus nigrifrons;* 41, *Pleolophus basizonus;* 42, *Pleolophus indistincta;* 43, *Endasys subclavatus;* 44, *Mastrus aciculatus;* 45, *Agrothereutes lophyri;* 46, *Delomerista japonica 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.

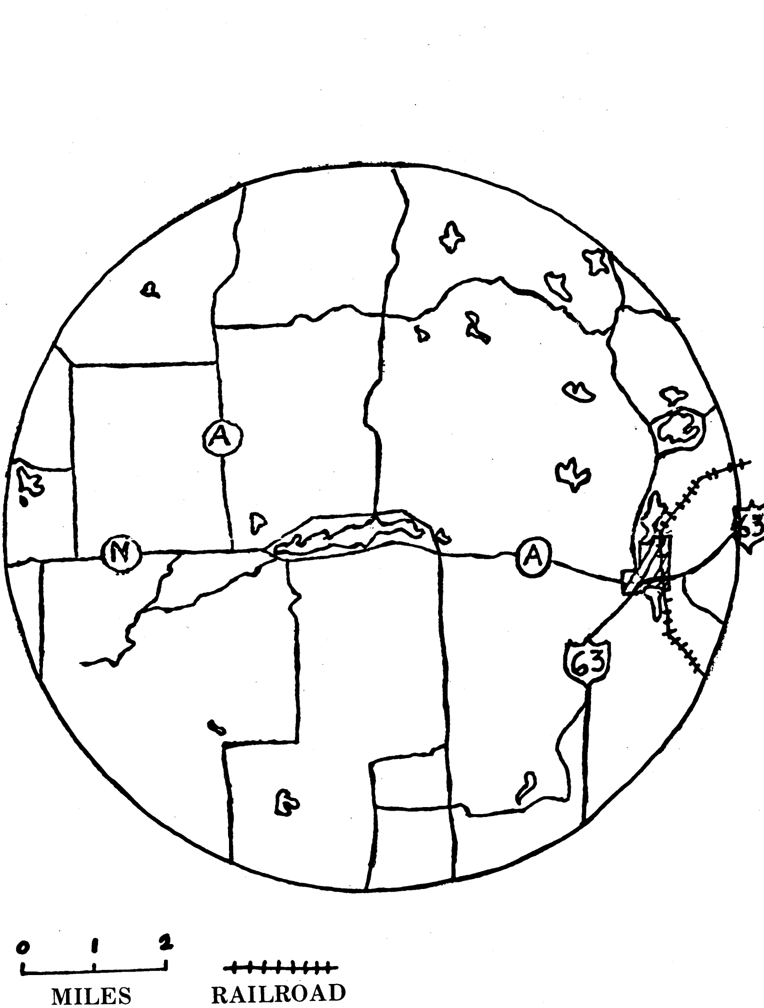

FIGURE 1. The Pigeon Lake Region

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

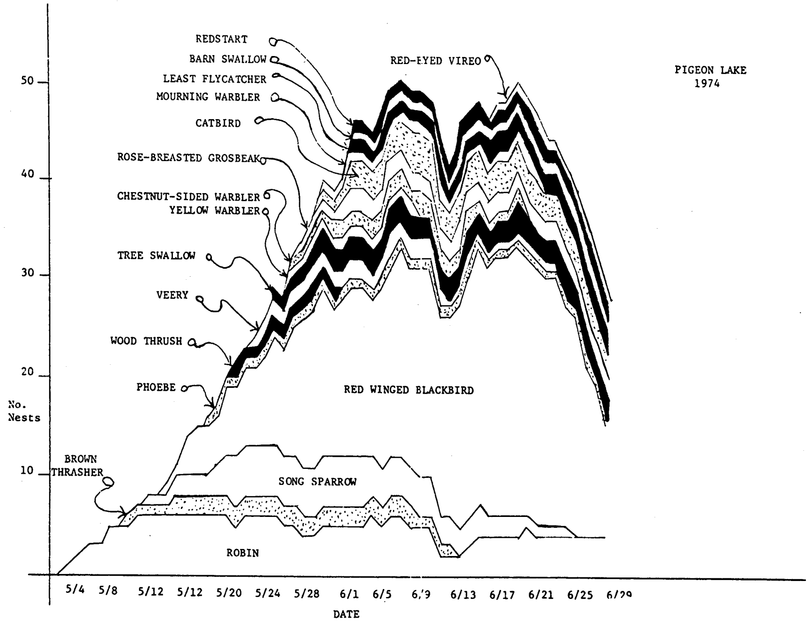

FIGURE 2. The Nesting Season at Pigeon Lake

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 Nests[a]	% Successful[b]	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.

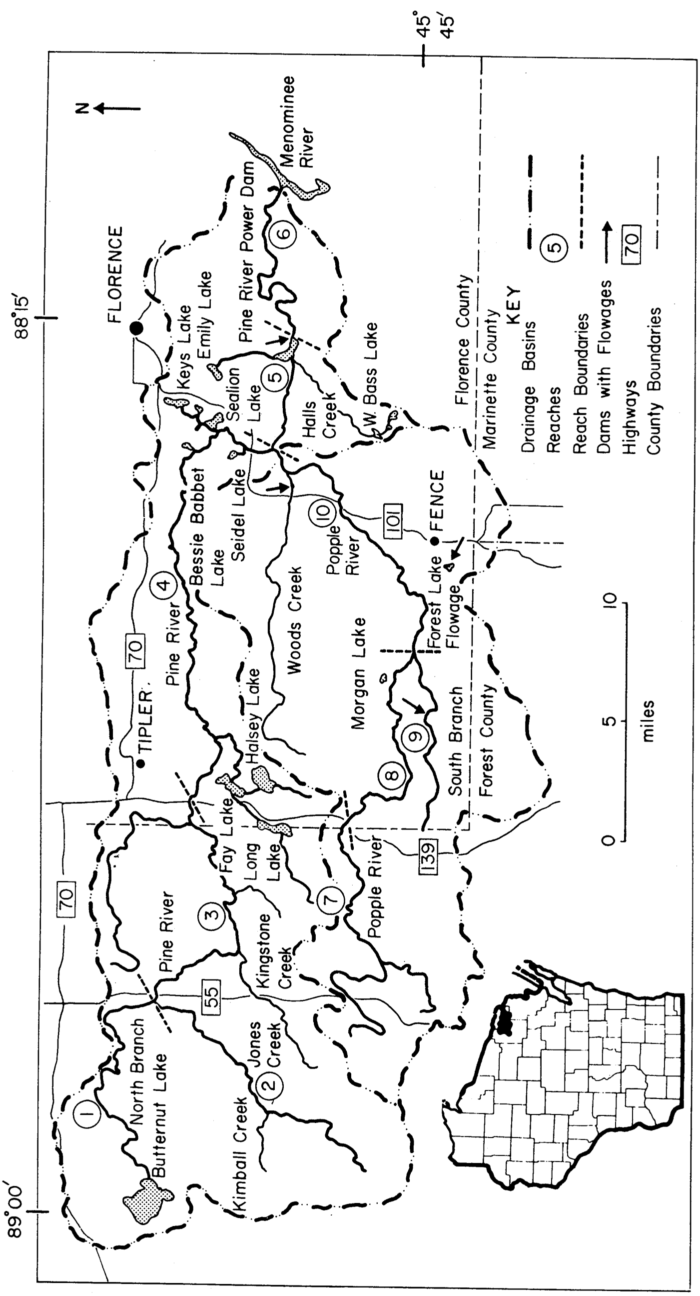

FIGURE 1. Pine and Popple River system, Forest and Florence Counties, Wisconsin.

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.

This project was financed by the Wisconsin Department of Natural Resources under a cooperative agreement with the University of Wisconsin-Whitewater. The following gave generously of their professional aid: Theodore S. Cochrane, Howard Crum, Steven Field, Robert Haynes, Lee Holt, Hugh H. Iltis, Jack Mason, Eugene C. Ogden, Robert K. Rose, Winona Welch and Tom Wirth. In addition, Robert Biller, Jr., William Hummel, James Olson, Aleene Rose, my sons Peter and Damon and my wife Rose all served as unpaid assistants.

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	10	11	12
	Popple R., S. branch	Popple R. from S. branch to Pine R.	Woods Creek	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 charcphytes in major reaches of the Pine and Popple Rivers and five tributary creeks.[1]

Species	Aquatic Plant Type[2]	Reach No.															
		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
		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			

REACH NO.		1 Pine R., N. Branch	2 Pine R., "So. Branch"	3 Pine R. from N. Branch to STH 139	4 Pine R. from STH 139 to Popple R.	5 Pine R. from Popple R. to Flowage	6a Pine R. from Flowage to Mouth	6b Pine R. Mouth (at Menominee R.)	7 Popple R. above FSR 2167	8 Popple R. from FSR 2167 to So. Branch	9 Popple R., So. Branch	10 Popple R. from So. Branch to Pine R.	11 Woods Creek	12 Halls Creek	13 Jones Creek	14 Kingstone Creek	15 Long Lake Outlet Creek
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]

		LAKES									IMPOUNDMENTS				
Species	Aquatic Plant Type[2]	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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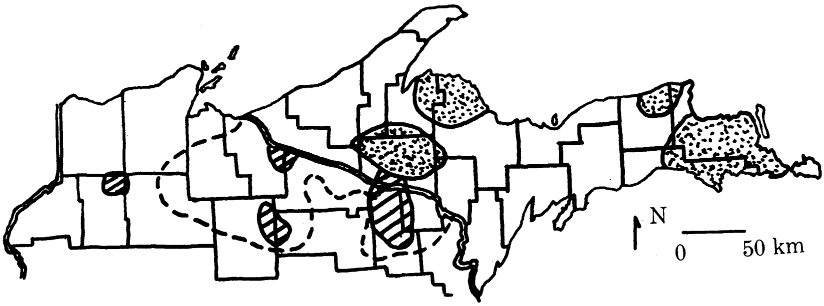
ABSTRACT:

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

Potential overstory trees	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	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.

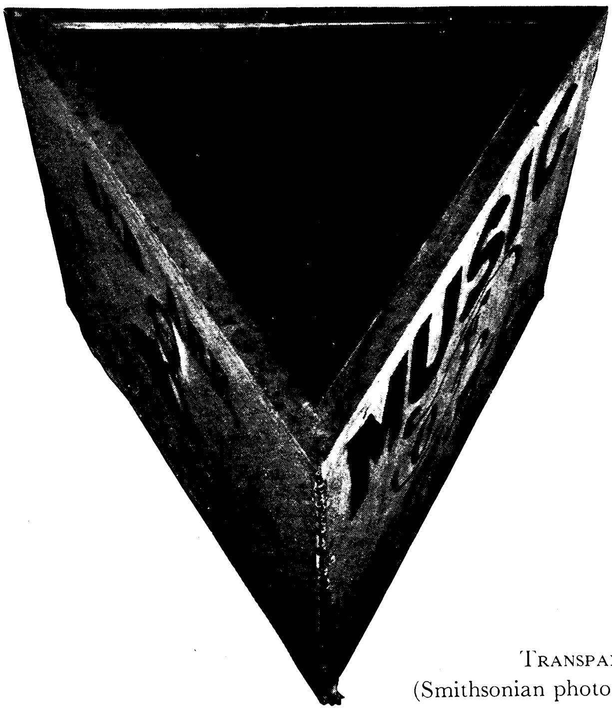
Tanner torchlighters in Milwaukee, Oshkosh and Madison had cavalry units organized as troops within the Tanner marching organization. Cavalry troops were used as honor guard escorts for visiting celebrities. Cavalrymen tended to be an elite Tanner unit, since they almost invariably were mounted on fine 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

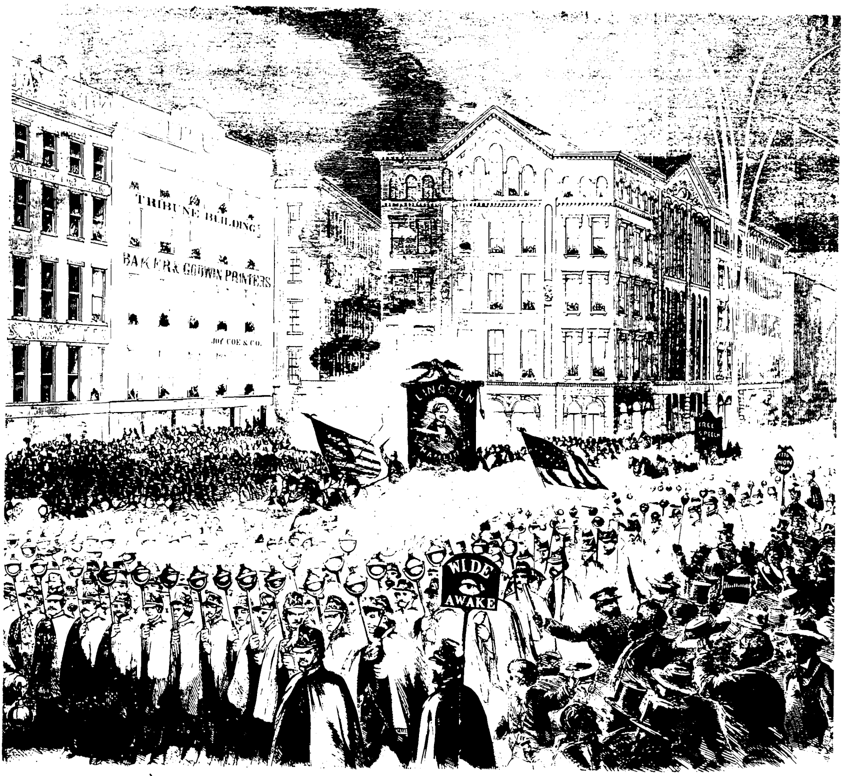
"Ullysses Forever, Horatio Never," and "Cursed be he who the Union would sever." The Janesville *Gazette* reported that the town of Milton sent a wagon procession to the same Janesville meeting which was half a mile long. The Milton wagons carried transparencies showing mottoes, two declaring, "We won't 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.

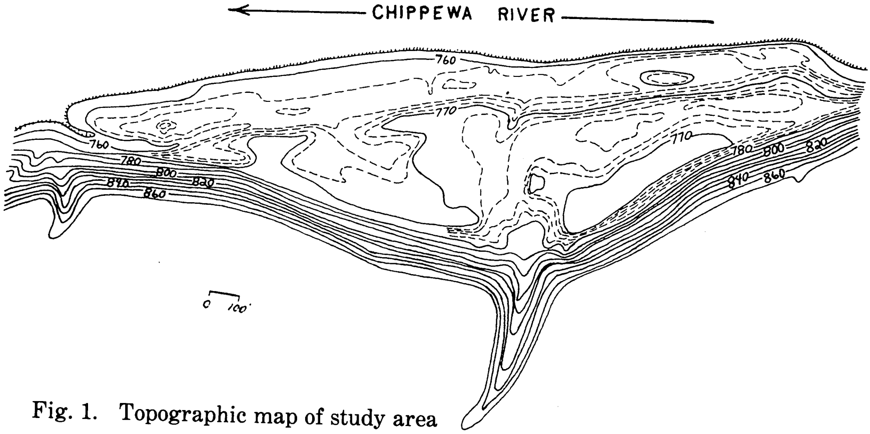

Fig. 1. Topographic map of study area

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.

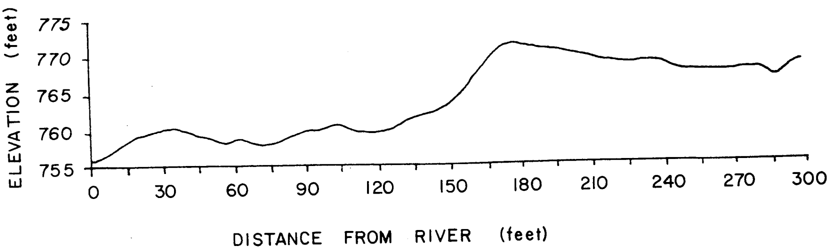

Fig. 2. Elevation profile of a typical transect (Transect #1) from the Chippewa River inland

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.

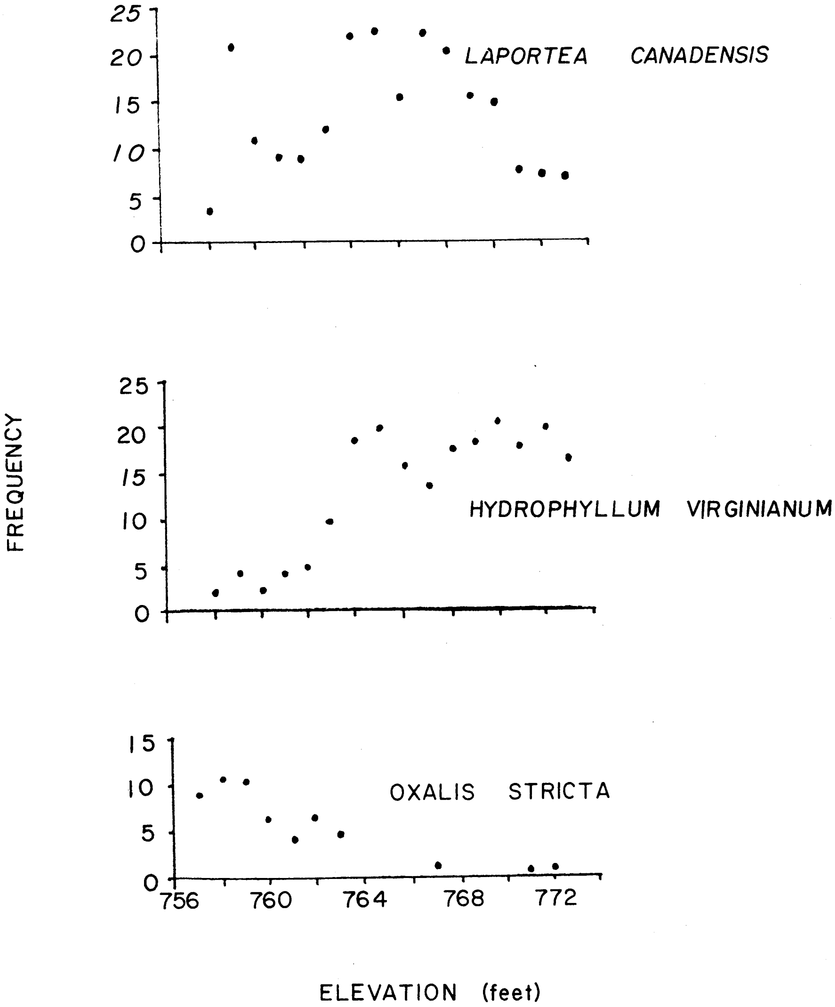

Fig. 3. Relationship of elevation to frequency of three herbs, *Laportea canadensis, Hydrophyllum virginianum* and *Oxalis stricta.*

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.

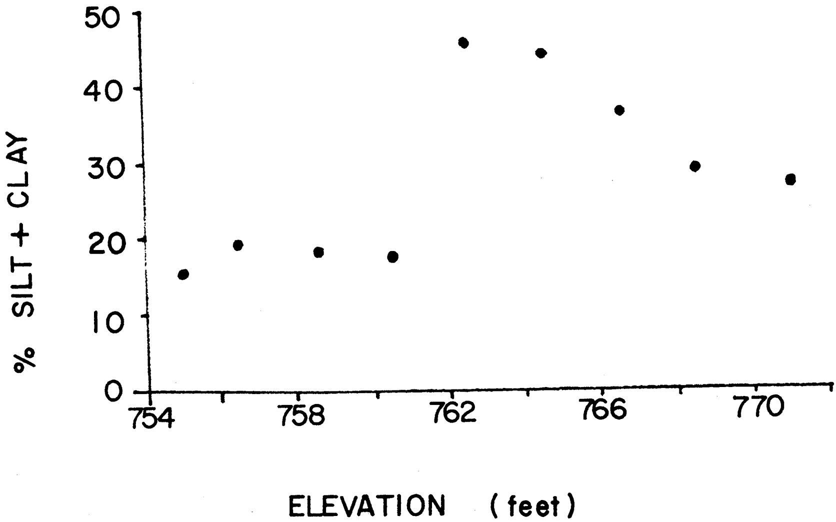

Fig. 4. Soil texture (percentage silt and clay) in relation to elevation

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).

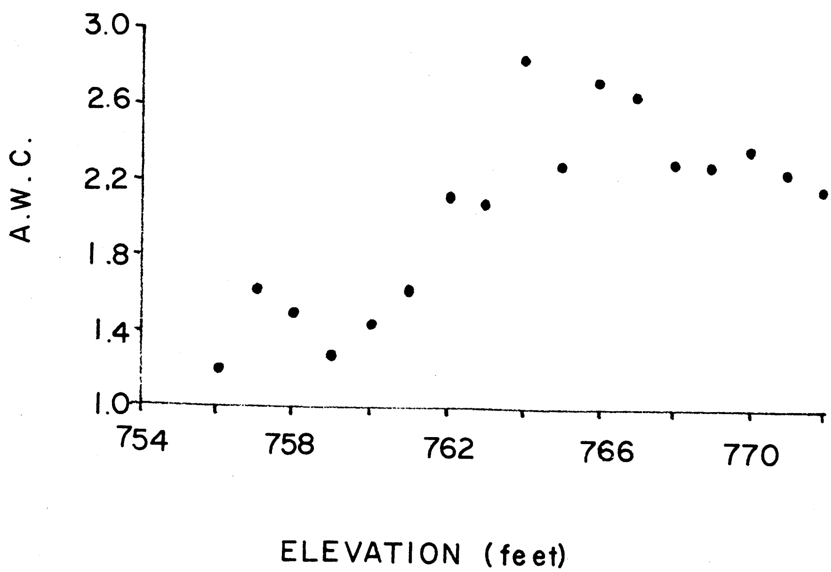

Fig. 5. Available water holding capacity of the soil in relation to elevation

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.

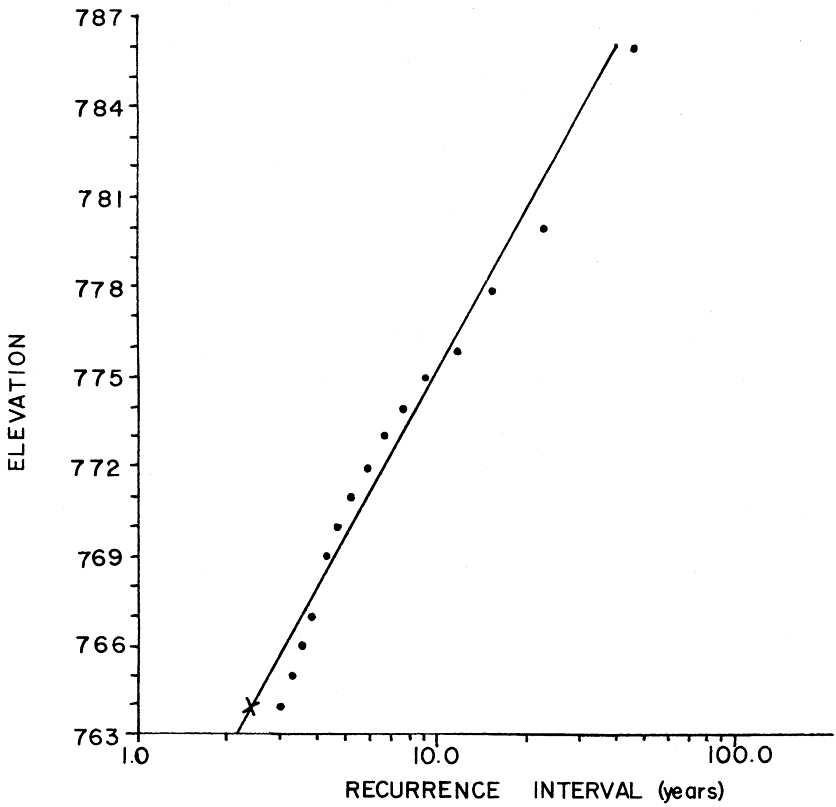

Fig. 6. Flood frequency for various elevations above the Chippewa River

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

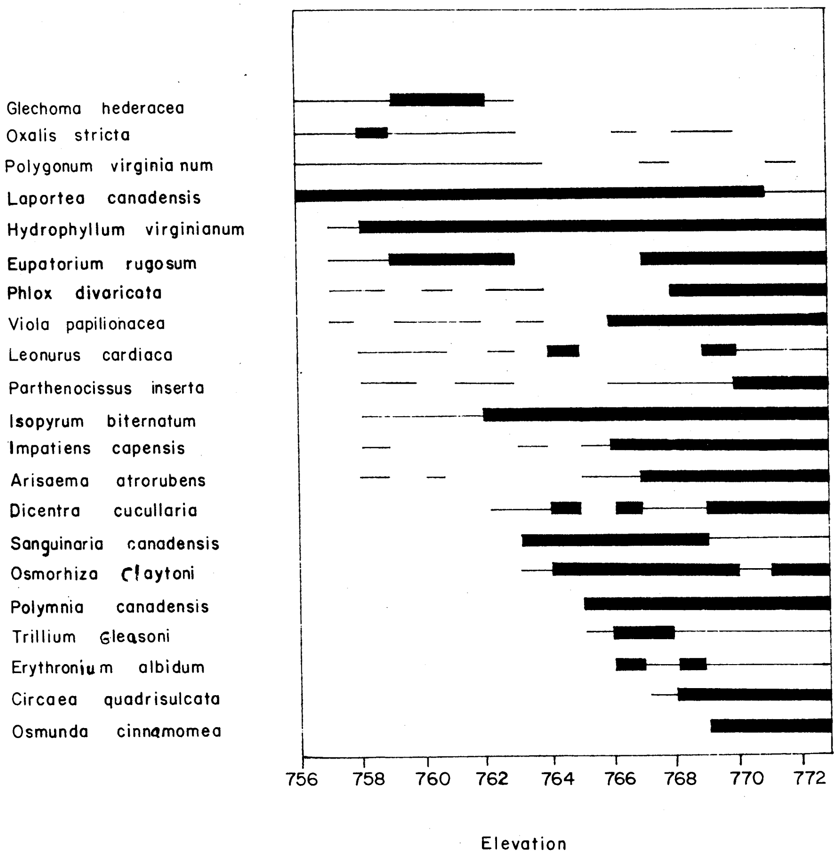

Fig. 7. Distribution patterns of herbaceous species along the elevational gradient. A thin line represents a frequency of less than 10 percent and a thick line a frequency of greater than 10 percent.

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.

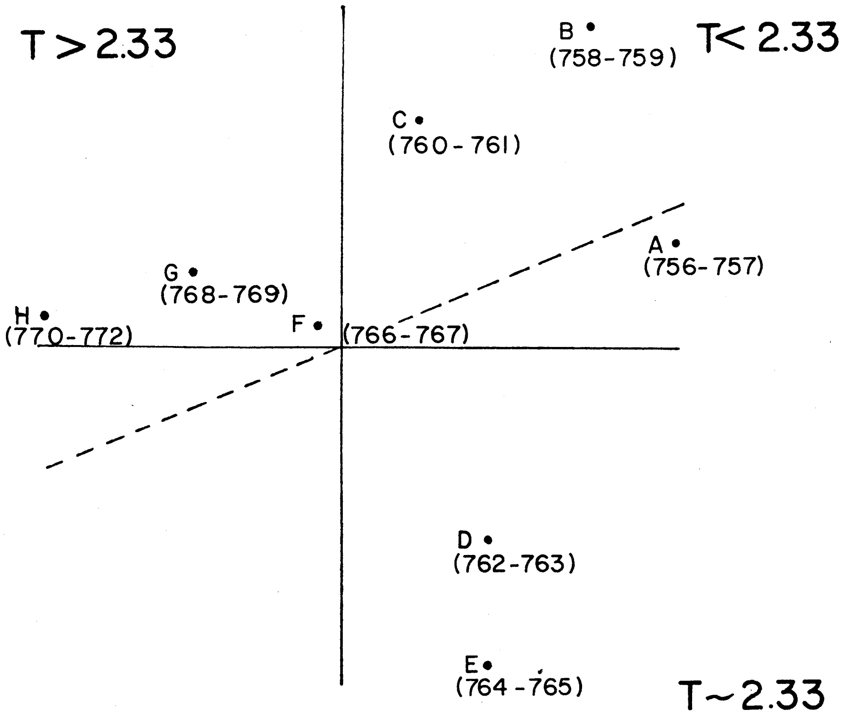

Fig. 8. Ordination of eight "stands" on the plane defined by the xy axis

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.

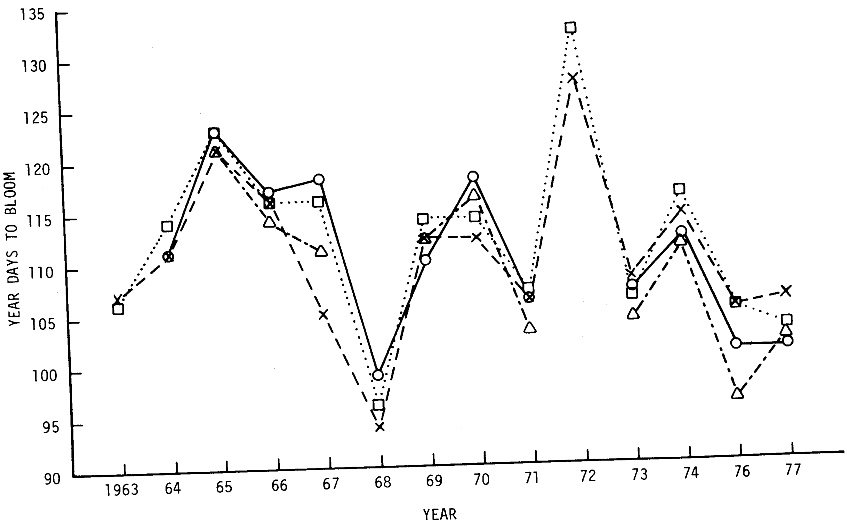

FIGURE 1. Number of days to bloom for plants of similar mean bloom date
Plant Key: X— — —X *Magnolia Stellata*
O———O *Forsythia suspensa*
□...........□ *Prunus tomentosa*
— · — · — *Forsythia x intermedia*

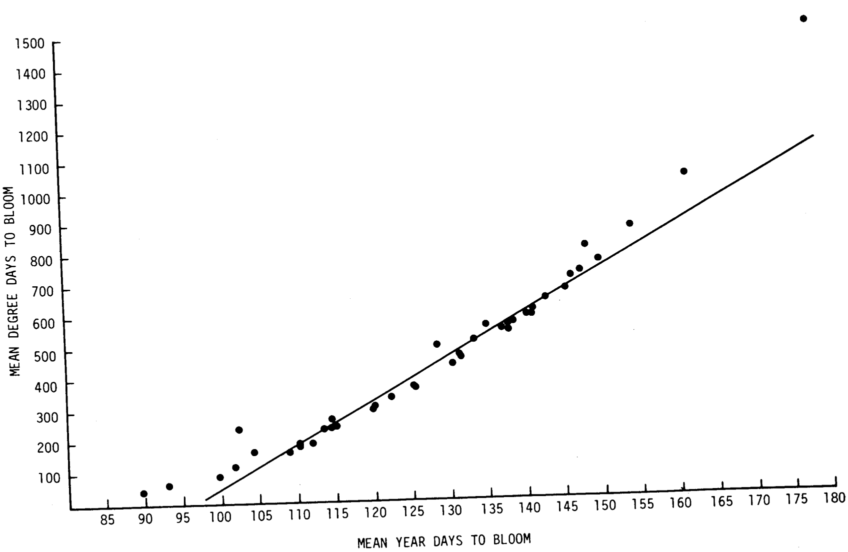

FIGURE 2. Mean number of degree days and year days to bloom for the plants listed on Table 1.

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.

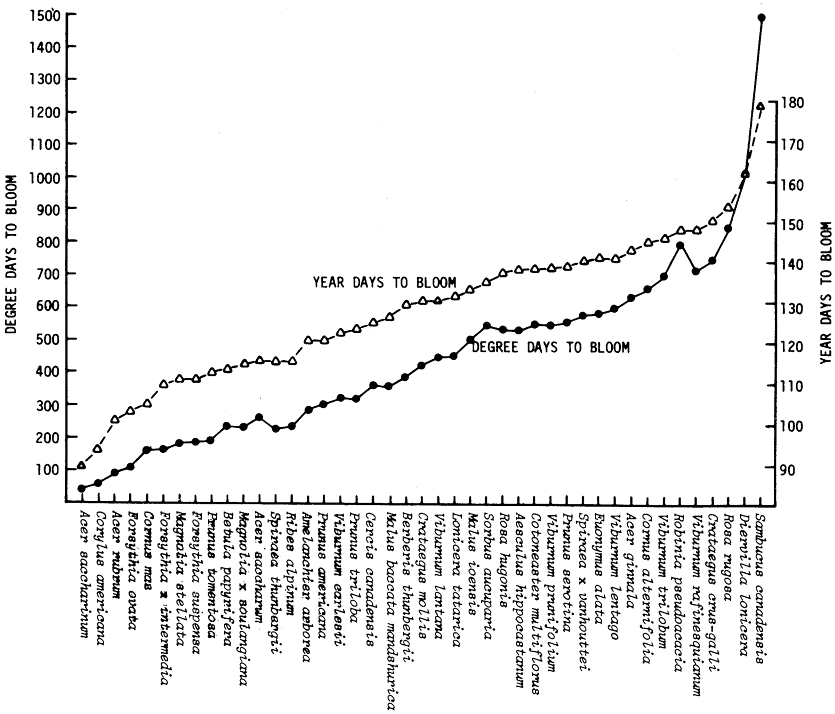

FIGURE 3. Mean number of degree days and days to bloom.

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.

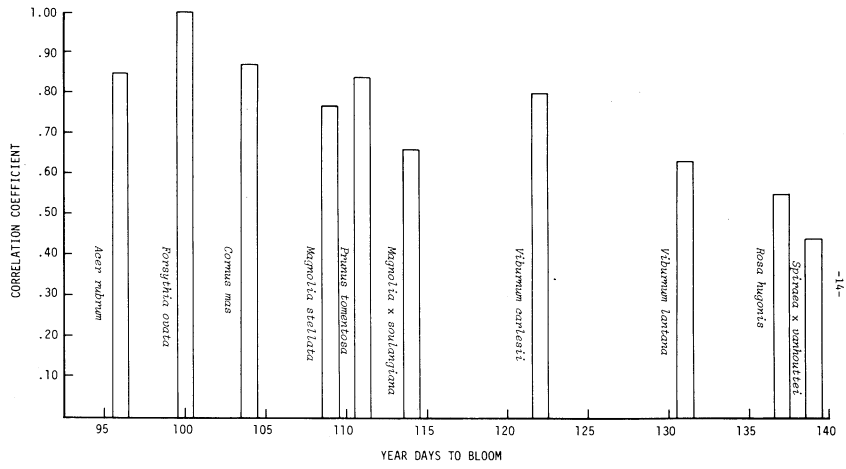

FIGURE 4. Relationship of bloom of various species to the bloom of *Forsythia ovata*. Based on 10 years of data (1966-1973, 1976-1977)

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).

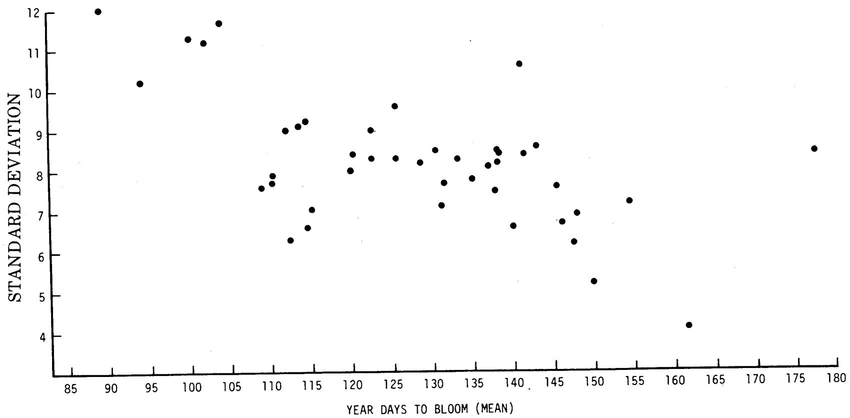

FIGURE 5. Standard deviation and mean number of days to bloom for the plants listed on Table 1.

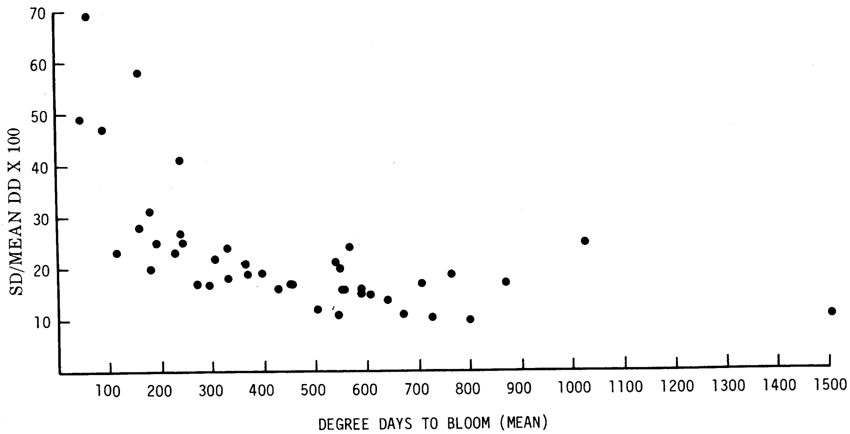

FIGURE 6. Relationship between mean degree days to bloom and standard deviation as a per cent of the degree days to bloom.

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

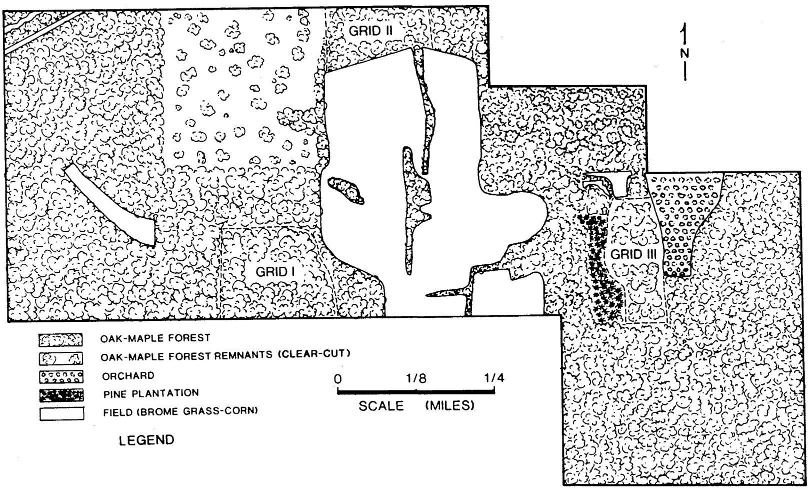

Figure 1. Potter Research Area.

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] (dm²)	Percentage Frequency	Percentage Density	Percentage 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

Grid	Individual Squirrel	Sex	Locations	Home Range Estimates: 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	Observation time hours	Gray Squirrels observed marked	Gray Squirrels observed unmarked	Largest no. seen on a single day	Estimated density/acre
Sept. To	I	7	45	9	75	16	1
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 To	I	9	84	16	14	7	1
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

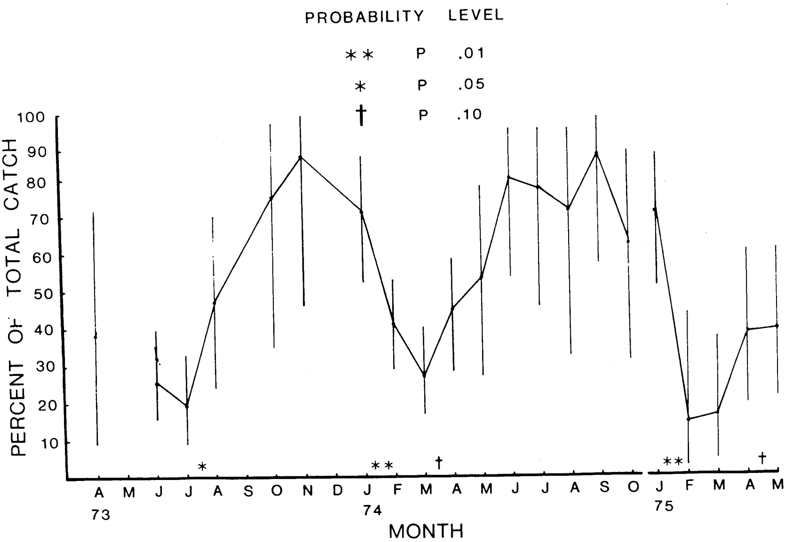

Figure 2. Changes in the proportion of unmarked gray squirrels in the monthly catch on the Potter Research Area. (Vertical lines represent 95 percent confidence intervals).

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

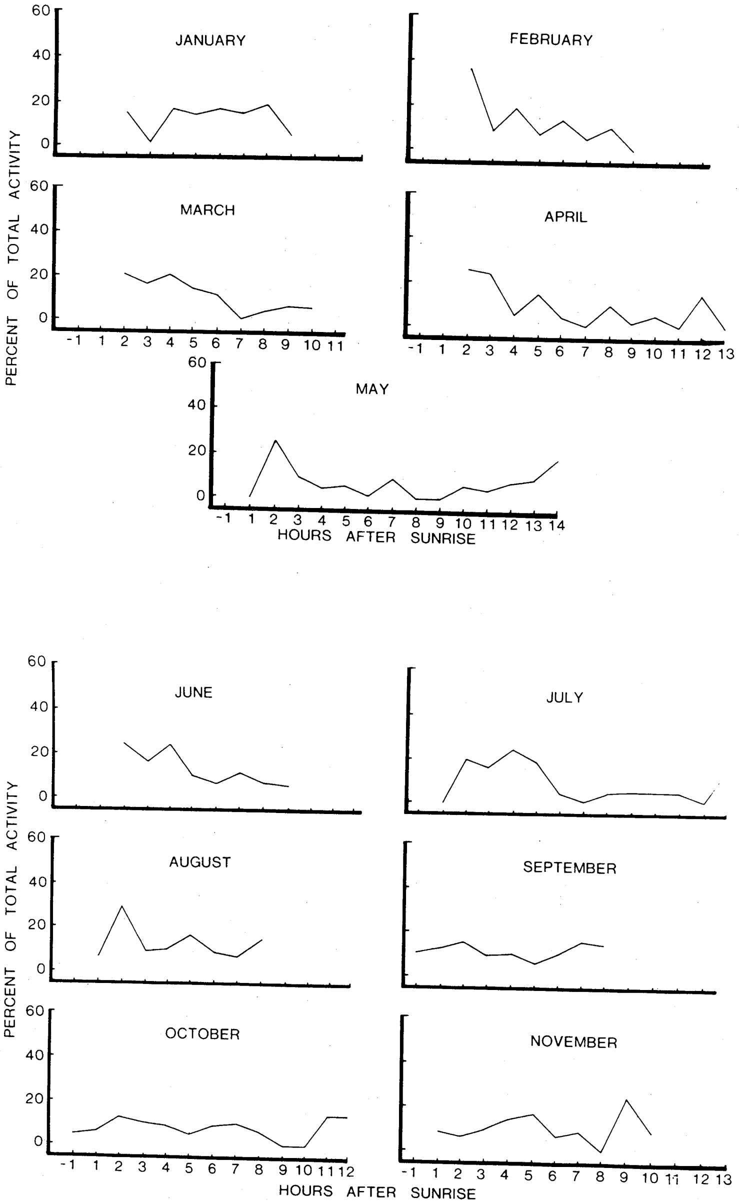

Figure 3. Average hourly activity rates for the gray squirrel on the Potter Research Area.

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

Grid	Length of observation period Hours	Days	Number of squirrels seen 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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