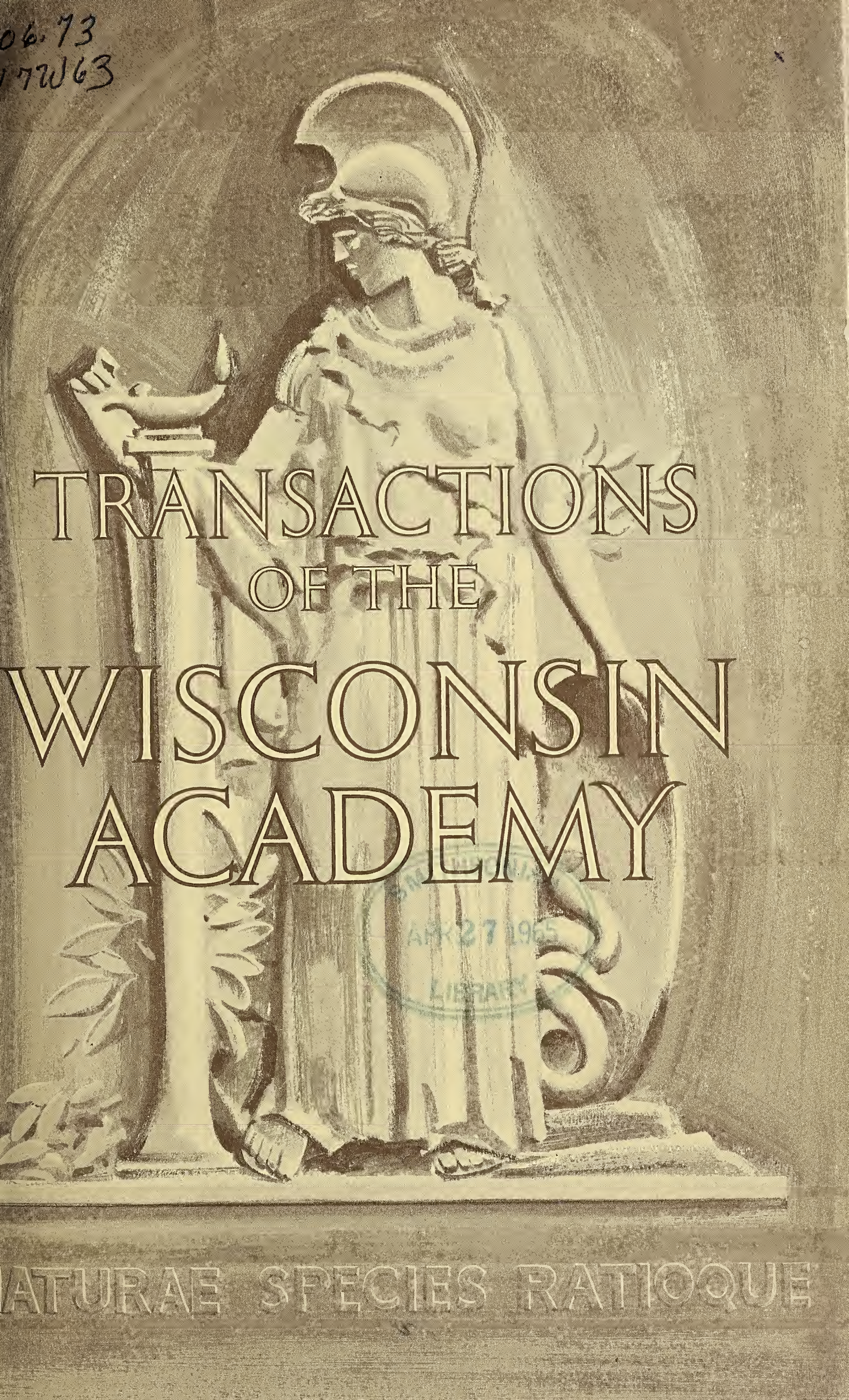
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GOODWIN F. BERQUIST, JR.

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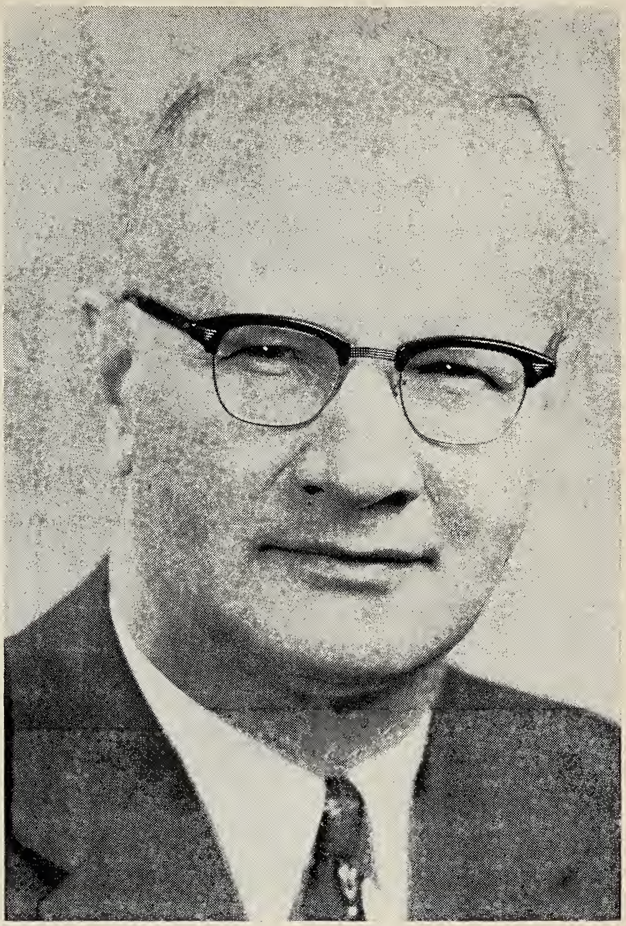

DR. AARON J. IHDE

43rd President of the

WISCONSIN ACADEMY OF SCIENCES, ARTS AND LETTERS

[illegible]

THE SCIENTIST AND THE MODERN WORLD

*Aaron J. Ihde**

Although human beings have been concerned about scientific matters since they mastered fire in paleolithic times, it has only been in the past century that scientific discoveries have rapidly and profoundly changed their way of life. In fact, modern science is the product of barely four centuries of activity. The year 1543 may be looked upon as the beginning of the modern scientific revolution. It was in that year that two of the great books in the history of science were published: *De revolutionibus orbium coelestium* (Concerning the revolutions of the heavenly bodies) by the Polish cleric Nicolaus Copernicus and *De humani corporis fabrica* (Concerning the structure of the human body) by the Belgian physician Andreas Vesalius. In the four centuries since their day we have seen many changes of fashion in science but it is interesting to point out that we have now returned to first interests—the most vigorous fields of mid-twentieth century science, like those of the sixteenth, deal with space and life.

In examining the role of the scientist in the modern world it is best to clarify the characteristics of both before proceeding further. Reading, observation, and reflection cause me to believe that scientists have certain common attributes. They are curious, especially with respect to the nature of nature. They are intelligent. They are enthusiastic. They are dedicated in their pursuit of understanding, frequently to the point of ignoring everything else in the world about them. They have faith that the universe is orderly. Except for these common characteristics, scientists vary tremendously. Some are thinkers, others are doers; occasionally the two characteristics are found in the same person. Some are innovators who see the important interrelationships between apparently dissimilar areas; others are cream-skimmers who seldom introduce new innovations but quickly recognize significant problems once they have been opened and exploit them enthusiastically before turning to a newer problem of significance. Finally, there are the clean-up men, persons of limited imagination who have the patience and conscientiousness to carry on after the glamor of the problem has passed. Fortunately, all three types are able to make important contributions.

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* The author is Professor of Chemistry and the History of Science and Chairman, Department of Integrated Studies University of Wisconsin–Madison.

Now, if we turn to the characteristics of the modern world, we observe a *shrinking globe* which is *potentially affluent* and is filled with a *multiplicity of misunderstanding*. I shall not further belabor the shrinking globe. Joel Carl Welty, in his address as retiring president of the Academy two years ago, stated, "Technological science has made it possible for man to circle the globe, not only in 80 days but in 80 minutes, and it promises soon to broaden his horizons to include other planets".[1] For those of us who have lived a significant part of our lives in the twentieth century there is little need to add more.

My characterization of the modern world as potentially affluent may be criticized, particularly in a period when the President makes elimination of poverty an important goal of his presidency. I do not deny that poverty exists. Starvation is a way of life in many parts of the world and we are not without it in the United States. However, the fact that as shrewd a politician as Lyndon B. Johnson is eager to make elimination of poverty the keynote of his presidency demonstrates, I think, that we are a society with the potential for affluence. This potential certainly exists in various parts of Europe and could, with wise nurture, be extended to the rest of the globe.

This potential for widespread affluence derives largely from the modern capacity for innovation, both economic and technological. The willingness to accept change leads naturally to the idea of progress, a concept which was unrecognized throughout much of human history.[2] Thus, it has been only in very recent centuries that such economic innovations as adequate capitalization, extensive division of labor, and mass production have become significant. Concurrently, technological innovations have led to the utilization, in prodigious quantities, of power from fossil fuels, and to automation.

The application of scientific knowledge to technological innovation is a development of the past century. Before 1864 technology contributed much more to science than science did to technology. The modern age of applied science may be considered to have had its origins with the synthetic dye industry and the electrical industry. The slow utilization of basic knowledge of chemistry and physics which stimulated the growth of these industries served as models for present day scientific technology. Today no major producer of goods questions the utility of a control and developmental laboratory and many progressive companies are recognizing the

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[1] J. C. Welty, "Knowledge and the Law of Diminishing Returns," *Transactions of the Wisconsin Academy of Sciences, Arts and Letters*, 51:7 (1962).

[2] Cf. J. B. Bury's *The Idea of Progress: An Inquiry into its Origin and Growth* (London: Macmillan, 1920).

importance of supporting basic research. The rapidity with which basic knowledge is applied today causes many farsighted industrialists and scientists to fear that applied science is outstripping the capacity of fundamental science to supply new basic discoveries.

My third characteristic of the modern world is multiplicity of misunderstanding. The spread of knowledge to remote parts of the globe has been a consequence of technological innovations which make rapid communication possible. Non-Western people are learning about those principles held dear in the Western world; freedom, justice, the dignity of the individual, and equality of opportunity. While our practice of these principles frequently leaves much to be desired, the existence of such concepts comes as a surprise in many parts of the world. Hence, knowledge of such concepts further intensifies the existing dissatisfaction with the status quo.

The same communications media which spread knowledge of these concepts also bring promises of easy relief. I have already pointed out that scientists all believe in a *concept of order*. In the politico-social-economic realm there is also belief in order—but the members of different schools each have their own concept of order. The world is therefore faced with *concepts of order*, with the devotees of each concept being convinced that their own brands of socialism, communism, capitalism, nationalism, colonialism, industrialism, tribalism, or internationalism are without blemish. Is it any wonder that the impact of these various concepts of social order on semi-literate peoples leads to the present multiplicity of misunderstanding?

The confusion of the contemporary social revolution is compounded by the impact of modern science, with its ability to effect massive changes. As examples we need only look at the results of electrical innovation: generators and motors, transmission of electromagnetic signals through space, transistorized circuits capable of accepting, storing, and manipulating information. Or we may examine the results of agricultural innovation where the application of fertilizers, agricultural chemicals, and knowledge of genetic principles has increased productivity enormously. In the field of medicine the recognition of the germ theory of disease stimulated the development of immunological practices and ultimately led to the rise of chemotherapy with its sulfa drugs, antibiotics, and steroids. Study of the atom led, on the one hand to nuclear weapons, on the other to nuclear power and isotopes for use in science, medicine, agriculture, and industry.

It is easy, in a society where the products of science are so readily apparent, to conclude that more science will settle our remaining problems. However, we must beware of simple answers. There is an unexpected deceptiveness in the application of science. While nuclear weapons may quickly and inexpensively destroy our enemies, they can also destroy us with the radioactive fallout produced. While chemical insecticides can hold in check the insect enemies of the forester, gardener and farmer, they can also contaminate the countryside and cause damage to innocent insects, fish, birds, and mammals. While synthetic detergents can make wash whiter with less human effort, they can also evade normal microbiological breakdown and pollute our surface and ground waters. While wonder drugs can save the lives of babies, they can thereby add to the numbers of individuals living in a state of chronic malnutrition if not outright starvation.

A great deal of heat and some thought has gone into the problem of control of scientific applications in the best interest of the public. Unfortunately, most socio-scientific problems are not easily resolved in a manner which leaves everyone happy. Frequently, available facts present a one-sided picture. This is particularly true when there are financial interests involved, as there usually are. One side of the picture frequently is adequately presented, the other not.

Since my own field of interest and competence lies in the realm of food and drug control, I would like to draw my examples from that area. One might equally well look at the regulation of nuclear energy, conservation of natural resources, prevention of pollution of air and water, regulation of cigarette advertising and sales, or the control of the mushrooming population.

The history of food and drug regulation may be characterized by a term heard so often during the early days of the second World War, "Too little and too late."

The American food industry grew to sizeable proportions in the decades immediately following the Civil war. Meat packing, canning, and the dairy industries had all reached sizeable proportions by 1900. The American propensity for self-medication meant that the drug industry was also a profitable one. Despite the lack of sanitation, the prevalence of adulteration and misbranding, and the widespread tendency toward misleading advertising, there was no federal food and drug legislation, except for very limited laws designed to benefit special producer interests. Need for general legislation was apparent by 1880 when Harvey W. Wiley became chief of the Bureau of Chemistry in the United States Department of Agriculture. Although remedial legislation was introduced in every session of Congress over a 25-year period, it was impossible to secure passage before 1906. Even then, passage would probably have failed had it not been for the demand for meat inspection created by publication of Upton Sinclair's book, *The Jungle*. Although the book was a novel dealing with the misfortunes of a slaughterhouse worker, the colorful descriptions of conditions in the packing industry led nauseated readers to clamor for reform. Investigations by government committees revealed that enough of the suspicions were true to justify reform and Congress was unable to resist the demand for a Meat Inspection Act. The momentum created for meat inspection swept the Food and Drug Act, commonly known as the Wiley Act, through at the same time.

Wiley's intention to fairly but firmly enforce the Food and Drug Act was frustrated from the beginning and he resigned from his post in 1912. His successors conscientiously attempted to cope with the problem of regulating two rapidly growing industries, but found themselves steadily losing ground. Up to 1930 there were no substantial changes in the law despite the fact that changes in the industries were creating many new regulatory problems, some of them brought on by scientific developments.

The first major attempt to overhaul the act of 1906 was made in 1933 when the Tugwell Bill was introduced. This was fought vigorously by lobbyists for the food and drug industries and less stringent bills were substituted. The Copeland Bill (named after the sponsoring Senator) was finally passed in 1938—but only after tragedy had occurred from the sale of "Elixir of Sulfanilamide." This product came on the market shortly after the effectiveness of sulfanilamide had been demonstrated. Its producer, seeking for a way to cut costs, introduced diethylene glycol as a solvent. It served very well for this purpose but very soon after it appeared on the market in the South, patients became violently ill and some of them died. Before all bottles of the product could be removed from the market, 107 persons were dead. The company's chemist became the 108th death when he committed suicide. It had never occurred to him or his employer that diethylene glycol might be toxic or that the producer had a moral obligation to look into such matters. Ironically, the only action the Food and Drug Administration could take under the existing Wiley Act was to seize the product for misbranding. The word "elixir" requires the use of alcohol as a solvent. The provisions of the Copeland Act would have prevented these needless deaths. It was passed *too late!* In fact, had the deaths not occurred it perhaps would not have passed for several more years.

The Copeland Act was reasonably adequate to deal with the major abuses prevailing in 1938 but the nature of the industries changed rapidly during World War II. The introduction of DDT was followed by other organic insecticides. Concurrently, the use of new preservatives, flavors, emulsifiers, hydrating agents, and other chemical "improvers" grew to major proportions. The powers of the Act and the appropriations for its administration proved *too little* for realistic regulation.

It is frequently alleged by apologists for the food industry that there has never been a recorded case of illness attributable to the use of chemical additives. These apologists are ignorant of or choose to ignore the vitamin deficiencies caused by use of mineral oil in low calorie foods, or the upsets caused by the substitution of lithium chloride in low sodium foods. They ignore the fact that, since 1945, such chemicals as dulcin (a sweetener), coumarin (a vanilla substitute), mono-chloracetic acid (a preservative), Agene (a flour bleaching agent), and at least six certified food colors have been withdrawn from the market.

Although Congressman John Delaney initiated hearings on the safety of food additives in 1950, it was not until 1954 that the Miller Amendment was passed to give the Food and Drug Administration realistic control of pesticides in foods. The Chemical Additives Amendment was only passed in 1958.

Despite the fact that the late Senator Estes Kefauver initiated hearings into the nature of operations in the drug industry in 1959, remedial legislation was not passed until autumn in 1962. Two months before passage, Kefauver's bill was doomed to a quiet death. However, the role of thalidomide in causing malformation of unborn infants became apparent just as that moment. Again, tragedy was necessary to bring about legislation to protect the public.

The history of food and drug legislation has been one of *too little* and *too late*. I am sure that a review of many other socio-scientific problems would reveal a similar history. I am particularly bothered to find the majority of scientists quite indifferent to these problems, or frequently aligned with the forces advising no action.

We come then to the question, "What is the responsibility of the scientist to the modern world in which he lives?" There are some who answer, "He has no responsibility other than to be a competent scientist," meaning that he need be only a competent searcher into the nature of nature who publishes his findings at the earliest opportunity. They argue that it is not possible for the investigator to foresee the use which will be made of his discoveries, therefore his only responsibility is to discover. I take issue with this position, feeling that scientists are also members of the human race and have a responsibility for the preservation and extension of civilization. Their high level of education and their generally favorable position in the economic system places them among the fortunate group which is in a position to exert a disproportionately large influence in formulating public opinion.

The scientist seeking to apply a new development has a responsibility to anticipate over-all effects, not merely the favorable effects.

While it is not always possible to foresee all possible implications, a sincere effort can be expected.

There is a further obligation to make his understanding available. The responsible scientist, because he has command of specialized and unique information, has the obligation not only to serve on governmental agencies when requested, but to speak out on issues of public importance when he can shed light on the problem.

Many intelligent persons excuse themselves from participation in public debate on the grounds that human beings are dominated by animal instincts and changes in ethical values are therefore not possible. I remind them that history reveals important changes in ethical values, at least in the Western world. We no longer practice infanticide nor abandonment of the aged. Human sacrifice was given up centuries ago. We have not burned any witches for two centuries. Slavery was outlawed in this country a century ago and, while it is still practiced in certain parts of the world, it keeps losing ground. Certainly there is still much to be desired in our treatment of fellow human beings but we have been making progress.

In view of the potential affluence of the world and of the inevitable increase in leisure time, can we not continue our progress toward greater freedom (with, of course, recognition of its attendant responsibilities), and greater understanding, and greater compassion for the less fortunate? We must continue to recognize our major problems, the spreading of education and opportunity, the wise use of our natural resources and our scientific resources, the control of population growth, and the abandonment of war as a tool of international policy. These are not small responsibilities and at times they appear hopeless but civilization is based upon the leadership of a small minority with a firm commitment toward desirable change.

I have always been thankful that the founders of our Academy had the foresight to accept the fact that science is not a monolith. They understood that it could serve society best if it joined hands with the arts and letters. This has not always been remembered by later generations. One of our obligations in this generation is to see that the Academy restores proper balance between the respective disciplines. We must further see that the Academy serves as a forum for discussion of the problems of Wisconsin, even when these problems transcend the borders of the State. Moreover, we must be eager to move into action toward the solution of these problems. If we carry on in this manner, such founders as Increase Lapham, John Hoyt, T. C. Chamberlain, Lyman Draper, A. L. Chapin, and Ronald Irving would be proud to have us as descendants.

JENS JENSEN—CONSERVER OF NATURE AND OF THE HUMAN SPIRIT

*Harriet M. Sweetland**

On the western bluffs of Door County, accentuated by pine and cedar, stands The Clearing—a unique, informal, cultural center, offering varied courses which change weekly. In nearby Ellison Bay a village school, unusual in America because of its natural setting in a growth of white pine, epitomizes the philosophy of a famous landscape architect's "school in a park" theory. In Racine, Wisconsin, that "little Denmark of America," a city park system, beautiful because of its natural winding lay-out, stretches invitingly to the wayfarer—heritage of its Danish-American planner. At Madison, Wisconsin, Children's Glen offers a delightful nature-retreat for the adventurous spirit of the playful young. Farther south, in the West Chicago park system, fatigued city-dwellers may find quiet spots of greenery in the confines of Columbus, Garfield and Humboldt Parks; and ringing the territory of Greater Chicago, along the waterways of the Des Plaines, Sac and Calumet Rivers, that same urbanite may discover a chain of wooded tracts, offering a country-like environment and known as the Cook County Forest Preserves. Circling the state of Illinois, particularly along the Mississippi, Rock River, and tributaries of the Ohio, there stretches a similar chain of *state* parks, instigated into being by a comparatively new organization—"Friends of Our Native Landscape." In central Illinois, at Springfield, the Lincoln Memorial Garden spreads out in the open-hearted, prairie-like candor, befitting the liberal spirit of the Great Emancipator for whom it is named. In the neighboring state of Indiana, a seven-hundred acre tract of dune land has been saved for posterity to serve as a natural text-book for the science-minded.[1]

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* Miss Sweetland is an instructor in the Department of English, the University of Wisconsin–Milwaukee. This paper was read at the ninety-fourth Annual Meeting of the Wisconsin Academy of Sciences, Arts and Letters.

[1] Because the private papers of Jensen were destroyed in a fire at The Clearing in the late 1930's, the researcher must rely largely on fugitive, secondary sources; but fortunately Miss Mertha Fulkerson, Jensen's private secretary for over two decades, is still available for information. Reference materials used for the factual, biographical data in this article were obtained from the following sources: Mertha Fulkerson, "Jens Jensen, Friend of Our Native Landscape," *The Peninsula* (June 1958), pp. 7–10; Mertha Fulkerson, Letter to author of this paper of April 12, 1964; interview held with Miss Fulkerson at The Clearing, April 25, 1964; Clifford Butcher, "Jens Jensen Renews War on City," *Milwaukee Journal*, June 9, 1935, II: 5; obituary articles in *Madison Capital Times*, October 1, 1951, pp. 1 and 3; *Milwaukee Journal*, October 1, 1951, pp. 1 and 2; *Chicago Tribune*, October 2, 1951, p. 20; and WHO WAS WHO IN AMERICA (Chicago, 1961), p. 448.

What have all these separate spots in common? What is their connecting link? In one way or another they represent either the creativity or the civic activity of a remarkable Danish-American landscape architect—who, up to his death in his ninety-first year, sought to preserve for his fellow Americans little retreats of natural greenery, where fatigued mankind could find moments for peace of mind and refreshment of spirit.

Although Jens Jensen grew up on the sea-tossed, history-drenched coastland of Denmark, receiving his training in landscape design at the agricultural college at Jutland, like many fellow Europeans who found the Continental political scene not to their liking, he fled to America—arriving in New York City in his early twenties with the proverbial "dime in his pocket." After brief farming jobs in Florida and Iowa, Jensen came to Chicago, starting up the ladder of the Chicago park system in a landscaping career which brought him national fame and caused him later to be titled "Dean of American Landscape Architects."

His rise to professional success parallels the typical progress of many a nineteenth-century American immigrant: Starting as a common laborer in Chicago's Washington Park, he soon won attention from the neighboring citizenry by his creation of a little wild flower garden in the heart of the city.[2] From there he worked his way up to become, in turn, head gardener at Garfield Park (whose world-renowned conservatory came into being largely as the result of his planning); foreman of Union Park; foreman of Humboldt Park—at the time Chicago's largest park; and finally, general superintendent and landscape architect for the Greater West Park system of Chicago, a position he held until 1920.[3]

In his Chicago park landscaping experimentations, Jensen is chiefly noted for his work at Columbus Park, which still exists today practically as it was created, relatively untouched by the political manipulators influential in most cities. Its open, sky-loving lagoon, with plantings of native hawthorn and crab-apple, stretches out restfully—exemplifying most concretely Jensen's philosophy of natural landscaping.[4]

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[2] Leonard Eaton, "Jens Jensen and the Chicago School," *Progressive Architecture* (December 1960), p. 145.

[3] Mertha Fulkerson, "Jens Jensen, Friend of Our Native Landscape," pp. 9–10; William Golden, *History of Columbus Park* (five-page typescript, signed by author, on file at the Chicago Historical Society); Chicago Bureau of Public Efficiency, *Park Government of Chicago,* No. 15 (Chicago, 1911), p. 8; West Chicago Park Commission, *Recreation Centers . . . of the West Chicago Park Commission* (Chicago, 1919), pp. 9–10; West Park Commission, *Catalog Guide to Garfield Park* (Chicago, 1924), Introduction; Eaton, *op. cit.,* p. 145.

[4] Jens Jensen, *Siftings, A Major Part of The Clearing, and Collected Writings* (Chicago, 1956), pp. 75–9 and 97; and Mertha Fulkerson, Letter to Author, April 12, 1964, p. 1.

For Jensen represented something new in the field of park planning, promulgating a novel, unconventional approach in landscape architecture: At a time when the Continental style of formal, geometric landscaping was very prevalent in public parks and private estates—influenced strongly in this direction by the Chicago World's Fair exhibits of 1893—Jensen advocated a type of design more closely resembling the English country park: informal, non-geometric, patterned after Nature's curving byways and making use of native plant materials. He used trees and flowers particularly indigenous to the region, rather than exotic, foreign plantings. His motif for this new type of landscaping he obtained by a careful study of the Illinois prairie country which his immigrant eyes had seen stretching all around him on his arrival in the Midwest. For Jensen came to love the prairie even more than he had loved his native sea-scape of Denmark. And the more he studied the prairie, the more he became convinced that the public and private grounds he was landscaping should contain only plants indigenous to that landscape; so he tried to recapture in his parkways the "feel of the prairie" as it must have appealed to the early settlers—using native wild phlox, blazing star, purple wild flag, swamp rose mallow, flowering shad, wild crab and hawthorne, beech, white oak, birch, sugar maple, and other trees belonging naturally to the region in which he was working.[5] In fact, Wilhelm Miller, Professor of Horticulture at the University of Illinois, cited Jensen as the pioneer in this form of landscape design, noting that Jensen was "probably the first designer who consciously took the prairie as his leading motive."[6]

But in utilizing these native materials, Jensen felt he must always consciously take into consideration the personality of the plant, the personality of the landscape, and the personality of the owner of the estate on which he was working. Moreover, landscape architecture, as he once noted, was one of the most difficult of the fine arts because the designer was working with living, changing material. So he must consider not just how a certain tree looks now, but "must see the tree in its full beauty hundreds of years hence," when it would have grown up to take in more of the sky line.[7]

Living at a time in Chicago when there was a great interest in "freedom of form"—a governing member of Chicago's Art Institute Board, and active in the Cliff Dwellers and other art groups —Jensen reflected in his landscaping that same "freedom of form"

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[5] Wilhelm Miller, "The Prairie Spirit in Landscape Gardening," *Circular 184 of Illinois Agricultural Station* (November 1915), pp. 2–4; Jensen, *Siftings*, pp. 20, 30–1, 35–6, 41–2, 61–3, 66–7, 77–8, 91–6; Eaton, pp. 145–6, 147, 149; *Handbook of Chicago Parks*, (Chicago, 1934), pp. 20–1.

[6] Wilhelm Miller, "The Prairie Spirit," pp. 2–3

[7] Jensen, *Siftings*, p. 19.

which was to be found in the creative work of some of his Chicago artist-friends in other fields: Louis Sullivan and Frank Lloyd Wright in the field of architecture; Carl Sandburg, Edgar Lee Masters, and Vachel Lindsay in poetry; and Lorado Taft in sculpturing.[8]

Speaking of Jensen's creations—both in private and public gardening projects—Leonard Eaton, professor of architecture at the University of Michigan, appraises Jensen as—

> perhaps America's greatest landscape architect. In addition to being a superb artist in his own field, Jensen was native in Chicago at a time when the artists of that city were in an extremely active phase and his career shows a remarkable interaction between the arts of architecture and landscape design. . . . Jensen was a major American artist, one of the most distinguished this country has produced. His design concepts were as original and daring as anything developed by the Chicago School in architecture and with that school he had an intimate connection. Perhaps the central trend of the movement was the belief that the region had a cultural identity distinct from that of the rest of the nation. . . . The achievement of Jens Jensen must, then, be understood in relation to the work of his contemporaries. In his best moments none of them surpassed him.[9]

Believing that "form must follow function" and that "happiness and full self-expression can only be found by spreading one's roots in the soil,"[10] Jensen sought means by which the city-dweller could be emancipated from the urban bee-hive for at least short moments of respite—by furnishing him with natural woodland retreats in the heart of the great city or on the outskirts of that great city.[11]

For Jensen's civic service did not stop with the West Chicago Park system. Loving the wide open prairie stretches with their native vegetation, Jensen noted the burgeoning out of Chicago in three directions and realized, foresightedly, that this native landscape would soon be swallowed up by city real estate developments unless steps were taken to preserve it. So, while still serving as the superintendent of the Chicago West Park system, he spent many Sundays surveying the areas along the Des Plaines, Sac and Calumet rivers, with the happy result that he soon forcefully advocated

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[8] Eaton, pp. 145–50; Fulkerson, letter to author, p. 1; "Upbuilders of Chicago," *Chicago Magazine,* 2:601 (September 1911); *Madison Capital Times,* October 1, 1951, p. 3.

[9] Eaton, p. 150.

[10] *Milwaukee Journal,* October 1, 1951, p. 1.

[11] Jens Jensen, *Greater West Park System* (Chicago, 1919), pp. 13–4, 20, 38–9; Jensen, *Siftings,* pp. 80–88; 120–1; Clifford Butcher, "Jens Jensen Renews War on City," *Milwaukee Journal,* June 9, 1935. Note, too, Mertha Fulkerson's quotation of Jensen's comment in her *Peninsula* article (June 1958), p. 8: "Mass education, mass production and mass thinking is levelling the world into a monotonous sameness and totalitarianism is the result. Now we are in a struggle to prove whether the individual is of any consequence or not. At such times the little violet along the trail can lead the way to sound reasoning and proper respect for individual effort. Lessons in the soil give the key to wholesome growth."

setting aside certain wooded areas—later to be known as the Forest Preserves of Cook County. To bring these Forest Preserves into being necessitated strong political action, but the genial Danish-American was skillful in finding backing among Chicago's wealthy residents as well as its average citizenry. Although it took both city and county action and the passage of an entirely new law to enable the county to hold land for the purposes Jensen recommended, eventually Cook County was empowered to purchase all the lands Jensen had advocated.[12] Even a casual glance at a map of the Greater Chicago area today will show just how wide-reaching and numerous are these county tracts—peaceful sanctuaries where today's citizenry may find retreat reminiscent of the land our Midwest pioneers remembered. According to one noted Midwest architect and city planner, these Preserves are unique in being "still the largest wilderness area contiguous in any major American city."[13]

But Jensen's civic-mindedness extended beyond the boundaries of Greater Chicago and Cook County. When that conservation-minded organization, Friends of Our Native Landscape, was formed in 1913, Jensen was its leading spirit and served as its first president—continuing in that office for over twenty years. During the first decade of its existence, the organization chose for its special project concerted action to save certain portions of natural beauty in Illinois for state parks. Their recommendations were published in a brochure entitled *Proposed Park Areas In The State of Illinois,* with Jensen serving as editor and chairman of the publication, as well as chief instigator to action. As he argued in the foreword:

> Practically all the lands mentioned in this report are of little or no agricultural value. They bring to us more of the spiritual side than the material. They represent Illinois as the white man found it—a different world from the man-made one. . . . They offer refuge for native wild life and a place of escape for a while at least from the grind and care of daily life.[14]

So today, largely because Jensen and his colleagues worked diligently through different community groups for their preservation, Illinois boasts such state parks as the Savanna Headlands of the

[12] The legislation concerning the formation of Cook County Forest Preserves was quite involved. Sources that clarify the matter are the following: Cook County Outer Belt Park Commission, *Forest Preserves* (Chicago, 1905), pp. 3–31; John B. Morrill, "Forest Preserve District of Cook County, Illinois," *Landscape Architecture,* 38:139–44 (July 1948); Daniel Burnham, *Planning the Region of Chicago* (Chicago, 1956), pp. 134–57; Harvey M. Karlin, *Governments of Chicago* (Chicago, 1958), pp. 271–83; John C. Bollens, *Special District Governments in the United States* (Berkeley, University of California, 1958), pp. 132–8; Leonard Eaton, p. 146; and Mertha Fulkerson, Letter to author, p. 2.

[13] Eaton, p. 164. (Present acreage is 52,000 acres, according to recent article in the *Christian Science Monitor,* May 4, 1964, II:2.)

[14] Friends of Our Native Landscape, *Proposeed Park Areas in the State of Illinois,* (Chicago, 1921), foreword by Jensen, chairman and editor.

Mississippi, Starved Rock State Park, the Apple River Canyon, and Ogle County White Pine Forest—the only native white pine forest in the state.[15] Of the twenty tracts recommended for preservation, only two failed to materialize. Of those which *did* become actualities, dearest probably to Jensen's heart was that inter-state section between Illinois and Iowa, encompassing the Mississippi Palisades and known as the Savanna Headlands. Jensen himself wrote the sections of the report advocating their salvation, noting—

> On these ancient cliffs of pre-historic time botanical and geological science, together with the early history of Illinois, vie with each other in importance of interest. The deep ravines are filled with forests of ferns and the crags and talus formations are full of interesting plants not found in the adjacent prairie country. . . .
>
> The views from the Palisades up and down the Mississippi are both dramatic and inspiring. It is here that we of Mid-America may feel the greatness of the praire country to the fullest. . .
>
> It is well to consider the significance of our heritage of river and stream and prairie. . . . I have often thought what it would mean if every boy and girl, and the grownups as well from farm and city, would come to these bluffs to get a greater outlook of the world. If only once a year they could sit down on the edge of a steep cliff and watch the currents flow by. . . . In this way our Mid-American rivers become the highway of our thoughts.[16]

That people can now experience this quiet pleasure from the Mississippi Palisades is largely due to the efforts of Jensen and his colleagues.

And the same civic-minded zeal which brought into being these eighteen Illinois State Parks—just as it had earlier instigated the West Chicago parkways and the Cook County Forest Preserves—aided also the neighboring state of Indiana: For it was Jensen who took a committee of Indiana officials (including the director of the Indiana State Parks, the governor of the state, and several state legislators) to the Dunes area, spurred them to climb one of the highest dunes, and pointed out from its top the area which should be included in an Indiana Dunes State Park. As Miss Mertha Fulkerson, Jensen's secretary for many years, notes—

> The importance of the Indiana Dunes to Jens Jensen was that here was the meeting ground of plants from as far north as Hudson Bay and as far south as the swamps of Florida. . . . Jensen's hope was to make this a natural textbook for the scientist . . . the botanist, the naturalist and the ecologist.[17]

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[15] Letters from Jensen to E. J. Parker, written March 24, 1911 and March 25, 1911, proposing plan for legislative action. (On file at Chicago Historical Society Library)

[16] Jensen, "Savanna Headlands" and "Preservation of Our River Courses and Their Natural Setting," in Friends of our Native Landscape, *Proposed Park Areas*, n. p.

[17] Mertha Fulkerson, Letter to author, April 12, 1964, p. 2.

Although Jensen recommended purchase of all land from Chesterton, Indiana, to Fremont—some 3,000 acres for the Dunes area—and although the governor and State Director of Parks were in agreement, some of the legislators favored a smaller purchase. As a result, Indiana today has a Dunes park of some 700 acres, when she might so easily have had more.

During the latter part of Jensen's life—in fact, after his sixtieth year—when the political machinery of Big Bill Thompson altered the Chicago scene, Jensen ended his long career as landscape designer for the city's park system and entered private practice entirely—planning the estates of such wealthy Midwesterners as Ogden Armour, Julius Rosenwald, Henry and Edsel Ford. But these private estates, like his public parks, bore evidence, too, of his original philosophy of landscape architecture. Always he studied the terrain, the plants native to the area, and his patron, and then sought to bring about a happy compatability of spirit of the three: For one person of nervous, high-strung temperament, who lived a life of tension in his work, Jensen planned a quiet retreat, with an open expanse facing the Western sunset, where the very landscape would suggest peace. For another patron, whose house was built in the horizontal planes of the Japanese influence, Jensen used native crab-apple as a compatible planning to carry out the horizontal lines.[18]

Then, after some years of landscaping for private individuals, Jensen established residence in Door County, Wisconsin—becoming, as usual, one of its most public-spirited citizens during the last sixteen years of his life. On a 120-acre plot of naturally timbered landscape, he built from native stone, and utilizing the crafts of native workmen, that unique, informal cultural center known as "The Clearing"—so titling it because he felt that "one must have a clearing to appreciate the forest."[19] Patterned somewhat after the Scandinavian folk schools, The Clearing was conceived to draw together craftsmen and creative artists of kindred outlook and inspiration—the landscape architect, the painter, the dancer, the artisan in wood, metal and stone. Since Jensen's death in 1951, Miss Mertha Fulkerson, his former secretary, and the Wisconsin Farm Bureau have continued the spirit of The Clearing with their summer cultural offerings which vary weekly: native geology, regional ecology, courses in modern drama and art, poetry, philosophy, and similar selections. In the beginning years, The Clearing also frequently served, during winter, as a craft-center for year-around residents of Door County—who took weaving, wood-carving, or

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[18] Jensen, *Siftings,* pp. 67–9 and Eaton, *op. cit.,* p. 149.

[19] *Milwaukee Journal,* October 1, 1951, p. 1.

homecrafts; for both Jensen and Miss Fulkerson believed strongly in community service.[20]

Although The Clearing was Jensen's chief interest during these latter years of his life, the genial Dane also found time for his usual civic contributions: He served on the Door County Park Board for five years, and it is largely because of his foresight that community park tracts were bought at Door Bluff, Ellison Bay Bluff and Sugar Creek, as well as additional land at Cave Point. In fact, Door County pioneered in the United States in the forming of township parks.[21] The Ellison Bay School also reflects his philosophy of a "school in a park setting", for the village bought land adjoining the school and Jensen also gave them a plot of white pine woodland, so today Ellison Bay school children may spread out in a woodland setting for their recess activities, or hold outdoor classes around their Council Ring in the spring and the fall.[22] During these latter years, too, Jensen was one of the active promulgators—together with Albert Fuller, Emma Toft, and others—for the creation of The Ridges Sanctuary, near Bailey's Harbor, where rare swamp plants may be found in the wetlands formed by the retreating beaches of Lake Michigan. Here shy orchids, maiden hair fern, and a variety of swamp vegetation, have been preserved in their native habitat from the ruthless fingers of mankind.

Although Jensen is probably best known for his civic activities, yet it must not be forgotten that underlying his public service, and guiding the direction which it took, was Jensen's *philosophy* of the land. Loving the prairies, he found in them not only the motif for his own landscaping but also his deep-rooted belief in conservation. He felt there was something so precious in the native landscape, he wanted to save it for posterity. As Mertha Fulkerson summarizes his philosophy:

> There was great thought given to tenderness expressed in a field of our native flowers, to strength expressed in mighty oaks, to humility expressed in violets, to peace expressed in the long shadows coming over the land from surrounding woodlands at the end of the day, of the daringness of pine and cedar clinging on the edge of a rocky cliff facing the elements. These were the motives of his work.[23]

Indeed, one might say that Jensen's public-service endeavors, such as the formation of the Cook County Forest Preserves and the State Parks of Illinois, are merely outward manifestations of that

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[20] Mary Ellen Gothberg, "The Clearing—from Vision, a Reality," *The Peninsula* (June 1958), pp. 11–12; Jensen, *Siftings,* p. 30; Clifford Butcher, *op. cit.,* p. 8; *Madison Capital Times,* October 1, 1951, pp. 1 and 3.

[21] Author's conversation with Mertha Fulkerson at The Clearing, April 25, 1964.

[22] For Jensen's theory of school settings, see "Neighborhood Centers," pp. 45–51 in his *Greater West Park System* and pp. 84–5 of his *Siftings.*

[23] Mertha Fulkerson, Letter to author, April 12, 1964, p. 2.

inner philosophy which drove him for most of his ninety-one years: his belief that the native spots of greenery must be cherished and preserved for refreshment of man's soul.

True, national acclaim came to Jensen for his public-spirited efforts: the Massachusetts and Minnesota Horticultural Societies gave him citations for his distinguished work in landscaping; the University of Wisconsin conferred on him an honorary degree in 1937; he was sought as a consultant in the formation of the Racine park system here in the Midwest and the Alleghany park system in the East; and he is accredited with saving Riverside Park in New York City at a time when commercial interests sought to destroy it. Theodore Roosevelt also called on Jensen's talents in helping to form the first national conservation program.[24]

Yet, in pre-occupation with Jensen's long career of public service, one must not slight his philosophy as a landscape artist. For, in the final analysis, the genial Dane was a singular blend of the artist-philosopher *and* the public-spirited citizen. And it was the artist-philosopher who guided the public-spirited citizen into the creation of those natural retreats of living greenery in Illinois, Wisconsin, Indiana, and other states of the Union. In a world where such green retreats are growing increasingly difficult to find, today's Americans owe much to Jens Jensen.

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[24] Mertha Fulkerson, "Jens Jensen, Friend of Our Native Landscape," pp. 9–10; *Milwaukee Journal,* June 20, 1937, p. 3; *Milwaukee Journal,* October 1, 1951, pp. 1 and 2; *Madison Capital Times,* October 1, 1951, pp. 1 and 3.

THE FISHES OF PEWAUKEE LAKE

*George C. Becker**

Pewaukee Lake, only 18 miles west of the city of Milwaukee, is a fisherman's Mecca. It has always produced large catches of panfish, and fishing for game species is excellent. Its importance from a recreational standpoint is obvious when we consider that a large metropolitan city and its suburbs almost reach to the Pewaukee city limits.

During 1960 and 1961 we collected at 11 stations, capturing a total of 29 species (Figs. 1 & 2). Recent literature and other records disclosed additional species, bringing the total of known species to 35. The 1960–61 survey was made by shoreline seining, using a 4′ x 20′ minnow seine with ¼″ square mesh. Approximately 100 yards of shoreline were seined at each station at depths up to three feet.

Acknowledgments are made to my sons, Kenneth and Dale, who assisted in the field; to Dr. Reeve M. Bailey, curator of fishes at the University of Michigan Museums who verified the identification of *Notropis anogenus;* to Elmer Hermann and Clifford Brynildson of the Wisconsin Conservation Department who supplied me with information from their files; and to Brynildson, Gordon Priegel, and Vern Hacker, all of the Wisconsin Conservation Department, who critically read the manuscript and proferred helpful suggestions.

Pewaukee Lake lies entirely within the county of Waukesha. It is 4.5 miles long, 1.2 miles in width and 2,502 acres in area. The basin of the lake is a pre-glacial erosion valley through which the Lake Michigan glacier moved toward the west. The valley was blocked at its west end by the stratified drift associated with the Kettle Moraine.

The western half of the north shore rises to a height of approximately 130 feet above the lake level but this is not reached for nearly a half mile from the lake. The south shore rises to a height of about 100 feet, but this slope is quite gradual. Much of the east-

* The author of this article is Professor of Biology, Wisconsin State University, Stevens Point, Wisconsin.

Figure 1
Sampling Stations

ern shore is low or swampy and the same is true of a small portion of the west end (McCutchin, 1946). The lake is divided into two parts. The western half has a known maximum depth of 45 feet, the eastern half has a maximum depth of 10 feet but most of it is considerably shallower. Much of the eastern end of the lake becomes choked during late summer with submergent and emergent aquatics which render boat passage difficult.

The eastern half of the lake owes its existence to the dam at the city of Pewaukee which holds a head of water of approximately six feet. Before this dam was installed this part of the lake was a swamp (Fenneman, 1902). Three small spring-fed streams, two on the south and one on the north shore (Fig. 1) flow into the lake. A number of springs discharge into the lake, chiefly along the north shore. The outlet, Pewaukee Creek, leaves the lake on the far eastern end and flows into the Fox River. The latter, flowing in a southwesterly direction, joins with the Illinois River which in turn flows into the Mississippi River. The bottom of the lake is mostly overlain with mud, although exposed sand was found at station 3 and sand and gravel at stations 8 and 9. On small areas alongside most piers, shoreline owners had deposited sand over the mud to improve the water for bathing.

FIGURE 2. FISH SPECIES TAKEN FROM PEWAUKEE LAKE BY SHORELINE SEINING

(George Becker)

Station Number	1	2	3	4	5	6	7	8	9	10	11	TOTAL	%
Date		9/9/61			8/5/60			8/3/60		9/10/61			
Longnose gar						1	1	1	1			4	0.1
White sucker								1				1	—
Lake chubsucker							1	1				2	—
Carp		1	10								2	13	0.2
Golden shiner					4		6	1				11	0.2
Bluntnose minnow	156	66	165	73	68	9	66	163	53	496	126	1441	21.9
Spottail shiner				22	1	3		12	1			39	0.6
Common shiner								7	1			8	0.1
Blackchin shiner			34			6	2					42	0.6
Pugnose shiner								2				2	—
Emerald shiner				4	3		2	2	2	1		14	0.2
Blacknose shiner			3			1	34					38	0.6
Bigmouth shiner							1					1	—
Yellow bullhead			1							1		2	—
Tadpole madtom			1							1		2	—
Northern pike								1				1	—
Grass pickerel		1										1	—
Banded killifish			53			4						57	0.9
Yellow perch	87	82	55	439	36	234	278	217	182	65	30	1705	26.0
Walleye							3					3	—
Central Johnny darter	1		8	21	9	9	+	2	2	3	8	63+	1.0
Largemouth bass	21	8	25	5	2	12	3	4	2	30	27	139	2.1
Black crappie	1		1	25	32	105	349	16	4	2		535	8.2
Pumpkinseed	7	3	40	29	14	16	6	15	4	21	4	159	2.4
Bluegill	141	119	203	16	184	159	12	169	34	102	94	1233	18.8
Rock bass								2				2	—
Green sunfish		2								2		4	0.1
Freshwater drum						1						1	—
Brook silverside	1		49	101	73	532		80	142	57	13	1048	16.0
Total	415	282	648	735	426	1092	764+	696	428	781	304	6571+	100
No. of Species	8	8	14	10	11	14	15	18	12	12	8	29	

Fish Species and Their Distribution

After the scientific name for each species I have indicated the station(s) on the lake where the species was collected (e.g., Pewaukee 6, 7, 8, 9 for the longnose gar).

1. Longnose gar—*Lepisosteus osseus* (Linnaeus). Pewaukee 6, 7, 8, 9. Pewaukee Lake apparently affords excellent conditions for this species. The four specimens which I took from four different stations were all young-of-the-year. The muddy bottom and densely rooted vegetation in extensive shallow bays is prime habitat. An item in the Wisconsin Conservation Bulletin of November, 1937, states:

> Ten thousand pounds of garfish were taken in a single haul by a state rough fish removal crew operating on Pewaukee Lake. One of the fish measured four feet, eight inches.

2. Bowfin—*Amia calva* Linnaeus. Greene (1935) examined the bowfin from this lake. Fishermen report taking it yearly from the western end of the lake.

3. White sucker—*Catostomus commersoni* (Lacépède). Pewaukee 8. We took one specimen, 99 mm. total length.

4. Lake chubsucker—*Erimyzon sucetta* (Lacépède). Pewaukee 7, 8. McCutchin (1946) recorded the following data on three specimens from Pewaukee Lake:

Age	No. of Fish	Tot. Length	Weight	Ave. Cond. Factor
III	1	208 mm.	124 gm.	1.38
IV	2	211 mm.	141 gm.	1.57

At station 8 on Pewaukee Lake I took a young-of-the-year, 34 mm. in total length and weighing 0.44 gm. On the same date at station 7 I captured a chubsucker 223 mm. in total length which weighed 169.6 gm. Greene (1935) also reported this species from Pewaukee Lake.

5. Carp—*Cyprinus carpio* Linnaeus. Pewaukee 3, 4, 11. When McCutchin made his survey in 1946 he failed to capture this species. Now the natives report that during the spring many carp spawn on the extreme western end of the lake. The 13 fish which I captured by shoreline seining comprised only 0.2% of the total number of fish taken.

6. Central stoneroller—*Campostoma anomalum pullum* (Agassiz). McCutchin (1946) listed this species as rare in Pewaukee Lake.

7. Golden shiner—*Notemigonus crysoleucas* (Mitchill). Pewaukee 5, 7, 8. This shiner is probably more common in the lake than the records indicate. McCutchin (1946) took a single individual in a fyke net. Greene (1935) captured the golden shiner from the eastern end of the lake.

8. Bluntnose minnow—*Pimephales notatus* (Rafinesque). Pewaukee 1 through 11. This species is, next to the yellow perch, the most common fish found in Pewaukee Lake, where it made up 21.9% of the total catch. The many items of rock, metal and wood which are thrown into this heavily used lake apparently furnish surfaces for egg attachment. McCutchin (1946) reported this minnow as abundant in Pewaukee Lake.

9. Spottail shiner—*Notropis hudsonius* (Clinton) Pewaukee 4, 5, 6, 8, 9. The spottail appears to be generally dispersed in the western half of the lake.

10. Common shiner—*Notropis cornutus* (Mitchill) Pewaukee 8, 9. McCutchin (1946) reported this minnow as abundant in 1946. The present survey finds this minnow uncommon.

11. Blackchin shiner—*Notropis heterodon* (Cope). Pewaukee 3, 6, 7. The blackchin was found travelling in schools at station 3. The bottom there was solid but overlain with a fine silt, and the water was clear. By contrast, the stations on the west end of the lake from which this species was captured had a bottom of mud overlain with fine organic debris; the water was highly turbid. Greene (1935) also reported this species.

12. Pugnose shiner—*Notropis anogenus* Forbes. Pewaukee 8. Two individuals were captured on August 3, 1960. This is the first report of this species from Pewaukee Lake, and, to my knowledge, the first time that it has been reported anywhere in the state since Greene (1935) made his survey from 1925 to 1928. The gradual disappearance of this rare minnow from its rather restricted range has been reported by Bailey (1959) and Becker (1961). In Pewaukee Lake this species is undoubtedly limited in numbers and range. It was captured from clear water over a bottom grading from heavy wave-washed, vegetation-free gravel to dense submergent aquatic plants over a bottom overlain with mud. Hubbs and Lagler (1958) state that this species occurs "scatteringly in clear and very weedy lakes."

The following data were taken from the specimens:

	Specimen 1	Specimen 2
Total length	52 mm.	53 mm.
Standard length	42 mm.	42 mm.
Weight	1.27 gm.	1.50 gm.
Peritoneum	black	black
Lateral line scales	38	37
Dorsal fin rays	8	9
Pelvic fin rays	8	8
Pectoral fin rays	13	12
Anal fin rays	10	8
Mouth width	1.9 mm.	2.0 mm.
Mouth length*	1.4 mm.	1.8 mm.
Head width	5.6 mm.	6.0 mm.
Head length	9.8 mm.	11.2 mm.
Snout length	2.0 mm.	2.2 mm.
Postorbital length	4.7 mm.	4.9 mm.

*Distance along sagittal line from medial anterior edge of mouth to a line connecting corners of mouth.

Unusual are the 10 anal rays in Specimen 1. According to Trautman (1957), the usual number is 8 (frequently 7). The 38 scales in the lateral line of the same fish also departs from the expected range of 34 to 37.

13. Emerald shiner—*Notropis atherinoides* Rafinesque. Pewaukee 4, 5, 7, 8, 9, 10. Distribution appears to be general in Pewaukee Lake but it is nowhere abundant.

14. Bigmouth shiner—*Notropis dorsalis* (Agassiz). Pewaukee 7. The single specimen was taken over a muddy, heavily-silted bottom. This contrasts with the sandy bottom in streams over which it is normally found.

15. Blacknose shiner—*Notropis heterolepis* (Eigenmann and Eigenmann). Pewaukee 3, 6, 7. I have encountered this minnow under many conditions but most frequently over mud or silt-covered bottoms in lakes and slow-moving streams. In 1946 McCutchin reported it as abundant. This species, I find, fluctuates greatly in number from year to year in a given body of water. In Eske Lake (Portage Co., Wis.) during 1959 this minnow was seen by the thousands along the southeast shore of the lake and hundreds were easily captured with a square-yard dip net. The following year the lake was visited frequently and none were seen in the same area, but a few were captured in the small creek draining the lake.

16. Black bullhead—*Ictalurus melas* (Rafinesque). Greene (1935) reported this species from the east end of the lake. McCutchin (1946) listed "bullhead" from Pewaukee Lake but made no distinction between the species in this genus.

17. Yellow bullhead—*Ictalurus natalis* (LeSueur). Pewaukee 3, 10. Greene (1935) reported this species from Pewaukee Lake.

18. Tadpole madtom—*Noturus gyrinus* (Mitchill). Pewaukee 3, 10. Greene (1935) captured this species from the east end of Pewaukee Lake and it was here also that I took two specimens during the 1960–61 survey. I consider it rare in the lake.

19. Grass pickerel—*Esox americanus vermiculatus* LeSueur. Pewaukee 2. Greene (1935) captured this species from the east end of Pewaukee Lake. My specimen was 87 mm. total length.

20. Muskellunge—*Esox masquinongy* Mitchill. Muskellunge were planted in Pewaukee Lake during 1937, 1939, and 1940 (McCutchin, 1946). From these original plantings occasional catches are still reported. In 1944 an 18½ pound fish was reported caught (Sprecher, 1945). On October 9, 1958, an alleged muskellunge, weighing 14 pounds 10 ounces and measuring 39 inches in total length was taken from the east end of the lake by Mrs. W. F. Boyd of the city of Pewaukee (pers. comm.). I examined a photograph of this fish; however, it was impossible to make a firm identification from it. On the other hand Mrs. Boyd's careful description of the scalation on the cheeks and opercula lead me to believe that the record is authentic.

21. Northern pike—*Esox lucius* Linnaeus. Pewaukee 8. McCutchin (1946) captured the northern pike at all the stations where he placed fyke nets and the 12 fish so caught constituted 2.4% of the total catch. This species appears to have a general distribution in the lake. Many northerns, five to ten pounds in weight, are taken yearly by fishermen.

22. Banded killifish—*Fundulus diaphanus* (LeSueur). Pewaukee 3, 6. Often found in large and widely roaming schools, this topminnow has probably a more general distribution in the lake than is indicated by the survey.

23. White bass—*Roccus chrysops* (Rafinesque). Greene (1935) reported a record from Pewaukee Lake. I have personally inspected this species in a fisherman's catch from Pewaukee Lake in September, 1961. McCutchin (1946) reported a dense population in the west end of Pewaukee Lake. In fyke nets he captured specimens from 11½″ to nearly 13½″, weighing up to a pound and a quarter. Twelve thousand fingerlings were planted in Pewaukee in 1943. There is no subsequent record of stocking.

24. Yellow perch—*Perca flavescens* (Mitchill). Pewaukee 1 through 11. The perch is probably the most abundant panfish in Pewaukee Lake. McCutchin (1946) reported a dense population.

Some fishermen, upon removing the spinous dorsal fin, use it as live bait for the northern pike.

25. Walleye—*Stizostedion vitreum vitreum* (Mitchill). Pewaukee 7. Greene (1935) recorded a report from Pewaukee Lake. McCutchin (1946) fyke-netted ten individuals, three to seven years of age and from 14 to 23 inches in total length. The largest fish weighed four pounds and five ounces. He found that these walleyes were well above the average length-weight and length-age ratio for Wisconsin walleyes. Millions of walleye fry and thousands of fingerlings were planted in Pewaukee Lake between 1937 and 1956. Large specimens of seven to nine pounds are occasionally caught by fishermen in the vicinity of stations 8 and 9.

26. Central Johnny darter—*Etheostoma nigrum nigrum* (Rafinesque). Pewaukee 1, 3 through 11. The general distribution of this species in Pewaukee Lake is due to man's efforts to create suitable swimming areas. In 1946 McCutchin reported this species as rare. Today it is common. Small patches of gravelled areas, representing many hundreds of tons of gravel, are found in connection with most piers in the lake. Since only small gravelled areas are needed by this species, it does very well in such artificially created habitats.

27. Smallmouth bass—*Micropterus dolomieui* Lacépède. Greene (1935) listed a report from Pewaukee Lake. In 1937 seventy adult smallmouth were stocked in the lake. According to an item in The Milwaukee Journal of February 25, 1956, a six pound 12-ounce smallmouth bass was taken from Pewaukee Lake the previous year.

28. Largemouth bass—*Micropterus salmoides* (Lacépède). Pewaukee 1 through 11. The largemouth bass is commonly found in Pewaukee Lake and is among the leading game fish caught. Many of the fish I captured were fingerlings, indicating good reproduction. McCutchin (1946) reports the largemouth as common in the lake. The large weed-filled areas along the shoreline afford favorite habitat for this species. The largemouth was last stocked in 1953.

29. Green sunfish—*Lepomis cyanellus* Rafinesque. Pewaukee 2, 10. McCutchin (1946) reported this species as rare in the lake.

30. Bluegill—*Lepomis macrochirus* Rafinesque. Pewaukee 1 through 11. This species was stocked in these waters through 1946. In the same year McCutchin reported it as abundant. A large share of the fisherman's yearly bag consists of the bluegill.

31. Pumpkinseed—*Lepomis gibbosus* (Linnaeus). Pewaukee 1 through 11. This species has general distribution in the lake and is common.

32. Rock bass—*Ambloplites rupestris* (Rafinesque). Pewaukee 8. Greene (1935) listed a report from Pewaukee Lake. McCutchin (1946) captured seven individuals in the western half of Pewaukee Lake. Continued eutrophication of this lake will probably keep this species at extremely low levels.

33. Black crappie—*Pomoxis nigromaculatus* (LeSueur). Pewaukee 1, 3 through 10. McCutchin (1946) listed this species as common. I have found it to be abundant and fishermen make excellent catches.

34. Brook silverside—*Labidesthes sicculus* (Cope). Pewaukee 1, 3, 4, 5, 6, 8, 9, 10, 11. I consider the brook silverside one of the most abundant species in the lake. It comprised 16% of the total catch by number. Numerous tight schools of several hundred young-of-the-year were swimming within a few feet of the shore and hundreds would swim or drop through the mesh of the seine before they could be counted. It was not unusual to surround two or three schools in a single haul.

35. Freshwater drum—*Aplodinotus grunniens* Rafinesque. Pewaukee 6. At present this species is no problem in Pewaukee Lake. Occasionally an individual is taken on hook and line.

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THE FISHES OF LAKES POYGAN AND WINNEBAGO

*George C. Becker**

Wisconsin's larger lakes have always been strongly patronized by fishermen because of their varied fish life. Two lakes which have been fished heavily are Lakes Poygan and Winnebago. The fish life is so varied in these waters that much confusion results as to what is caught. Although no key for identification is included, the present study attempts to assess what these waters hold. Considered together, these lakes have now (or have had in the recent past) at least 71 species of fish.

I undertook the survey of the fishes of these lakes in the fall of 1959 and continued during the summers of 1960 through 1963. Not only did my study show a rich variety of fish, it also indicated changes in fish distribution which had taken place since C. Willard Greene (1935) made his report based on the 1925–1928 survey of Wisconsin lakes and streams. During the intervening three decades, fish have moved into new areas of the state via natural or man-made waterways. They have crossed from one watershed to another, from one drainage basin to another. Sometimes man intentionally effected this movement by transferring these fish in minnow bucket or tank; some species have managed this on their own. I have tried, wherever possible, to point out these changes in the text which follows.

Assisting me in the field were my sons Kenneth and Dale, who performed their tasks gratis. Had it been otherwise, the survey would never have been made. I therefore gratefully acknowledge their help. Also I am indebted to the following for their advice, open files and assistance: Vern Hacker, Gordon Priegel, John Keppler, Thomas Wirth, all of the Wisconsin Conservation Department. I wish to thank Vern Hacker, Gordon Priegel, and Thomas Wirth for their critical reading of the manuscript and their helpful suggestions. I assume full responsibility for any errors that remain or inferences which will not stand up under the test of time.

Lakes Poygan and Winnebago lie in the Great Lakes drainage basin and drain into the Green Bay waters of Lake Michigan. Both are eutrophic lakes which in late summer present a problem to

* Mr. Becker is Professor of Biology, Wisconsin State University, Stevens Point, Wisconsin.

shoreline owners. Growths of algae and rooted aquatics make many shallows, especially in protected bays, undesirable for bathing and fishing. In late summer, for instance, the public beach at Fond du Lac on Lake Winnebago is frequently closed because of algal contamination, and in Lake Poygan large areas of dense aquatics make boating difficult, if not impossible.

Located in the counties of Waushara and Winnebago in eastcentral Wisconsin, Lake Poygan (Fig. 1), covering 10,992 acres (Wis. Cons. Dept., 1958), is formed by a widening of the Wolf River which drains the northeastern quarter of the state. Two other streams of medium size, Pine River and Willow Creek, flow into the west end of the lake. Poygan, the second largest natural lake in the State of Wisconsin, is 7.8 miles long and approximately 3.4 miles wide. Much of the north shore between the west end of Boom Bay and Bergner's Point is a shallow swamp thickly grown with emergent vegetation which makes this area unusable for bathing but important as a waterfowl area. This swamp, included as lake proper, extends well out into the lake. During the summer of 1961 wild rice *(Zizania aquatica)* appeared as a dominant plant in the shallower waters around the entire lake. Islands of *Scirpus* sp. were seen near all shores of the lake. The lake has a maximum depth of 12 feet but most of the lake is less than 10 feet deep. The bottom is mostly firm sand; however, the bottom of the west shore and parts of the north are overlain with a thick layer of mud. A small amount of rubble is found along the southwest shoreline.

Lake Winnebago, located in the counties of Winnebago, Calumet and Fond du Lac in eastcentral Wisconsin, is the largest inland lake in the state. It is 28.5 miles long at its longest point, 10.5 miles wide at its widest point and covers 137,708 acres. Its maximum depth is 21 feet. A natural dam of glacial drift at the north end of the lake holds the water in the basin. Its water supply which pours into the lake at the city of Oshkosh comes primarily from the Wolf and upper Fox rivers. Lake Winnebago is approximately 17 miles downstream from Poygan and drains to the north through the lower Fox River into Green Bay of Lake Michigan.

The western shores of Lake Winnebago are low, and on the southern end near Fond du Lac they are marshy. The high cliffs of the Niagara escarpment arise from the eastern shores. These cliffs are not due to wave work but to preglacial and glacial erosion of resistant limestone underlain by weak shale (Martin, 1916). The bottom along the east shore is mostly heavy gravel, rubble and boulders. Due to wave action, very little submergent vegetation is found here and practically no emergent vegetation. At Waverly Beach on the far north end of the lake the bottom consists of a

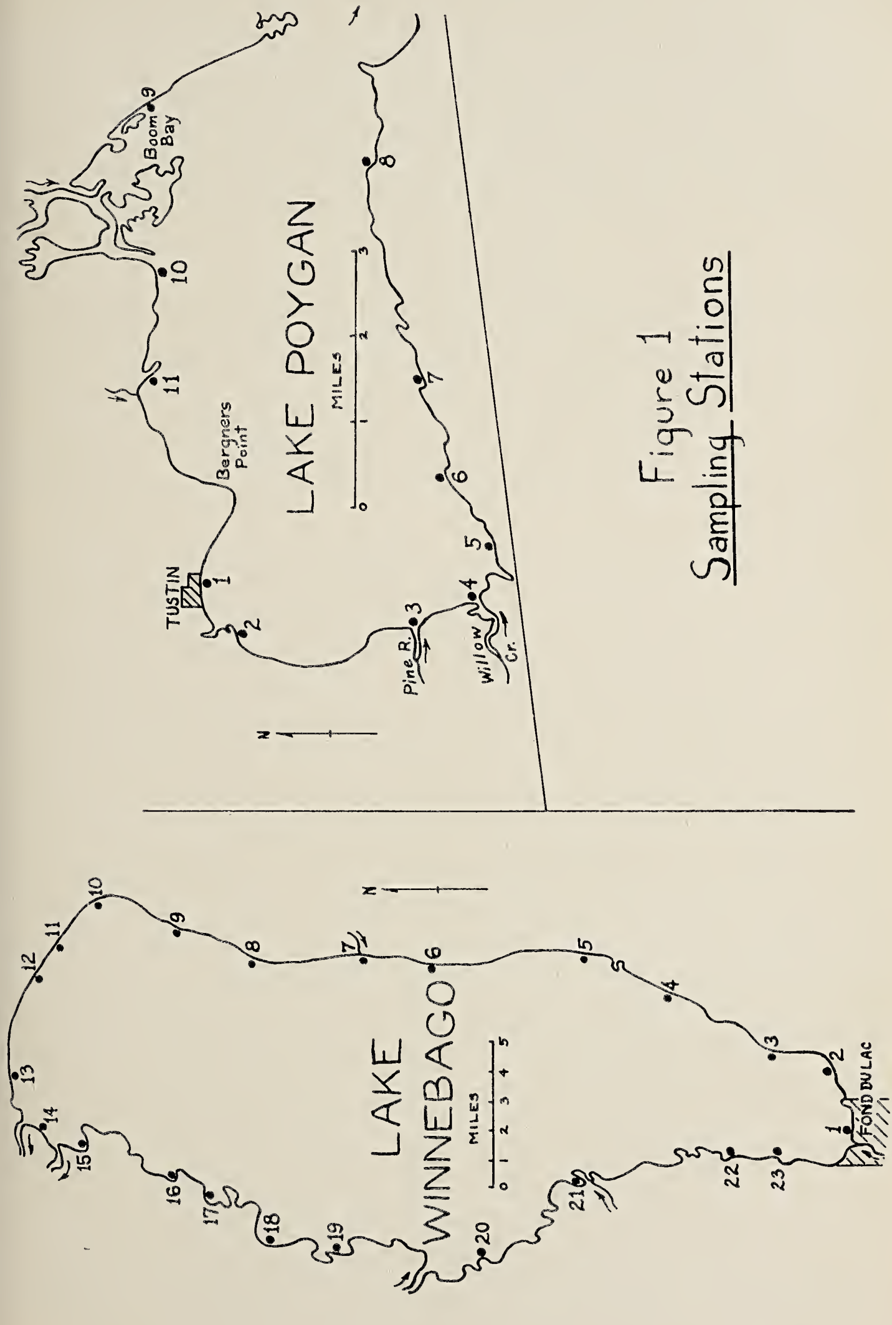

Figure 1
Sampling Stations

series of sandy ridges. The bays on the west side of the lake have bottoms with mud from a few inches to a foot in depth. Where the water is sheltered from wind and wave actions, dense beds of submergent vegetation appear in late summer. On calm days during August, shallow and pelagic waters are covered with a heavy scum of blue-green algae. Occasional points of land jutting out into the lake have their bottoms swept clear of mud and debris. Here the shore bottom is generally a firm sand, gravel and/or rubble.

Origin of Data

The best authority for the record of a species is an actual specimen (e.g., the fish listed in Figs. 2 and 4). Where the specimen is lacking, I have relied primarily upon the reports of trained biologists (e.g., Figs. 3 and 5). Next, some species are listed on the authority of commercial fishermen. Lastly a few species are listed on the basis of newspaper accounts and the word of fishermen. I have included such species and records only when I felt reasonably sure of their accuracy.

Fig. 1 gives the stations where I sampled for fish. In Figs. 2 and 4, I have summarized my samplings in Lakes Poygan and Winnebago. At all stations I used a 20′ by 4′ seine with ¼″ mesh. The length of shoreline which was seined at each station varied from 100 to 200 yards. As many habitats as possible were sampled at a station. These included open water, weed beds, and various bottom types. Although hauls were made mostly along the shoreline in water two feet or less in depth, at each station a few hauls were made in waters up to three-and-one-half feet in depth. On Lake Poygan, for instance, we sampled around and through beds of *Scirpus* sp. which were, in some cases, several hundred feet from shore. We used here an unorthodox and only partially effective seining system which we called the "circle net lift". In short, after hauling the seine through a sampling area, the two ends of the seine were brought together and then a single operator, grasping both seine sticks, would quickly back away from the net, pulling the seine sticks along until the right and left halves of the lead-line and the float-line were almost touching one another. Then, reaching under water, he would gather the doubled-up lead-line to himself quickly, following this up by gathering in the doubled-up float-line. The net would then be placed into a tub for releasing or preserving whatever fish still remained in the bag. The circle net lift was used primarily with the standard seine. Superior to it is an especially constructed seine into the middle of which is sewed a large deep bag. Such a seine is somewhat more effective

FIGURE 2. FISH SPECIES TAKEN FROM LAKE POYGAN BY SHORELINE SEINING
(George Becker)

Station Number	1	2	3	4	5	6	7	8	9		10	11	TOTAL	%
Date	9/7/59	7/19/60	7/23/60	7/23/60	7/19/60	7/23/60	8/9/61	8/9/61	8/8/61	7/8/63	8/8/61	8/8/61		
Longnose gar					1							2	3	0.1
White sucker				1	2			1		7	1		12	0.2
Northern redhorse	11				1			9			1		22	0.4
Spotted sucker		1											1	—
Carp								1	1	29			31	0.6
Pugnose minnow	13	13			3								29	0.5
Golden shiner		8						29	18	41			96	1.7
Bluntnose minnow		34		14				5		17			70	1.3
Hornyhead chub										1			1	—
Spottail shiner	43	146			31	247		83		3	1	93	647	11.6
Spotfin shiner		36		35		18		14			1	22	126	2.3
Common shiner		15		2		4				2			23	0.4
Blackchin shiner				1				3	17	69			90	1.6
Blacknose shiner										1			1	—
Pugnose shiner									2	41			43	0.8
Emerald shiner										24		3	27	0.5
Bigmouth shiner		1											1	—
Yellow bullhead		1						2					3	0.1
Brown bullhead								1					1	—
Channel catfish					1								1	—
Tadpole madtom	1	3					1	2	1	3	7		18	0.3
Central mudminnow									2				2	—
Northern pike	1	2											3	0.1
Banded killifish	9	32		24						72	3		140	2.5
Burbot	2			1									3	0.1
Trout-perch	19												19	0.3
White bass	18				311	13	8						350	6.3
Yellow bass	2						6					11	19	0.3
Yellow perch	5	428	16	53	16	34	36	316	177	600+	617	36	2334+	41.9
Walleye	1				1		1	1					4	0.1
Logperch	23			13	7	10	13	54			39	62	221	4.0
Blackside darter				1									1	—
River darter												2	2	—
Johnny darter		2				3	5	8	8	3	2	1	32	0.6
Iowa darter									3				3	0.1
Largemouth bass	2	36		12	2	16	13	6	12	60	17	7	183	3.3
Black crappie	10	76			36	7	5	25	36	45	15		255	4.6
Pumpkinseed	+	5	1			10	50	79	133	42	54		374+	6.7
Bluegill	+	55	14	14	9	18	86	104	39	13	12	10	374+	6.7
Rock bass					1			3	2				6	0.1
Freshwater drum												1	1	—
Total	160+	894	31	171	422	380	224	746	451	1073	770	250	5572+	100
No. of Species	17	18	3	12	14	11	11	20	14	19	13	12	41	

FIGURE 3. SELECT SURVEYS SHOWING COMPOSITION OF SAMPLES FROM LAKE POYGAN

	(1) Vern Hacker		(2) Thomas Wirth		(3) W. Berwig and B. J. Rost	(4) Gordon Priegel	
	No.	%	No.	%	No. or lbs. (#)	No.	%
Lake sturgeon	...	...	38	0.7	77	5	1.1
Lampreys spp.	...	...	...	...	...	3	0.7
Chestnut lamprey	...	...	20	0.4	...	1	0.2
Longnose gar	...	...	148	2.6	210#	...	...
Spotted gar (1)	...	...	1	—	...	...	...
Bowfin	...	...	...	...	40#	...	...
Mooneye	...	...	14	0.2	20#	...	...
Suckers sp. (2)	...	...	...	...	785#	...	...
White sucker	29	0.5	24	0.4	...	3	0.7
Spotted sucker	27	0.5	4	—	...	...	...
Northern redhorse	...	...	148	2.6	1,015#	3	0.7
Quillback	...	...	...	...	65#	2	0.4
Carp	...	...	30	0.5	100#	3	0.7
Shiners spp.	10	0.2	...	...	...	6	1.3
Spottail shiner	8	0.1	...	...	...	28	6.2
Channel catfish	...	...	3,530	62.9	4,100	32	7.1
Flathead catfish	...	...	5	—	8	1	0.2
Bullheads spp.	...	...	...	...	14	...	...
Yellow bullhead	...	...	1	—	...	...	...
Tadpole madtom	1	—	...	...	...	...	...
Northern pike	1	—	4	—	46	1	0.2
Burbot	...	...	13	0.2	515#	...	...
Trout-perch	...	...	...	...	...	240	53.4
White bass	1	—	240	4.3	2,508	28	6.2
Yellow bass	...	...	1	—	25	...	...
Walleye	2	—	190	3.4	975	21	4.7
Sauger	...	...	1	—	...	...	...
Yellow perch	5,074	87.3	15	0.3	2	48	10.7
Logperch	524	9.0	...	...	...	...	...
Smallmouth bass	6	0.1	...	...	2	...	...
Largemouth bass	29	0.5	...	...	14	...	...
Bluegill	74	1.3	24	0.4	216	1	0.2
Pumpkinseed	22	0.4	10	0.2	36	...	...
Black crappie	13	0.2	143	2.5	6,711	15	3.3
White crappie	...	...	...	...	33	...	...
Rock bass	...	...	11	0.2	3	...	...
Freshwater drum	...	...	1,000	17.8	37,570#	9	2.0
Totals	5,821	100	5,615	100		450	100

(1) The presence of *Lepisosteus oculatus* has not as yet been established in Wisconsin waters.

(2) White sucker, but may include others.

FIGURE 4. FISH SPECIES TAKEN FROM LAKE WINNEBAGO BY SHORELINE SEINING
(George Becker)

Station Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	TOTALS	%
Date	8/29/61	8/29/61	8/29/61	8/29/61	8/28/61	8/20/60	8/20/60	8/20/60	8/20/60	8/17/60	8/17/60	8/17/60	8/18/60	8/18/60	8/18/60	8/18/60	8/19/60	8/19/60	8/19/60	8/30/61	8/30/61	8/28/61	8/28/61		
Silver lamprey															1									1	—
Shortnose gar																							6	6	0.1
White sucker			1		1			10	2					1	1						2			18	0.4
Carp											1	1	1		1			3				7	8	22	0.5
Golden shiner								1							1									2	—
Bluntnose minnow															11				3				1	15	0.4
Fathead minnow					1																			1	—
Spottail shiner	6	1			1	1	1		1	14		2	1		9	7	1		33	10	6			94	2.3
Spotfin shiner						4							1			29	1		7		10	2	4	58	1.4
Common shiner	2						3	4													2		1	12	0.3
Emerald shiner	116	2	243	11	47	11	13	3	12	31	26	9	10	1	13	29	19		16		9	2	13	636	15.6
River shiner			26				1	3	8	32	13		160		3	38	11							295	7.2
Sand shiner															1									1	—
Black bullhead															3		1	2					2	8	0.2
Brown bullhead																							1	1	—
Channel catfish										1														1	—
Tadpole madtom																						1	4	5	0.1
Northern pike					1													1				1		3	0.1
Burbot																					1		1	2	—
Trout-perch													1											1	—
White bass	239	99	7		2	4	7	7	4	16	5	6	7			8	11	1		3	45	5	24	500	12.2
Yellow bass	14	4	7		4	26	2	58	48	157	6	2	6	1	6	310	72	3	10		53	1	1	791	19.3
Yellow perch	5				4			7	1	3		6	3	1	256	7	4		112	+	59	11	43	522+	12.7+
Walleye					1	1		1	1	2	6		1		1	1	4			4			3	26	0.6
Logperch	8		1	4		2		25	8	3						1	1	8	9	10	7	2	1	90	2.2
Slenderhead darter						1												1	1					3	0.1
River darter										2					1			6	2	8	4	2		25	0.6
Johnny darter		1	5			1									1					1		4		13	0.3
Largemouth bass															3				9					12	0.3
Smallmouth bass																2	1	6						9	0.2
Black crappie	2														5		4	1	39	3	8	2	41	105	2.6
White crappie										1														1	—
Pumpkinseed		1			1										1		1		15		7	11	84	121	3.0
Bluegill	14		1	1	6					1		3	1		47	4	1	1	16	28	122	17	222	485	11.9
Rock bass																	2		12					14	0.2
Freshwater drum		8	15		5	1		2	1			1	2	1	6		39	24	1	2	31	18	3	160	3.9
Mottled sculpin					1										1			3		4		14	2	25	0.6
Totals	406	116	306	16	75	52	27	121	86	263	57	30	194	5	372	436	173	60	285	73+	366	100	465	4084+	100
No. of Species	9	7	9	3	13	10	6	11	10	12	6	8	12	5	21	11	16	13	15	11	15	16	20	37	

FIGURE 5. SELECT SURVEYS SHOWING COMPOSITION OF SAMPLES FROM LAKE WINNEBAGO

	(1) Vern Hacker		(2) Calumet Harbor & Vern Hacker	(3) Calumet Harbor & Gordon Priegel	(4) Gordon Priegel	
	No.	%	Number	Number	No.	%
Lake sturgeon			927	1,264		
Lampreys spp.			43	12		
Garfish spp.			61	67		
Bowfin			3			
Mooneye			968	1,332		
Suckers sp.*			6,553	14,910		
White sucker	1	0.1				
Northern redhorse			452	188		
Quillback			5,408	1,655		
Carp				1,028		
Shiners spp.			3,405			
Blackchin shiner	50 (est.)	4.7				
Emerald shiner					929	2.1
Channel catfish			4,127	5,952		
Flathead catfish			2			
Bullheads spp.			2,594	1,255		
Northern pike	2	0.2	431	171		
Muskellunge			21	9		
Burbot			7,564	6,371		
Trout-perch					27,407	62.4
White bass	3	0.3	228,782	302,304	2,540	5.8
Wellow bass			278			
Saalleye			31,415	17,386	2,073	4.7
Yuger			30,258	30,602	1,230	2.8
Lello w perch	649	61.1	10,581	8,679	2,055	4.7
Sogperch	6	0.6				
Lmallmouth bass			146	10		
Yargemouth bass	1	—	4	2		
Bluegill	50	4.7	34	4		
Pumpkinseed			12	2		
Black crappie	300	28.2	5,437	20,795	220	0.5
Rock bass			16	4		
Freshwater drum			1,310,367	1,098,816	7,454	16.9
Totals	1,062 (est.)	100	1,649,889	1,512,818	43,908	100

*White sucker, but may include others.

in capturing fish from open water and I used it in a few collections on Lake Poygan. I have preserved examples of all species of fish for each lake studied. These are stored at Wisconsin State University in Stevens Point, Wisconsin.

Data on the select surveys from Lake Poygan, which are tabulated in Fig. 3, are as follows:

Column *1*. Vern Hacker.[1] These data include the first two of three seine hauls made on the southwest shore, September 29, 1952. Botton, sand. Water, up to 2.5 feet in depth. 100′ x 6′ seine with ¼″ mesh.

Column *2*. Thomas Wirth.[2] These data include fish taken from the extreme east end of the lake between January 9 and February 4, 1953, in two double-end trap nets with 2.5″ mesh. Depth of water, 9 to 10 feet.

Column *3*. W. Berwig & B. J. Rost.[3] Trap nets generally of 14 hoops, size of mesh in pots—3″. Nets were lifted at weekly intervals from December 22, 1958, to February 12, 1959, and from December 14, 1959, to December 30, 1959. Traps were set well out from shore opposite stations 6, 7, and 8 (See Fig. 1), in approximately 9 feet of water.

Column *4*. Gordon Priegel. A total of 22 hauls were made on August 15, 1961, with a 12-foot bait trawl. This trawl was towed in open water 6 to 9 feet deep at the end of a 150-foot cable (Priegel, 1962).

Data on the select surveys from Lake Winnebago, which are tabulated in Fig. 5, are as follows:

Column *1*. Vern Hacker.[4] These data are for the second haul along the shoreline of a 100′ x 6′ seine with ¼″ mesh. The haul was made on September 15, 1952, in Asylum Bay which lies five miles north of the city of Oshkosh.

Column *2*. Calumet Harbor & Vern Hacker.[5] The data here are a composite from two studies made by Wisconsin Conservation Department personnel on Lake Winnebago. The Calumet Harbor rough fish removal crew inspected a total of 930 trap net sets in open water from April through November in 1958 and another 690 from April through November in 1959. Vern Hacker, fishery biologist, tabulated data from 708 trap net sets in open water from April through November of 1957 and another 397 from April through November in 1958.

Column *3*. Calumet Harbor[5] & Gordon Priegel. The data here are a composite from several studies made by the Calumet Harbor rough fish removal crew and Gordon Priegel, fishery biologist. These studies include 16 winter trap net sets inspected from December, 1959, to March, 1960; 525 open water trap net sets from April to November, 1960; 54 winter net sets from January to February, 1961; 399 open water trap net sets from April to November, 1961; and 1619 trawl hauls with a 30-foot trawl during 1961 (Priegel, 1962).

Column *4*. Gordon Priegel. Total catch from 187 hauls (five to seven-minute tows), using a 12-foot bait trawl, from June to November, 1960 (Priegel, 1960).

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[1] Intra-office memorandum from Vern Hacker to Richard Harris. In Lake Poygan File, Eastcentral Area Hdqts., Wis. Cons. Dept., Oshkosh, Wisconsin.

[2] Intra-office memorandum from Tom Wirth to Richard Harris. In Lake Poygan File, Eastcentral Area Hdqts., Wis. Cons. Dept., Oshkosh, Wisconsin.

[3] Ledger on rough fish removal from Lake Poygan. On file in Eastcentral Area Hdqts., Wis. Cons. Dept., Oshkosh, Wis.

[4] Intra-office memorandum from Vern Hacker to Richard Harris. In Lake Winnebago File, Eastcentral Area Hdqts., Wis. Cons. Dept., Oshkosh, Wis.

[5] Ledger on rough fish removal from Lake Winnebago. On file in Eastcentral Area Hdqts., Wis. Cons. Dept., Oshkosh, Wis.

Fish Species and Their Distribution

In the text which follows, after each species' name I have indicated the name of the lake(s) and station(s) where each was collected.

1. Silver lamprey—*Ichthyomyzon unicuspis* Hubbs & Trautman. Winnebago, 15. The single adult specimen which I took on August 8, 1960, in a weed-filled bay was 192 mm. long. The lake bottom at the site of capture was deep, soft mud, I examined another adult, 196 mm. in length, which was taken from Lake Winnebago by a WCD trawl on September 17, 1959. The site of capture was not indicated. Priegel (pers. comm.) reported this species as abundant in Lake Winnebago where as many as 17 lampreys have been taken off one sturgeon. He also reports this species in the upriver lakes.

2. Chestnut lamprey—*Ichthyomyzon castaneus* Girard. Wirth reported taking approximately 20 chestnut lampreys in trap nets set in Lake Poygan during January and February, 1953 (Fig. 3). In a personal letter to me (March 5, 1962) he wrote: "I recall having identified both chestnut and silver lampreys in Winnebago and connecting waters".

3. Lake sturgeon—*Acipenser fulvescens* Rafinesque. This species is found commonly in the lakes of the lower Wolf River and in Lake Winnebago. It spawns in the Wolf River up to the Shawano dam and in the Fox River up to Princeton. Sturgeon research in these waters is part of the fisheries program and special efforts have been made to tag them. A limited spearing season has been in effect in recent years in which fish 40″ or more in length may be legally taken. The state record sturgeon, speared in Lake Winnebago in 1953, weighed 180 pounds with an estimated age of 82 years.

4. Longnose gar—*Lepisosteus osseus* (Linnaeus). Poygan 5, 11. Greene (1935) reported this species from Winnebago. Priegel (pers. comm.) reported that he has taken the longnose gar in South Asylum Bay regularly since 1960 and that it spawns in the bay. In Poygan 148 longnose gar were taken in WCD trap nets during January and February, 1953.

5. Spotted gar—*Lepisosteus oculatus* (Winchell). Wirth reported this species from the east end of Lake Poygan (Fig. 3). Priegel (pers. comm.) wrote: "The spotted gar was taken in great numbers in Lake Poygan and Wolf River (mouth of Rat River to Mills Landing) while boom shocking during the summer, 1962."

Since no actual specimens were available, I sent a colored slide, furnished by Priegel, to Dr. Reeve M. Bailey, curator of fishes at the University of Michigan, for verification as to species. Bailey in a letter dated Nov. 4, 1963, wrote: "I know of no substantiation for the occurrence of *L. oculatus* in Wisconsin, although it would not be too surprising to have it turn up in eastern or southern Wisconsin. . . . It is clear from the color photo you sent that the lower specimen is either *platostomus* or *oculatus* but I cannot make a firm determination."

On the basis of the above reports this species should be considered questionable for these waters until that time when positive identification of actual specimens is possible.

6. Shortnose gar—*Lepisosteus platostomus* Rafinesque. Winnebago 23. Greene (1935) reported the shortnose gar from several stations on the Mississippi River and from Lake Mendota. To my knowledge my records for Lake Winnebago are the first for this species in the Great Lakes drainage basin. Data on five of these specimens, taken on August 28, 1961, are as follows:

Total Length mm.	Standard Length mm.	Snout Divided by Rest of Head	K	Lat. Line Scales
558	483	1.54	0.46	60
540	472	1.38	0.52	62
536	468	1.27	0.70	61
497	425	1.37	0.61	61
467	405	1.51	0.44	62

In September, 1962, Priegel (1963a) took a specimen from South Asylum Bay (station 19), Lake Winnebago. It was sent to Dr. Bailey, who verified the identification.

It seems likely that this species may have entered the upper Fox River (Great Lakes drainage) and its lakes via the Fox–Wisconsin canal at Portage, Wisconsin. According to Hubbs and Lagler (1958) this species on the north of its range prefers open silty rivers. My specimens were captured in water less than 1.5 feet in depth between large beds of submergent aquatics. The shallows abutted a jetty extending out into the lake.

7. Bowfin—*Amia calva* Linnaeus. Two-hundred-and-fifteen pounds of dogfish were reported taken at the mouth of Willow Creek (Lake Poygan, station 9) by commercial fishermen during May, 1947. During the winter of 1958–59 forty pounds were reported taken by the WCD sturgeon research and rough fish removal unit on Poygan. On Lake Winnebago the WCD rough fish removal crew from Calumet Harbor reported taking one bowfin in 1958 and

another in 1959. Hacker reported shocking about 20 in Asylum Bay, August 5, 1962, and that he has noted this species every year since 1952 (pers. comm.).

8. Mooneye—*Hiodon tergisus* LeSueur. Greene (1935) captured this species at several places in Lake Winnebago. The WCD rough fish removal crew working out of Calumet Harbor on Lake Winnebago reported taking 258 mooneye in 1960 and 1,067 in 1961. Hacker told me in conversation that he has seen many of these fish among the docks at Oshkosh during summer evenings. This species is occasionally caught in Lake Poygan and in the Wolf River upstream from Lake Poygan.

9. Cisco—*Coregonus artedii* LeSueur. Priegel reported that on June 5, 1962, a research crew while shoreline seining in Lake Winnebago off Neenah (northwest shore) took a young cisco, 32 mm. long (pers. comm.). The fish was identified by Dr. Bailey. Normally this species is found in only cold water which is considerably deeper than that of Lake Winnebago. Its presence in Lake Winnebago must be considered accidental. Hacker (pers. comm.) believes that this individual originated from the cisco population of Green Lake.

10. Lake trout—*Salvelinus namaycush* (Walbaum). According to Hacker (pers. comm.) lake trout are occasionally taken by fishermen. One was caught in Lake Butte des Morts (between Lakes Poygan and Winnebago) during the spring of 1962. The finclip indicated that it came from Green Lake. Another, weighing 17 pounds, was caught in a fyke net in Little Lake Butte des Morts (outlet of Lake Winnebago) in about 1955. In April, 1962, a lake trout was reported caught from the upper Fox River at Eureka dam. Hacker believes that all must have come from Green Lake.

11. Brook trout—*Salvelinus fontinalis* (Mitchill). A brook trout was reported taken from Lake Winnebago early in 1957 by Ray and Don Tuttle, commercial fishermen. Otis Smith, another commercial fisherman, reported capturing a brook trout on April 16, 1958, on the north end of the same lake. The waters of Lake Winnebago can hardly be considered brook trout habitat. It is doubtful if the above migrants were able to survive summer temperatures.

12. Rainbow trout—*Salmo gairdneri* Richardson. A rainbow trout, 19″ in length, was taken in WCD nets off Brothertown Point (east side of Lake Winnebago) on June 19, 1958, in 18 to 20 feet of water. John Keppler, conservation aid, reported to me that a rainbow was taken in recent years off Hospital Point (north of Oshkosh). On August 28, 1963, a 14.6″ rainbow was caught off the Bowen Street dock at the front of the Wis. Cons. Dept. headquaters in Oshkosh (Priegel, pers. comm.).

13. Brown trout—*Salmo trutta* Linnaeus. The following article appeared in the Wisconsin Conservation Bulletin for September, 1938:

> Oshkosh—Samuel Kingsley caught a brown trout in Lake Winnebago near Island beach, north of the city.

Priegel (pers. comm.) wrote that three brown trout were caught off Fairy Springs (near station 9) in Lake Winnebago during August and September, 1962. A resort owner on the west end of Lake Poygan told me that brown trout are occasionally taken in early spring from the open water. Undoubtedly such salmonids have drifted into Poygan and the lower lakes from streams like the Pine River (Poygan, station 3) and Willow Creek (Poygan, station 4).

Conditions in the lakes of the upper Fox River are unsuitable for trout, and the above records are unusual. It is doubtful if any spawning takes place in these lakes.

14. White sucker—*Catostomus commersoni* (Lacépède). Poygan 4, 5, 8, 9, 10; Winnebago 3, 5, 8, 9, 14, 15, 21. This species is commonly taken in Lake Poygan. Hundreds of pounds are removed yearly by rough fish removal crews. A limited study by Wirth (Fig. 3) revealed the capture of 24 common suckers which represented 0.4% of the catch. I find that this species frequents the deeper water of the lake. In our shallow-water seining we captured only 12 specimens at five stations on Poygan. On Lake Winnebago commercial fishermen removed thousands of pounds yearly. The Calumet Harbor (WCD) rough fish removal crew captured 6,553 suckers from April, 1957, to November, 1959.

15. Northern redhorse—*Moxostoma macrolepidotum* (LeSueur). Poygan 1, 5, 8, 10. This species appears to be the most common sucker in Lake Poygan. Wirth (Fig. 3) captured 148, representing 3.0% of the total catch. Between December, 1958, and December, 1959, the WCD rough fish removal crew on Lake Poygan removed 1,015 pounds of redhorse against 785 pounds of all other suckers (mostly *Catostomus commersoni* and some *Minytrema melanops*). From Lake Winnebago the Calumet Harbor (WCD) rough fish removal crew captured 452 redhorse between April, 1957, and November, 1959.

16. Spotted sucker—*Minytrema melanops* (Refinesque). Poygan 2. This species has been recorded regularly from Lake Poygan although it is the least common of the species of suckers present. Wirth (Fig. 3) took four specimens in his study. I took only one in 1960. Hacker (Fig. 3) captured 27. Greene (1935) did not capture the spotted sucker from Lake Poygan but took it from Willow

Creek, several miles upstream from its mouth at Lake Poygan. Priegel reported to me that this species is found throughout the upper Fox River and in the Wolf River up to the Shawano Dam. He captured this species from South Asylum Bay (station 9) of Lake Winnebago while boom shocking in September, 1963.

17. Lake chubsucker—*Erimyzon sucetta* (Lacépède). Priegel captured a specimen from Boom Bay in Lake Poygan while boom shocking in the summer of 1962. Greene (1935) reported the lake chubsucker from Willow Creek several miles upstream from Lake Poygan. Hacker (pers. comm.) wrote that it is abundant in the Auroraville Pond on Willow Creek.

18. Quillback—*Carpiodes cyprinus* (LeSueur). Commercial fishermen and rough fish removal crews refer to this species as the "white carp". A catch of 500 pounds was reported by WCD crews for April 29, 1947, near Herbst (station 6) on Lake Poygan. On May 14 of the same year another catch of 100 pounds was made. From December, 1958 to December, 1959, about 65 pounds of quillback were taken by WCD fishing crews between Herbst and Brettschneider (stations 6 and 7). From the records in WCD files which I have seen it is apparent that this species has decreased in numbers in Lake Poygan and it is taken infrequently at the present time. In Lake Winnebago Greene (1935) reported this species from seven different localities. The Calumet Harbor (WCD) rough fish removal crew captured 5,408 individuals from April, 1957, to November, 1959. During 1960 up through February, 1961, 1,655 individuals were captured.

19. Buffalofish—*Ictiobus* sp. Infrequent records of "buffalofish" appear in the commercial fish reports from Lake Winnebago. Otis Smith, a commercial fisherman, reported one individual captured with a trap net in May, 1956, and another with an open water trap in the fall of 1957. One individual was reported by the WCD rough fish removal crew in a trap net at Fond du Lac. Richard Harris, Area Supervisor of fisheries at Oshkosh, told me that the buffalofish is rare in Lake Winnebago. I have not been able to find any specimens to verify as to species; however, it seems likely that the form taken in Lake Winnebago may be the bigmouth buffalo, *Ictiobus cyprinellus*. Nevertheless, all the above is conjecture and must be considered tentative to the capture and verification of an actual specimen.

20. Carp—*Cyprinus carpio* Linnaeus. Poygan 8, 9; Winnebago 11, 12, 13, 15, 18, 22, 23. Priegel stated that carp are abundant in Lake Poygan and quite common in Lake Winnebago. He cited the following records for Lake Poygan: April 11, 1961, at Lone Willow one seine haul 1,200 feet long—3,000 pounds of carp; April 20,

1961, at Haulover bay, one seine haul 1,200 feet long—16,000 pounds of carp. For Lake Winnebago: June 27, 1960, at Supple's Marsh near Fond du Lac, one seine haul 4,500 feet long—18,400 pounds of carp; June 8, 1961, at Supple's Marsh, one seine haul 4,500 feet long—8,000 pounds of carp (pers. comm.).

21. Central stoneroller—*Campostoma anomalum pullum* (Agassiz). Greene (1935) reported this species from the east shore of Lake Winnebago. Although considered a stream fish, the stoneroller commonly seeks water of lower gradient after spawning and it is possible to encounter this species in lakes near the mouths of streams from which it has migrated.

22. Longnose dace—*Rhinichthys cataractae* (Valenciennes). Priegel (pers. comm., Dec. 9, 1963) reported seeing this minnow seined by a minnow dealer in late September, 1960, from the west shore of Lake Winnebago just south of the mouth of the upper Fox River.

23. Pugnose minnow—*Opsopoeodus emiliae* (Hay). Poygan 1, 3, 5. Greene (1935) reported the pugnose as a rare minnow of the Mississippi drainage. It is generally southern in distribution and is probably a recent arrival in Wisconsin. My three collections from the western end of Lake Poygan in 1959 and 1960 are the first reported from the Great Lakes drainage of the state of Wisconsin. Priegel reported taking five adult pugnose minnows while shoreline seining in Lake Winnebago on June 14, 1962, off the south side bathing beach at Oshkosh (pers. comm.).

24. Golden shiner—*Notemigonus crysoleucas* (Mitchill). Poygan 2, 8, 9; Winnebago 8, 15. Although this species appears to be generally distributed in Lake Poygan, it is not numerous. Greene (1935) captured the golden shiner at only one station for each lake.

25. Northern redbelly dace—*Chrosomus eos* Cope. Priegel (pers. comm., Dec. 9, 1963) reported seeing this minnow seined by a minnow dealer in late September, 1960, from the west shore of Lake Winnebago just south of the mouth of the upper Fox River.

26. Bluntnose minnow—*Pimephales notatus* (Rafinesque). Poygan 2, 4, 8, 9; Winnebago 15, 19, 23. This species, commonly distributed throughout the state, is uncommon in Lake Winnebago and common only in certain shoreline areas of Lake Poygan.

27. Fathead minnow—*Pimephales promelas* Rafinesque. Winnebago 5. The single individual captured was probably a release from a fisherman's minnow pail.

28. Hornyhead chub—*Hybopsis biguttata* (Kirtland). Poygan 9. This species is typically a minnow of clear medium-sized streams. It is seldom taken in lakes or quiet water.

29. Spottail shiner—*Notropis hudsonius* (Clinton). Poygan 1, 2, 5, 6, 8, 9, 10, 11; Winnebago 1, 2, 5, 6, 7, 9, 10, 12, 13, 15, 16, 17, 19, 20, 21. This species is common in Lake Winnebago and abundant in Lake Poygan. In the latter it was the most common minnow found. Large schools of young-of-the-year were captured and many more wriggled through the mesh of the net and were lost. Numerically, the spottail was second to the yellow perch (Fig. 2). Adults of this species are commonly found in the open lake. Greene (1935) took this species at one station on Lake Poygan and at several stations on Lake Winnebago.

30. Spotfin shiner—*Notropis spilopterus* (Cope). Poygan 2, 4, 6, 8, 10, 11; Winnebago 6, 13, 16, 17, 19, 21, 22, 23. This species is of general distribution in the lakes of the Wolf and Fox rivers. It is commonly found in shallow water, often in the vicinity of piers. Greene (1935) took this species at one station on Lake Poygan and at all stations on Lake Winnebago.

31. Common shiner—*Notropis cornutus* (Mitchill). Poygan 2, 4, 6, 9; Winnebago 1, 7, 8, 21, 23. In the present survey this minnow was not considered common, although its distribution appears to be general. It was more frequently found where the water was clear and the bottom of gravel.

32. Blackchin shiner—*Notropis heterodon* (Cope). Poygan 4, 8, 9. This minnow was nowhere common in Lake Poygan. At the stations where I took this minnow, the bottom was of sand or mud, covered with a fine silt which resulted in heavily roiled waters as we dragged the seine. Vern Hacker (Fig. 5) estimated that he captured 50 in Asylum Bay on Lake Winnebago in September, 1952.

33. Blacknose shiner—*Notropis heterolepis* Eigenmann & Eigenmann. Poygan 9. In Central Wisconsin I have taken this species in small silt-bottom lakes and in small streams with slow to medium current. In larger lakes, if found at all, it was taken in protected bays generally on the north side of the lake.

34. Pugnose shiner—*Notropis anogenus* Forbes. Poygan 9. Two individuals were captured from this station on Boom Bay on August 8, 1961. In order to secure an adequate study sample of this rare minnow I made a return trip to the same area on July 8, 1963, at which time I took 41 individuals. During the 1963 trip the vegetation in the area was very heavy. There were considerable stands of bulrush (*Scirpus* sp.). Submergent vegetation coupled with heavy growths of filamentous algae (primarily *Spirogyra* sp.) made seining difficult. The water was clear. Several springs had been piped into the bay at that point. The bottom consisted of fine

gravel and sand overlain with a very fine silt. Because of the problems encountered with the vegetation we seined primarily the areas which had been cleared alongside piers for boat passage and swimming. The pugnose shiners were in these open areas in schools of a dozen or more fish in water one-and-one half feet or less in depth. All individuals were taken within thirty feet of shore.

35. Emerald shiner—*Notropis atherinoides* Rafinesque. Poygan 9, 11: Winnebago 1 through 17, 19, 21, 22, 23. The emerald shiner appears to be the most common minnow in Lake Winnebago and is present in both shallow water and in the open lake. According to Priegel (1962a) it is the preferred forage fish during the winter for the walleyes of Lake Winnebago. For the sauger it is, next to the trout-perch, the most frequently found forage fish in stomach analyses. Apparently this shiner fluctuates greatly in numbers on Lake Winnebago. Priegel (1960) found that it decreased by 12.5% from 1959 to 1960. Also the young-of-the-year averaged 2.1″ in length in October, 1959, but only 1.6″ in October, 1960.

36. Bigmouth shiner—*Notropis dorsalis* (Agassiz). Poygan 2. The single individual captured was probably a migrant from one of the streams opening into the west end of Lake Poygan. Normally this species is found in moderate-sized streams over sand bottom.

37. River shiner—*Notropis blennius* (Girard). Winnebago 3, 7, 8, 9, 10, 11, 13, 15, 16, 17. This species is commonly distributed over the northern and eastern shores of Lake Winnebago over sandy and rocky bottom. Next to the emerald shiner it appears to be the most common minnow in the lake. According to Hubbs and Lagler (1958), Lake Winnebago is the only water in the Great Lakes drainage from which this species is known. It is a common minnow in the larger waters of the Mississippi River drainage basin.

38. Sand shiner—*Notropis stramineus* (Cope). Winnebago 15. The sand shiner is a common species in medium and large-sized streams. In Wisconsin it is taken only infrequently in lakes. In Michigan lakes, Hubbs and Cooper (1936) report the species as frequenting sandy shoal areas.

39. Black bullhead—*Ictalurus melas* (Rafinesque). Winnebago 15, 17, 18, 23. Greene (1935) reported this species from Lake Winnebago. The black bullhead prefers the mud-bottomed and silt-covered bays found on the west side of Lake Winnebago. Priegel reported taking this species while seining in Lake Poygan during the summer of 1962 (pers. comm.).

40. Yellow bullhead—*Ictalurus natalis* (LeSueur). Poygan 2, 8. Priegel reported having taken this species often in Lakes Poygan and Winnebago while seining, trawling or netting (pers. comm.).

41. Brown bullhead—*Ictalurus nebulosus* (LeSueur). Poygan 8; Winnebago 23. Greene (1935) had a single record from Lake Winnebago at Oshkosh.

42. Channel catfish—*Ictalurus punctatus* (Rafinesque). Poygan 5; Winnebago 10. This species is one of the most common of the larger fishes in Lake Poygan. In 1953 Wirth (Fig. 3), using 2½″ trap nets captured 3,530 catfish which made up 62.9% of the total catch. On the same lake other WCD research crews captured 4,100 catfish in the period between December, 1958, and December, 1959 (Fig. 3). On a pound-to-pound basis this was exceeded only by the fresh-water drum. The channel cat is also common in Lake Winnebago although numerically it is superseded by several species of game and rough fishes (Fig. 5). The catfish is distributed throughout both Poygan and Winnebago and during the day appears to confine itself to the deeper waters.

43. Flathead catfish—*Pylodictis olivaris* (Rafinesque). Greene (1935) reported this species only from the Mississippi drainage of Wisconsin. The records from Lakes Poygan and Winnebago are the first for the Great Lakes drainage in the State of Wisconsin. In recent years this species has been taken consistently but in small numbers from both Lake Winnebago and Lake Poygan (Figs. 3 and 5). From April, 1957, to November, 1959, 13 flathead catfish were reported taken in trap nets from Lake Winnebago by commercial fishermen. Individuals from 20 to 40 pounds in weight are not uncommon.

44. Tadpole madtom—*Noturus gyrinus* (Mitchill). Poygan 1, 2, 7, 8, 9, 10; Winnebago 22, 23. This species is rare in Lake Winnebago. In Lake Poygan its distribution is more general but it is still uncommon.

45. Central mudminnow—*Umbra limi* (Kirtland). Poygan 9. The mudminnow is commonly found in bog lakes and small streams in Central Wisconsin. It has seldom been taken in large lakes.

46. Northern pike—*Esox lucius* Linnaeus. Poygan 1, 2; Winnebago 5, 18, 22. Greene (1935) reported this species from several stations on Lake Winnebago. It appears to be more generally distributed than my station data indicate.

47. Muskellunge—*Esox masquinongy* Mitchill. Greene (1935) recorded a report of muskellunge from Lake Winnebago. Netting operations on that lake in recent years indicate that a small population is present (Fig. 5). Between April, 1957, and November,

1959, commercial fishermen reported capturing a total of 46 individuals from the lake. I was not able to find any reports of this species from Lake Poygan although conditions there appear to be favorable for it.

48. Banded killifish—*Fundulus diaphanus* (LeSueur). Poygan 1, 2, 4, 9, 10. Greene (1935) reported this species from five stations on Lake Winnebago although none of the recent surveys captured it there.

49. Burbot—*Lota lota* (Linnaeus). Poygan 1, 4; Winnebago 21, 23. Greene (1935) reported this species from four stations on Lake Winnebago. Priegel wrote that tons of lawyers are taken with nets from Lake Winnebago during their spawning season (pers. comm.).

50. Trout-perch—*Percopsis omiscomaycus* (Walbaum). Poygan 1; Winnebago 13. Since the trout-perch frequents open water, it is seldom taken by shoreline seining. In trawl hauls it is commonly captured, frequently appearing as the most abundant species in the catch. In Lake Poygan it comprised 53.4% of the catch in 22 trawl hauls (Fig. 3); in Winnebago, 62.4% of the catch (Fig. 5). This small species is a mainstay in the winter diet for both walleyes and sauger in Lake Winnebago (Priegel, 1962a). Priegel (1959) observed large numbers of trout-perch which were spawning among the rocks along the east shore of Lake Winnebago.

51. White bass—*Roccus chrysops* (Rafinesque). Poygan 1, 5, 6, 7; Winnebago 1, 2, 3, 5 through 13, 16, 17, 18, 20, 21, 22, 23. Greene (1935) reported this species from many stations on Lake Winnebago. The majority of white bass taken from Poygan and Winnebago by shoreline seining were young-of-the-year. They constituted a substantial percentage of the catch (Figs. 2 & 4). Fishermen complained frequently that Lake Winnebago was over-populated with this species.

52. Yellow bass—*Roccus mississippiensis* (Jordan & Eigenmann). Poygan 1, 7, 11; Winnebago 1, 2, 3, 5 through 19, 21, 22, 23, Greene (1935) reported this species from a few stations on the Mississippi River. Since then, it has been taken from many inland waters in southern Wisconsin (Helm, 1958). In Lake Winnebago I found this species as widely distributed as the white bass. The largest yellow bass on record from Wisconsin waters was taken in a state fish management trap net from Lake Poygan in January, 1964. It measured 16.2 inches in length, weighed three pounds two ounces and was six years old.

53. Yellow perch—*Perca flavescens* (Mitchell). Poygan 1 through 11; Winnebago 1, 5, 8, 9, 10, 12 through 17, 19 through 23. The perch is probably the most abundant panfish in Lake Poygan, and in Winnebago it is second only to the white bass.

54. Sauger—*Stizostedion canadense* (Smith). Hook and line winter fishing produces sauger in great numbers in Lake Winnebago. For the same lake, Priegel reported good 1957 and 1959 year classes but that there is no evidence for successful hatches in 1960, 1961 and 1962 (pers. comm.). Food habits of the sauger in Lake Winnebago are discussed by Priegel (1963b). Greene (1935) reported a record for Lake Winnebago, but he failed to take any in his own collections. A single specimen was taken in a trap net in 1953 from Lake Poygan.

55. Walleye—*Stizostedion vitreum vitreum* (Mitchill). Poygan 1, 5, 7, 8; Winnebago 5, 6, 8, 9, 10, 11, 13, 15, 16, 17, 20, 23. Greene (1935) took this species in both lakes. The walleye is considered one of the most important game fishes in Lakes Poygan and Winnebago where it appears to have general distribution. In the spring of the year many walleyes from these lakes migrate up the Wolf and Fox rivers to spawn. After the eggs are hatched, the fry are quickly carried downstream by the current to the lakes of the lower Wolf River (Priegel, 1960). Priegel (1963b) has analyzed the fall and winter food habits of walleyes from Lake Winnebago.

56. River darter—*Percina shumardi* (Girard). Poygan 11; Winnebago 10, 15, 18, 19, 20, 21, 22. Greene (1935) captured this species only from the Mississippi drainage in Wisconsin. In addition to the Poygan and Winnebago collections, I have taken the river darter from the lower Waupaca River, two miles downstream from Weyauwega, Waupaca County. These apparently are the first records of this species from the Great Lakes drainage in the State of Wisconsin. The Fox-Wisconsin canal at Portage, Wisconsin, probably acted as a connective between the two drainage basins. The spread of this species is similar to that indicated for the rainbow darter *(Etheostoma caeruleum)*, discussed in a previous paper (Becker, 1959).

57. Blackside darter—*Percina maculata* (Girard). Poygan 4. This darter is taken commonly in medium to large-sized streams. It is uncommon in lakes.

58. Logperch—*Percina caprodes* (Rafinesque). Poygan 1, 4, 5, 6, 7, 8, 10, 11; Winnebago 1, 3, 4, 6, 8, 9, 10, 16 through 23. Greene (1935) reported this species from Lakes Winnebago and Poygan. The logperch is generally distributed throughout the shores of these lakes where the bottom is of heavy gravel, rubble or boulders. It is found commonly on the wave-swept shores and seldom in those areas protected from wind action.

59. Johnny darter—*Etheostoma nigrum* Rafinesque. Poygan 2, 6 through 11; Winnebago 2, 3, 6, 15, 20, 22. Greene (1935) reported this species from several stations along the eastern shore of Lake

Winnebago. The form taken in this survey was that subspecies formerly called the scaly Johnny darter *(Etheostoma nigrum eulepis)*, described by Hubbs and Greene (1935), in which the nape of the neck, the cheeks and the breast are well-scaled. Recently Underhill (1936) has presented evidence that it is undesirable to continue to recognize the scaled form as a subspecies.

60. Iowa darter—*Etheostoma exile* (Girard). Poygan 9. This species is commonly taken from boggy lakes and streams draining such lakes in Central Wisconsin. Its appearance in a large lake such as Poygan is unusual.

61. Fantail darter—*Etheostoma flabellare* Rafinesque. Greene (1935) recorded this species for Lake Winnebago at the point where the upper Fox River enters the lake.

62. Smallmouth bass—*Micropterus dolomieui* Lacépède. Winnebago 16, 17, 18. Greene (1935) reported this species from Lake Winnebago. Several samplings in the deeper waters of Lake Poygan included the smallmouth (Fig. 3). In Lake Winnebago this species is found most commonly along the east and northwest shores.

63. Largemouth bass—*Micropterus salmoides* (Lacépède). Poygan 1, 2, 4 through 11; Winnebago 15, 19. The largemouth bass is commonly found throughout Lake Poygan where extensive weedy areas provide excellent habitat for it. Lake Winnebago has submergent vegetation only in a few mud-bottomed bays on the west shore. Due to restriction of proper habitat this species is uncommon in that lake. Hacker reported that he saw about 15 nice largemouth bass in Asylum Bay while shocking on September 5, 1962 (pers. comm.).

64. Pumpkinseed—*Lepomis gibbosus* (Linnaeus). Poygan 1, 2, 3, 6, 7, 8, 9, 10; Winnebago 2, 5, 15, 17, 19, 21, 22, 23. Greene (1935) reported this species from Poygan and Winnebago. I have found that the pumpkinseed has a general distribution along the shores of both lakes. In Lake Winnebago it is more commonly taken from the bays on the west shore and is rare to uncommon on the east shore. In Lake Poygan this species is abundant and constitutes a large part of the panfish population.

65. Bluegill—*Lepomis macrochirus* Rafinesque. Poygan 1 through 11; Winnebago 1, 3, 4, 5, 10, 12, 13, 15 through 23. Greene (1935) captured this species from the north end of Lake Winnebago. Although this species made up almost 12% of all the total number of fish which I captured from Lake Winnebago, I frequently heard about the absence or shortage of this species in that lake. Fishermen in some cases doubted the presence of the bluegill in Winnebago until I showed them specimens. Priegel reported that the blue-

gill, except as a rare specimen, has never entered the Lake Winnebago fishery (pers. comm.).

66. Rock bass—*Ambloplites rupestris* (Rafinesque). Poygan 5, 8, 9; Winnebago 17, 19. Greene (1935) captured this species in Lakes Poygan and Winnebago. The enrichment of these waters by effluent and chemical fertilizers will continue to interfere with the establishment of a strong population of this species. It is doubtful that the rock bass will ever contribute much to the fisherman's catch from these lakes.

67. White crappie—*Pomoxis annularis* Rafinesque. Winnebago 10. Greene (1935) captured this species from several sites on the Mississippi River and its tributaries. He took it in the Lake Michigan drainage only from the Root River in the southeastern corner of the state. In addition to the single specimen from Lake Winnebago, I made another capture on July 30, 1960, from a feeder stream to the Grand River in Green Lake County. This stream, lying in the Lake Michigan drainage basin, is not far from the Fox-Wisconsin canal at Portage. Hacker reported this species as common in Kingston Pond of the Grand River (pers. comm.). It appears possible, therefore, that the canal at Portage may have acted as a route whereby this species recently passed from the Mississippi into the Great Lakes drainage of Eastcentral Wisconsin. Berwig and Rost (Fig. 3) reported this species from Lake Poygan.

68. Black crappie—*Pomoxis nigromaculatus* (LeSueur). Poygan 1, 2, 5 through 10; Winnebago 1, 15, 17 through 23. This species was captured by Greene (1935) in both lakes. It is abundant and well distributed in Lake Poygan and common on the western and southern shores of Lake Winnebago.

69. Freshwater drum—*Aplodinotus grunniens* Rafinesque. Poygan 11; Winnebago 2, 3, 5, 6, 8, 9, 12, 13, 14, 15, 17 through 23. Greene (1935) captured this species at several stations on Lake Winnebago. Numerically it is the most successful species of large fish found in that water (Fig. 5). With the 20-foot seine I captured several individuals weighing over three pounds. According to Priegel over 30 million pounds have been removed from Lake Winnebago in the last decade (pers. comm.). More pounds of drum have been netted from Lake Poygan than any other species of fish (Fig. 3).

70. Mottled sculpin—*Cottus bairdii* (Girard). Winnebago 5, 15, 18, 20, 22, 23. This species appears to be generally distributed in Lake Winnebago. All individuals which I captured were two inches or less in total length, averaging considerably shorter than those I have taken in the streams of Central Wisconsin.

71. Brook stickleback—*Eucalia inconstans* (Kirtland). Priegel (pers. comm., Dec. 9, 1963) reported seeing this species seined by a minnow dealer in late September, 1960, from the west shore of Lake Winnebago just south of the mouth of the Fox River. In another letter (Dec. 10, 1963) he reported a specimen, 0.9 inches in length, which he took while shoreline seining off the east shore of Lake Winnebago on June 20, 1962.

Undoubtedly additional species of fish would be found in these lakes with more intensive sampling. It is of interest here to consider a collection of fishes made by Mr. Richard Simpson of Appleton who on April 21, 1962, seined the lowermost portion of a small creek and its mouth near Kerr's Resort on Boom Bay of Lake Poygan. I examined the collection and aside from some species listed above I found the northern mimic shiner *(Notropis v. volucellus)* and the rosyface shiner *(Notropis rubellus)*. Mr. Simpson was not sure whether these species had been taken in the Boom Bay portion of Lake Poygan or in the stream itself.

Sampling these lakes during the winter would probably produce several species of minnows and darters which are normally found only in streams. Ice has in the past rather effectively concealed the winter distribution of our fish fauna. For instance, we know now that the creek chub *(Semotilus atromaculatus)*, which spends the spring, summer and early fall near the headwaters of a stream, will migrate downstream and pass the winter in a large river or lake (Trautman, 1957). As the ice goes out, this species migrates upstream to spawn where it will remain until the following fall. The longnose dace engages in similar migratory habits. However, a few individuals may move from the torrential parts of the stream, where they are normally found from April through November, into adjacent shallow iced-over pools during the months of January, February and March (Becker, 1962). Actually the 71 species listed above are a countdown of the spring and summer forms. An equally thorough sampling of the fall and winter population of the same lakes would undoubtedly show a considerably enriched fish fauna.

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DIE FREIEN GEMEINDEN IN WISCONSIN

*Berenice Cooper**

If a tourist of today should wander two blocks from the main street of Sauk City, Wisconsin, and come upon a large wooden building standing at the edge of a shaded park, he might be curious about the name, *Freie Gemeinde*, on a small metal plate at the corner of the building. The old-fashioned bandstand in the center of the park implies community gatherings in the past. The tall pine trees suggest daytime picnics over a period of years. Inquiries into the significance of this building and the surrounding park will reveal that both are the property of the Free Congregation of Sauk City.[1] Park Hall was erected in 1884 by the *Freie Gemeinde* (since 1937 known as the Free Congregation) of Sauk City, an organization founded there in 1852 by German-American settlers, who brought with them from their fatherland this free thought movement (X, pp. 1, 15, 19; XI, pp. 169–72).

Among the German Forty-eighters who settled here and in other Wisconsin communities were members of Free Congregations formed in Germany after 1840 (V, pp. 9–10; IX, pp. 673–75).[2] From Burlington north to Sheboygan and across the state through Mayville to Bostwick Valley,[3] there were in 1852 thirty similar societies of free-thinking Germans (I, December 1862, p. 91). But today Sauk City and Milwaukee are the only *Freien Gemeinden* which are still active.

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* Miss Berenice Cooper is Professor Emeritus, Department of English, Wisconsin State College, Superior.

[1] The congregation was organized as the *Freie Gemeinde von Sauk County* because many of the members were farmers living near Honey Creek and Merrimac and in other directions. In 1861 Honey Creek built a hall of their own; in 1863 Merrimac dedicated their hall. Although there is no longer a congregation at Honey Creek, the hall is kept in good repair and the cemetery around it is maintained by a cemetery association, Mrs. Clara Runge says that Merrimac hall was sold to the Merrimac *Gesangverein* in 1878 (X, p. 13). The active group is now in Sauk City and is spoken of as the Free Congregation of Sauk City.

[2] The Germans who migrated to the United States after the 1848 Revolution failed, are usually referred to as the "Forty-eighters." Often they immigrated to escape political or religious persecution by the victorious reactionary forces. A. E. Zucker is editor of a book of essays by different historians, *The Forty-eighters: Political Refugees of the German Revolution of 1848* (New York, 1950).

[3] In the passage cited from his reminiscences, Eduard Schröter lists the following *gemeinden* as active in 1852: Burlington, Calumet, Cedarburg, Fond du Lac, Germantown, Hermann, Howel's Road, Jefferson, Koskonony, Kilbourn Road, Madison, Manitowoc, Mayville, Mequon River, Milwaukee, New Holstein, Oshkosh, Plymouth, Polktown, Racine, Schleisingerville, Sheboygan, Sheboygan Falls, Theresa, Town Rhine, Two Rivers, Watertown, Waterville, Waukesha, West Bend.

The history of the German Free Congregations *(Freien Gemeinden)* in Wisconsin began in Germany in 1840–46,[4] when both Protestant and Catholic groups revolted against authoritarianism in church government and in theological dogma and withdrew from their orthodox churches to become independent groups (V, pp. 3–5; IX, pp. 672–73). Those members who came to the United States brought with them the principles of independence of the congregation and freedom of thought for the individual which became basic in the organizations formed in thirty Wisconsin communities.

The story of these independent-thinking societies belongs in the history of movements which have contributed to intellectual and religious liberalism in Wisconsin. Evidence of their rational philosophy and their democratic practices, which will be cited in this paper, show that nineteenth century science and humanism were strong influences upon the beliefs of the *Freien Gemeinden.* Although they did not unite with the Free Religious Association of the United States, they extended to them the hand of fellowship and sent observor-representatives to their conventions (I, March 1869, pp. 138–43; May 1869, p. 172; September 1870, p. 140).[5]

The purpose of this research is to discover and organize chronologically the available information about the *Freien Gemeinden* in Wisconsin so that their significance in the cultural history of the state may be apparent. This paper reports only the beginning of a continuing effort to discover more facts about the decline of the *Freien Gemeinden* in Wisconsin from thirty congregations in 1852 to the two surviving societies of 1964.

Since these Free Congregations are almost forgotten in Wisconsin, it may be appropriate to begin with some examples of their distinctive beliefs and practices. The constitutions of the two surviving societies, the resolutions passed when local congregations met in national convention to discuss and recommend, but not to legislate, the free thought magazine, *Blätter für freies religiöses Leben,* and reports of the national association, are some of the most useful sources for this information.

Like all Free Congregations in Germany and the United States, the Wisconsin groups guarded the independence of the congregation and the individual. The local organization was the highest authority

[4] The history of the movement in Germany and the causes of migration to the United States, written from the point of view of a Forty-eighter, may be found in Friedrick Schünemann–Pott's *Die Freie Gemeinde* (Philadelphia, 1861).

[5] The executive committee of the *Bund* suggested cooperation between the two organizations through *Bund* members joining as individuals the Free Religious Association and through exchange of publications. The committee wrote to the F.R.A. in English and included an English translation of the *Bund* constitution to show the similarity of the aims of the two organizations. In May, 1870, Alexander Loos, secretary of the *Bund,* attended the Boston meeting of the F.R.A. See *Blätter* . . . XV:3 (September 1870) 38–40, for his report.

in church government and there were no specific beliefs which every member must accept. The Sauk City congregation made this statement in Article II, sections 4 and 5 of its constitution adopted in 1853:

> There shall be no doctrine formally stated and authoritatively proclaimed or laid down, as by a church. We shall endeavor, however, to institute a self-sufficient philosophy in keeping with our ideals. We shall not profess atheism (theoretically), the denial or disbelief in the existence of a Supreme Being, but rather a practical atheism, namely: living so that we can interpret our Supreme Being as we desire and hold our own conception of immortality.
>
> We shall not designate any member to function as a priest or a minister does in a church. We shall have no specified lecturer or teacher unless the congregation so decides.

Nowhere in the constitution of Sauk City is there mention of an authority higher than the congregation.

A national association of congregations, *Bund der freien Gemeinden von Nordamerika,* was formed in 1859, but its constitution adopted in that year and revised in 1876, protected the local organizations from domination by a national organization:

> Regular conventions are to be held every third year. . . . No questions of principle are to be voted upon, yet the resolutions regarding them may be discussed and recommended to the further consideration of the single congregation. The resolutions of the convention regarding external matters of administration become binding only as soon as a majority of the members of the Association expressly ratify them. (I, March 1869, p. 140)

The Milwaukee constitution of 1949, section X, states the same principle of local autonomy:

> Affiliation with kindred organizations having the same or similar ideological aims as those of our organization can only be accomplished by vote of members of the *Gemeinde*. Only the *Gemeinde* as parent organization is impowered to elect delegates to such an organization.

Milwaukee has kept in its constitution the principle of freedom of thought which has guided all Free Congregations since they were founded in Germany. Section II states the purpose of the Milwaukee *Freie Gemeinde:*

> Conscious of the limitations of the human mind and aware of our dependence upon the forces known and unknown amid which our brief lives are spent, we seek nevertheless through education and dissemination of the truths of science to dispel ignorance and mysticism and destroy superstition, to create a wide and inclusive mental attitude which accepts the supremacy of human reason.
>
> We endeavor to establish through observation and experience a system of philosophy wide as the world and embracing all men, which will attempt to ascertain man's relation to the universal forces about him, and place him in harmony with such forces mentally and physically.

> Through knowledge of his common origin, his common end, and a realization of his common needs and tasks, to which we subscribe, men will eventually be able to make of this earth, which is our home, a place where ideals may grow, justice prevail, and where the good and true and beautiful may survive.

The emphasis upon this-worldliness, not other-worldliness, expressed in the last paragraph is in harmony with Sauk City's statement in its constitution (Article II, section 1) that the organization's aim is "to promote and cultivate the highest possible standards of ethics and morals in regard to all individual, social and business relationships" and with the *Bund* statement of 1876, "The highest good is earthly happiness through phyical, mental and spiritual well-being."

The most complete statement of belief discovered in this research is that of the Plymouth *Gemeinde* (I, May 1870, pp. 173–74). It begins, "We place reason above revelation," and it continues in parallel phrases to contrast the dogma of Christianity with the principles of Free Thought: for faith they substitute knowledge; for two worlds, one whose existence is certain; for an autocratic removed-from-the-universe God, the rule of eternal universal law; for miracles, natural law; for God's providence, man's own providence; for predestination, fate; for man torn apart by strife between flesh and spirit, unified, harmonious man; for trust in God, self-reliance; for humility, consciousness of human dignity; for abstinence, moderate use of pleasures; for desire for reward, love of good for its own sake; for heaven in another world, heaven in this world (in the hearts, homes, societies, and states of mankind); for values in heaven, values here; for inexplicable mysteries, unsolved problems; for the Bible, the book of nature and history; for the pulpit, the speaker's platform; for the preacher, the speaker; for supernatural salvation of the soul, natural education of the spirit and heart; for prescribed rituals, free customs; for the Christian school, the humanist school.

The platform concludes:

> This is our present general rule and plumb line. But there are no irrevocable conclusions of faith. We can make . . . in the future better rules and plumb lines . . . Each age is its own law-giver.

These principles of freedom of thought and democratic procedure are typical of the contribution which the German Free Congregations have made to the growth of rational philosophy and religious liberalism. But their contribution has received little recognition. The usual sources of information about Wisconsin history rarely mention them; only from their own publications and reports, in the German language, can facts be gathered to form the beginning of a history of the *Freien Gemeinden* in Wisconsin.

The first Free Congregation of Wisconsin was established at Painesville, south of Milwaukee. Some German Protestants from Wittenberg had settled in Oak Creek and Franklin townships. Displeased with the strict theology of their Lutheran pastor, they withdrew from the church and formed a Free Congregation, which first met at Buckholtz Tavern where today United States highway 41 meets Wisconsin 100. By 1851 they had incorporated with about 35 members and had been given an acre of land upon which to build a hall, which was completed in 1852. According to their report to the *Bund* in 1876, the membership in the 27 years of their history had increased to only 37, but their report explained that this seeming lack of growth was due to the fact that eight or ten families had moved to Minnesota,[6] where they had joined other Free Thought societies (IV, p. 60).

The activities at Painesville listed in this report included biweekly lectures at ten o'clock Sunday morning, a *gesangverein,* the circulation of Free Thought literature such as the *Freidenker* (or the *Truthseeker* for those who did not read German), and pamphlets by Karl Heinzen. The members lived on farms eight or ten miles from the hall, but a Sunday school of 15 or 20 members was maintained.

According to this 1876 report, the first speaker at Painesville was Herr Rausch (1851–53). His short service was terminated when he forsook Free Thought and became a Lutheran pastor in Racine. Robert Glatz, a former Catholic priest in Hanau, Germany, was the next speaker until his death in 1856. After Glatz' death, Christian Schröter, a farmer living seven and a half miles from the hall, was speaker and the writer of the 1876 report.

In the sources examined for this research no more information about Painesville appears until the *Bund* report for 1899. After paying their dues for that year, Painesville withdrew from the *Bund,* giving as the reason that "they had always been alone and in the future would remain alone" (VII, p. 1). Occasional meetings were held until about 1905 (II, p. 2).

The name, Painesville,[7] cannot be found on a modern map of Wisconsin, but it can be located in the *Historical Atlas of Wisconsin* (Milwaukee, 1878). The hall built in 1852 has been preserved because of the recommendation of Alexander Guth, an architect who surveyed and appraised historical buildings in Wisconsin in 1955. Following his recommendation, the Painesville Memorial Associa-

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[6] A number of Free Thinkers from the neighborhood of Milwaukee moved to Carver County, Minnesota about 1870. From Carver County, some moved on to Otter Tail County where their Free Thought cemetery, near Vergas, is located.

[7] Painesville is not spelled consistently in maps and records. *The Historical Atlas of Wisconsin* (Milwaukee, 1878) spells it Paynesville.

tion was organized and through its work the hall was restored and a bronze commemorative tablet placed at the right of the door (III, p. 7).[8]

Today one may see the simple white colonial hall, 24 by 36 feet, surrounded by the cemetery and protected by a white fence. Inside are the original pews and pulpit, and a stove bearing the date 1848. On the walls, just as described in the 1876 report, are portraits of Benjamin Franklin, Alexander Humboldt, and Thomas Paine. Unfortunately, the original hand-glazed windows were destroyed by vandals. The Girl Scouts now meet in the basement, which was added in 1939 as support for the walls. The Girl Scouts leader, Mrs. Harvey Davitz, is in charge of the hall.

Not long after Painesville organized, a Lutheran church in Milwaukee decided to declare its freedom from orthodoxy and invited Eduard Schröter, a Forty-eighter who had been lecturing in the East, to come to Milwaukee and organize them as a Free Congregation. While he served as speaker in Milwaukee (1851–53), Schröter established a Free Thought newspaper, *The Humanist,* and made missionary journeys lecturing in the state. When in 1853, he accepted the invitation to become speaker at Sauk City, he apparently left a vigorous group in Milwaukee. But soon after his departure, differences of opinion arose in this *gemeinde* which resulted in the group's disbanding in 1854 (XI, pp. 172–88; I, November 1856, pp. 78–80). Until 1867 there was no *Freie Gemeinde* at Milwaukee. Sauk City is, therefore, the older of the two surviving societies.

The Sauk City *Gemeinde* under Eduard Schröter as speaker grew from a few Free Thinkers gathered together by Carl Dürr to a society of 60 members in 1859, with a school and a library. By 1876 their activities included a women's society, a mixed chorus, and a theater society. The membership, which at that time included Honey Creek and Merrimac, has increased to 80 (IV, pp. 61–62; XII, p. 31). Later *Bund* reports show that membership continued to increase for the next 64 years: in 1918, 85 members; in 1923, 97; in 1940, 111.

Mrs. Clara Runge, a life-long member at Sauk City, wrote a history of the congregation for their 1940 Founders' Day celebration. In it she pays tribute to the quality of instruction in Schröter's

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[8] The inscription on the tablet reads:

> The Painesville Memorial
> Erected in 1852 as the
> "First Free Christian Church
> of the town of
> Franklin and Oak Creek."
>
> The chapel has been preserved
> in its original condition for
> its historical and architectural interest.
> October 1939 The Painesville Memorial Association

Sunday afternoon classes and in his meetings for older students on Thursday evenings. "He always introduced the best German poems and required each pupil to memorize and recite a poem each Sunday." On Thursday evenings there were discussions of literature and of passages from the Old Testament. Both Schröter and Friedrick Schünemann-Pott, speaker at Philadelphia and an active national leader in the *Freien Gemeinden,* referred to themselves as humanists and considered humanism a religion (X, pp. 6–7).

During the twenty-four years since Mrs. Runge wrote her history, the membership of the Sauk City Congregation has been decreasing. President Ralph Marquardt says that at present the membership is about fifty, but that attendance at the monthly meetings is often only fifteen or twenty. Founders' Day, Thomas Paine's birthday, and the Spring Festival are still observed, but the quiet celebrations of the present are a sharp contrast to the days older members recall.

Miss Minnie Truckenbrodt, the oldest member of the Congregation, remembers that in her girlhood the Spring Festival was an all day and all night celebration, beginning with a band concert at ten o'clock Sunday morning and concluding with a dance that lasted until the early hours of Monday morning.

There was a speaker at eleven Sunday morning. During his lecture, the good cooks inside the hall were preparing chicken, beef, potatoes, beans, peas, carrots, lettuce, kraut-salad, and pies. Tables were filled several times for the noon feast. An afternoon of visiting and music followed, interrupted by coffee and cake in the dining room at three, or visits to refreshment stands in the park. At six o'clock, the women served a substantial supper, not a snack. About eight o'clock, a dance orchestra began to play in the lecture room on the main floor. Every one danced: children, young people, parents, grandparents. The floor was crowded for polkas, waltzes, and square dances. Downstairs beer was sold to the thirsty dancers. At midnight came another hot dinner, *not a lunch,* says Miss Truckenbrodt.

A large number of the members were farmers. They reasoned why not finish the night dancing? Why leave after midnight and get home for very little sleep before five o'clock milking? Why not dance on and go right to work when they got home? So that is what they did.

Such gayety was only one of the *Gemeinde* activities. There were plays, a *gesangverein,* declamation and debate programs, concerts, lectures, and a library of German books.

A few examples from the subjects of lectures which Mrs. Runge has listed show that Sauk City had serious intellectual interests: Eduard Schröter, "Schiller, His Work and His Death"; Dr. Herman

Lueders, "Bacteria, Their Relation to Agriculture"; Mrs. Hedwig Henrich-Wilhelmi, "The Modern Woman of Europe"; Rev. Howard Udell, "Henrich Ibsen's *Brandt*"; Mrs. Mary Church Terrell, "Negroes and their Rights." (X, pp. 20–26).

A further evidence of the intellectual interests of the Sauk City Congregation is the library, seldom used now, since most of the books are in German and only the older members read German with ease. A room off the balcony above the lecture room holds books, magazines, and pamphlets that contain valuable source material for a history of the *Freien Gemeinden* in Wisconsin.[9]

Since so few of the younger generations use the German language, Sauk City in 1937 adopted English for its meetings and records and translated its official name to the Free Congregation of Sauk City. In 1955, the group affiliated with the Unitarian Church and became the Free Congregation of Sauk City—Unitarian Fellowship.

The other surviving *Gemeinde,* Milwaukee, has kept its German name and uses the German language in its business meetings and most of its activities, although there is a discussion section conducted in English. Organized in 1867 with only nine members, the Milwaukee *Gemeinde* enrolled 250 members by 1868. By 1876 it had established a variety of activities: 26 lectures a year with an average attendance of 70 or 80; a Sunday school of 150 in which instruction in the catechism of humanism was given; debates, festivals, a women's society, a singing society, a reading section, and an organization to give assistance to the families of deceased members (II, July 1868, p. 12; IV, pp. 63–67).

Bund reports from 1900 to 1924, on file in the Free Congregation library of Sauk City, show fluctuations in number of members from 157 to 250. According to Walter Niederfeld, secretary, the present membership is 129. Although there are no young people's organizations or Sunday school classes, as in the years 1876–1924, the Milwaukee *Freie Gemeinde* is carrying on a variety of activities.

It rests upon a successful business organization because Jefferson Hall is a source of considerable income and an assurance of financial stability. The basement of the large brick building is leased to the operator of a well-patronized bowling alley. On the first floor are social rooms with kitchens which are rented every day between Easter and the middle of June. A bar on this floor

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[9] In the Sauk City Free Congregation library, there is rare material on the history of the *Freien Gemeinden* in the United States and in Germany. The Free Thought magazine, *Blätter für freies religiöses Leben,* (18 volumes) contains reports from local *gemeinden* in the United States and in Europe, the travel-letters written by Schünemann–Pott on his lecture tours through the East and Middle West, and articles about the principles of the *Freien Gemeinden.* The nearly complete files of *Bund* reports up to 1924 and over forty thin volumes of sermons preached in Germany to the Free Congregations 1840–50 are also valuable sources of historical information.

brings in more income. On the second floor is an auditorium where there is a concert nearly every Sunday. Here also are staged dramatic performances which continue a traditional *gemeinde* activity.

Discussion groups meet once a month, a German and an English group. The *Gesangvereinsektion,* which attended the International Song Festival in Germany in 1962, the *Damenchor,* and the *Frauenverein* are activities announced in the monthly magazine *Voice of Freedom* (carrying as its subtitle the former German name, *Das Freie Wort).* Secretary Niederfeld says that the group is much interested in politics and in all legislation for freedom of the individual citizen.

The advantage of being located in a city with a large German-American population is one explanation of the survival of the Milwaukee *Freie Gemeinde.* The ability of its executive board to adapt the financial organization of the society to meet requirements of modern tax laws, has made the operation of the hall profitable and insured Milwaukee against the financial problems which have been a factor in the disappearance of *Gemeinden* in so many smaller communities.

Among the five Wisconsin *Gemeinden* reporting to the *Bund* in 1876 were Bostwick Valley and Mayville, both of which became inactive early in this century. Neither used the name *gemeinde:* Bostwick Valley called itself the *Freidenker-Verein* and Mayville reported as *Der Freie Manner-Verein* (IV, pp. 67–68).

According to its report, Bostwick Valley was founded in 1869 and had just celebrated its seventh Founders' Day on June 11. It belonged to the *Provincial Verbande von Wisconsin* to which it made a yearly contribution of twenty dollars. On May 8, 1876, it had joined the *Bund* with a membership of 33.

Maxmillan Gross, the speaker, reported a library of 15 volumes, a school of about 12 students meeting three times a week under the instruction of the speaker, and a *gesangverein* in the process of organization. The speaker lectured twice each month. The group was free from debt, owned its hall, the furnishings, and the lot. The property was valued at $700.00. Yearly contributions from the members amounted to about $200.00.

Later *Bund* reports found in the Sauk City library show that in 1914 Bostwick Valley had only 20 members, a library of 29 volumes, and property valued at $4000.00. Two years later, the president of the *Bund* reported that Bostwick Valley had been dissolved on June 25, 1916, because of lack of financial support. He added that a few members from West Salem and La Crosse had joined the *Bund* as individuals.

Inquiries by the writer of this paper in April, 1963, resulted in locating among the older citizens of West Salem a few persons who remembered that in their youth the Free Thinkers of Bostwick Valley were an active group. Some had attended the summer school conducted by the Free Thinkers in order to study German. Alfred Hemker, son of the president of the group in its last years, recalled lively social affairs; at one of the dances held in the basement of the hall he had met his wife. The brick hall, mentioned in *Bund* reports, is still standing in Bostwick Valley, but it has been purchased by Barre Mills for use as the town hall.

The last of the five Wisconsin groups reporting at the 1876 convention was Mayville. According to a letter written by the secretary, Charles Ruedebusch in 1868, Mayville had been organized in 1863 (II, August 1868, p. 32). The *Bund* report of 1876 is very brief, not signed by an officer of the society, and reads as if the *Bund* office were speaking. After the statement that Mayville *Freie Männer-Verein* of Dodge County joined the *Bund* in 1870 (after it had been organized several years) and that their principal activity had been the undertaking of a German school, which had now been incorporated with the public school, comes the statement that no specific statistics or other announcements about themselves have been received "in spite of our requests." The report concludes, "The spiritual growth of the members is directed by the lectures of a traveling speaker" (IV, p. 71).

In *The Mayville Story,* a booklet issued in 1947 to commemorate the centennial of the city, a few historical sketches written by Mayville citizens mention German organizations but do not connect them with the Society of Free Men. Mrs. Ottilie Ruedebusch tells of *Die Freie Deutsche Schule,* which taught both German and English. It was built in 1871 because there was no public school, but when a public school was built in 1876, the German school was discontinued and the building given to the Turners, who enlarged it and used it as a social center until 1946 when they sold it to the Masons.

Mrs. Charles Schumann in "A Walk Through Mayville Fifty Years Ago," tells of a *Frauenverein* and a *Männerchor,* but does not connect them with a Free Thought group. Mr. John Husting, attorney at Cedarburg, in a letter of September 13, 1963, says that his mother, who came to Mayville in 1893 at the age of 14, has no knowledge of a Free Thought group at that time. "The Turner was for many years the center of Mayville's culture: plays, musical affairs, gymnastic exhibitions. It is not known whether the Free Thinker group helped or not."

From the evidence available at present, we can be sure a Mayville *Freie Männer-Verein* did exist for a few years after 1870, the year they joined the *Bund.* The sale of the schoolhouse might indicate their decision to unite with the Turners in the German activities of that organization.

In several little communities near Milwaukee, Free Thought groups at one time were active. In the case of Thiensville, there are interesting legends reported by a *Milwaukee Journal* feature writer (October 13, 1940). According to this story, Thiensville was a "godless city," the "Paris of Wisconsin;" the town managed to keep out churches until 1919 when a Catholic church was finally established. Older citizens of Thiensville, children of Free Thinkers, and in some cases Free Thinkers themselves, agreed upon being interviewed that they had never heard of any active opposition to the organization of churches. "We just felt we didn't need churches, and we wanted to be left alone," was the way one woman put it.

Paul Seiffert is a retired pharmacist, whose grandfather Baron von Seiffert came from Saxony in 1845 and hung on the door of his log cabin the coat of arms given his family in 1716 for their service to the state. Mr. Seiffert was willing to talk about his childhood in a family of Free Thinkers. When as a young boy he asked his father's permission to attend a church Sunday school with one of his friends, the answer was, "No. When you are twenty-one and old enough to make your own decisions, you may decide for yourself."

Although Mr. Seiffert does not remember that any direct instruction in principles of Free Thought was given the children in the home, he does recall the Sunday walks with his maternal grandfather Von Barkenhauser, who would take Paul and his sister to the woods and teach them to recognize different trees and flowers. He was certain that in his boyhood there was no formally organized *gemeinde* but there were a singing group and informal social activities for the Free Thinkers. Others interviewed were in definite agreement on this point.

When it came to marriages and funerals, the Free Thinkers never had a minister. A justice of the peace or a leader in the Free Throught group officiated at marriages. Funerals were non-religious with one of the Free Thinkers speaking briefly. One man requested that his friends take a walk in the woods instead of giving him any funeral ceremony.

A bit of information about Mequon and three other vanished *gemeinden* comes in a letter from an unnamed correspondent to the *Blätter für freies religioses Leben* (I, November 1856, pp. 79–80). He writes that there has been no *gemeinde* at Milwaukee since 1856, but that there are *gemeinden* at Kilbourn Road and Cedarburg, and the ruins of one at Howel's Road, and that there is a report that a *gemeinde* may be organized at Mequon. This correspondent concludes that "there is a field here and there in the Milwaukee neighborhood, but the spiritual power and the outward means are entirely lacking."

Cedarburg, Howel's Road, Kilbourn Road, and Mequon are among those communities listed by Schröter in 1862 when he was lamenting the diminishing interest in Free Thought: "Where except on the banks of the Wisconsin River in Sauk and Dane Counties is there a trace of the many victories of enlightenment?" (I, December 1862, p. 91)

Schröter's lament over the retreat of the "forces of enlightenment" was prophetic. Fourteen years later only four Wisconsin groups reported to the *Bund:* Painesville, Sauk City, Milwaukee, Bostwick Valley. As we have seen, the lack of a report from Mayville was noted by the *Bund* office. During and after the 1876 *Bund* convention, the organization by Karl Heinzen of a *Bund der Radikalen* disrupted the *Bund der Freien Gemeinden und Freidenker-Verein,* and it was not reorganized until 1897 (V, pp. 11–12). In 1900 only Bostwick Valley, Milwaukee, and Sauk City reported, and Painesville withdrew "to be alone." In 1916 Bostwick Valley disbanded because of lack of financial support. In succeeding reports only Milwaukee and Sauk City represent Wisconsin. Today these two societies go their separate ways. Milwaukee belongs to the American Rationalist Association; Sauk City is affiliated with the Unitarians.

A variety of reasons may be logically conjectured for the diminished membership of the *Freien Gemeinden* in Wisconsin: marriage of children of *gemeinden* families with children of orthodox families; loss of interest in German language and culture by the second and third generations of German-Americans; lack of enough leadership and money to keep the movement alive; the growing liberalism in some orthodox churches which gave less ground for objection to their principles.

In summary, it may be said that the illustrations of the beliefs and practices of the *Freien Gemeinden* in Wisconsin presented in this paper, show these contributions to the cultural history of Wisconsin:

1. In a period of conflict between orthodox religion and science, they were among the first to demand that religion should be in harmony with the developing scientific knowledge.
2. They believed in the right of the individual to search for truth wherever he found it whether or not the results agreed with traditional beliefs.
3. In their ideal of using new knowledge of nature and man to make this world a better place for human beings, they were among the nineteenth century humanists who anticipated the "social gospel" of the twentieth century churches.

4. These men and women were among the earnest intellectuals of the state for while enduring the hardships of pioneer life, they took time and energy to nourish the life of the mind by listening to lectures on philosophy and literature, by establishing libraries, by organizing groups to perform in drama and in vocal and instrumental music.

In taking stock of its cultural heritage, Wisconsin should recognize the contribution made by the *Freien Gemeinden.* Two practical means of recognition would be the effort to preserve such of their records as are not already lost and the commemoration by appropriate historical markers of the buildings and communities connected with their history.[10] The Painesville Memorial is an example of what should be done for the hall in Bostwick Valley and for all places where these independent-thinking pioneers gathered to keep alive the best of the heritage of the Old World culture and to add to it the new knowledge of the nineteenth century.

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[10] See unpublished manuscript "A Partial Bibliography of Material on the *Freien Gemeinden* in the Library of the Free Congregation of Sauk City," prepared by Berenice Cooper, in manuscript department of the Library of the Wisconsin Historical Society. Milwaukee County has a collection of material on the *Freien Gemeinden,* assembled by Theodore Mueller, retired librarian.

THE EFFECTS OF FIRE ON THE VEGETATIONAL COMPOSITION OF BRACKEN-GRASSLANDS

*Richard J. Vogl**

A study of the vegetational composition of bracken-grassland communities and of changes resulting from fire was undertaken during the summers of 1959 and 1960.[1] Six Conservation Wildlife Areas in Vilas, Florence, Marinette, and Oconto Counties in northeastern Wisconsin were selected for study (Figure 1). The vegetation of these areas is being managed for sharptailed grouse *(Pedioecetes phasianellus)* by using prescribed burning.

Bracken-grasslands have only recently been recognized as a major type of grassland in Wisconsin (Curtis 1959). Previously, little information was available on the composition and origin of this community. Curtis (1959) stated that bracken-grasslands in Wisconsin occur on open upland sites north of the tension zone. These upland openings are generally surrounded by northern pine-hardwoods or boreal forest. The bracken-grasslands (Figure 2), however, are usually treeless and dominated by bracken fern *(Pteridium aquilinum)*.[2]

There is general agreement that fire is an essential factor in the initiation of bracken-grasslands (Maissurow 1941, Curtis 1959). Bracken-grasslands that originated since recent European settlement are considered the result of logging followed by fire (Schorger 1943, Hamerstrom *et al.* 1952, Stearns 1961). Before logging and burning, some areas were covered by thin forests of red pine *(Pinus resinosa)* and scattered white pine *(Pinus strobus)* (Wilde *et al.* 1949). Other areas were occupied by more mesic stands of sugar maple *(Acer saccharum)* and associated species or by boreal forest. Today these areas, known locally as "stump prairies," are occupied by bracken-grasslands dotted with stumps.

In an attempt to utilize "stump prairie" openings, the U.S. Forest Service and county forest agencies tried to establish pine plantations on them which subsequently failed (Frome 1962). This failure was blamed not only on drought and poor planting techniques, but

* Richard J. Vogl is an Assistant Professor of Botany at Los Angeles State College. Field work for this study was undertaken as part of the author's doctoral program at the University of Wisconsin–Madison.

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[2] Nomenclature for plant species follows Fernald (1950).

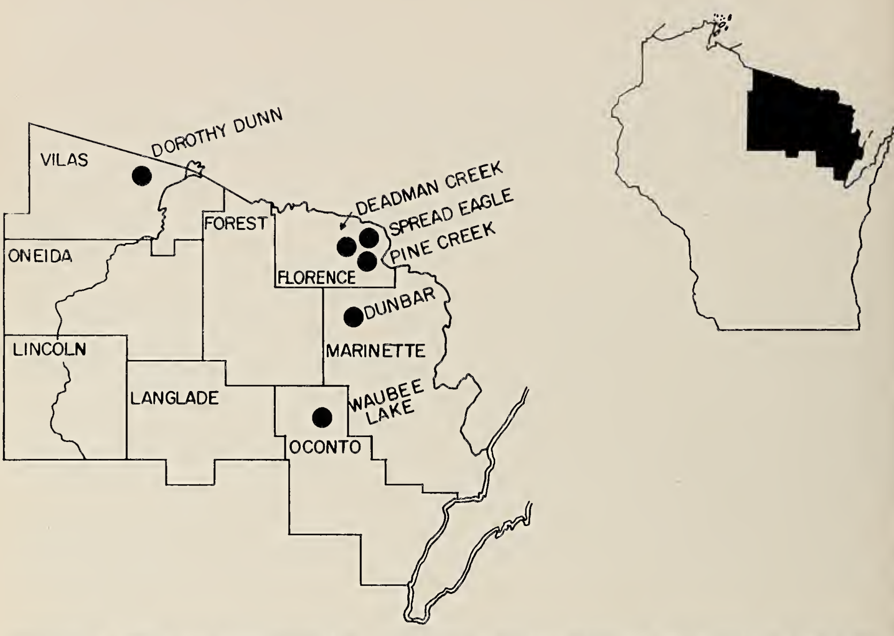

FIGURE 1. The six Conservation Wildlife Areas selected for study of bracken-grasslands in northeastern Wisconsin.

also on frost, since some of these areas are depressions or natural "frost pockets" (Curtis 1959, West 1961). As a result, some "stump prairies" have been classified as unfit for reforestation (Stoeckeler and Limstrom 1942) and are presently being managed for sharptailed grouse by the Wisconsin Conservation Department.

Sharptailed grouse and their habitat have gradually been fading from the landscape in northeastern Wisconsin (Lintereur 1959). Typical sharptail country consisted of large open areas several thousand acres in size with scattered patches of low brush and thickets of young forest (Newman 1959). In an effort to restore the sharptailed grouse to higher densities, intensive management of the vegetation was undertaken by the Game Management Division of the Wisconsin Conservation Department. Twenty wildlife areas in the state, totaling 116,406 acres, were being managed for sharptails as of 1959 (Newman 1959). Many openings are reverting to forest as a result of improved fire protection, reforestation and the abandonment of marginal farms. In these areas, prescribed burning is being used as a management tool to recreate openings in the encroaching second-growth forest (Schorger 1962).

I am indebted to the late Dr. John T. Curtis, University of Wisconsin, for his stimulating discussion, encouragement, and guidance throughout the course of this work.

FIGURE 2. A burned bracken-grassland dominated by bracken fern.

DESCRIPTION OF STUDY AREAS

Six areas which contained experimental tracts that had been subjected to prescribed burning were selected. The Dorothy Dunn Wildlife Area is in north-central Vilas County near the headwaters of the Manitowish River. The terrain consists of a series of rolling to choppy hills with narrow, steep ridges separating deep "pockets" or depressions. It is generally open with some timber on the ridges, mainly white birch *(Betula papyrifera)*, red pine, jack pine *(Pinus banksiana)*, and red maple *(Acer rubrum)*. Old decomposed pine stumps are found scattered over the ridge slopes and depressions. The predominant groundlayer vegetation on the ridges and hillsides is low in form, dominated by poverty grass *(Danthonia spicata)*, orange hawkweed *(Hieracium aurantiacum)*, and numerous lichens.

Three of the study areas, Spread Eagle Wildlife Area, Deadman Creek, and Pine Creek are adjacent to each other and are very similar. They cover 7000 acres in the extreme northeastern part of Wisconsin in Florence County, west of the Menominee River (the Michigan-Wisconsin boundary) (Figure 1). The landscape consists of a series of huge, open, upland basins which contain scattered small hills, with adjacent basins separated by steep ridges (Figure 3). Timber in the form of scattered large red pines, coppiced, open-grown white birches, and red maples occurs only on the separating ridges. Dense stands of jack pine grow on the north-facing slopes of the hills. The hills and ridges are covered by bracken fern and the low terrain is dominated by slender wheatgrass *(Agropyron trachycaulum)*, wild chess *(Bromus kalmii)*, rice grass *(Oryzopsis*

FIGURE 3. Spread Eagle Wildlife Area, composed of a series of open, upland basins. Bracken fern covers the ridges along with red pine, jack pine, and white birch.

asperifolia), and barren strawberry *(Waldsteinia fragarioides)*. This area is unique because there are no stumps in the clearings which indicates that the present openings did not support forest growth in presettlement times. This agrees with information obtained from logging records and long time residents.

The Dunbar Wildlife Area, an opening of over 1000 acres, is known locally as the "Kohler Flats." These level uplands, which contained some stands of red pine, have been logged and cleared since white settlement (Lintereur, personal contact). Now, huge pine stumps, large Juneberry *(Amelanchier* sp.) bushes, and an occasional small tree dot the flats. The ground vegetation is dominated by slender wheatgrass, poverty grass, and ciliated aster *(Aster ciliolatus)*. Sand cherry *(Prunus pumila)* and sweet fern *(Myrica asplenifolia)* have the highest shrub frequencies.

The last study area consists of several Wisconsin Conservation Department management units within Nicolet National Forest. Included are several small upland openings, some of which are located in well drained pockets or depressions. The surrounding forest of second-growth northern pine-hardwoods is encroaching upon the openings which are dotted with old pine stumps. The ground-layer vegetation is dominated by bracken fern, little bluestem *(Andropogon scoparius)*, and common goldenrod *(Solidago missouriensis)* along with large local patches of sweet fern and wild bergamot *(Monarda fistulosa)*.

Soil samples taken were variable. All of the soils were sandy, ranging from fine sands and sandy loams to melanized sands. Some of the grassland soil samples were similar to the surrounding forest soils. Others had a deeper litter (A_0 layer) and a richer organic horizon (A_1 layer) than the adjacent forest soils.

Soils in the Dunbar area were extremely sandy with a poorly developed A_1. The soils of Spread Eagle and adjacent areas were melanized sands with a heavy A_0 layer and a dark, rich A_1 horizon. Areas within Nicolet National Forest were very rocky; this made it difficult to install adequate firebreaks for the prescribed burning.

Methods

To determine the effects of fire on the vegetational composition of bracken-grasslands, 27 stands were selected for survey. The number of stands sampled was limited by the number of bracken-grasslands burned.

The criteria used in the selection of each stand are that it be dominated by bracken-grasslands species (Curtis 1959), be of uniform topography, be at least 25 acres in extent and be an upland site—one which is well drained and never has standing rain water on the surface. The unburned areas or controls were free from disturbance for at least the past 25 years. The adjacent burned stands were similar to the controls in site, slope, exposure, history, and vegetational composition, differing only in the treatment of fire. When two burned stands were similar and in the same immediate area, only one adjacent control stand was sampled for comparison.

The main purpose of the control burning conducted by the sharp-tailed grouse management program of the Wisconsin Conservation Department was to try to extend the present grasslands by reducing the density of the surrounding woodlands and by eliminating the encroaching trees and shrubs. Firing of the grasslands was also expected to stimulate sharptailed grouse foods, reduce undesirable species, and to increase bird accessibility to the grasslands by eliminating accumulated dead growth.

All burning was done in the months of March and April. The 15 burned stands and adjacent control stands were sampled in July and August of the year of the burn or the year following. All stands, except three, were subjected to one prescribed fire. Two stands were control-burned three times and one stand was swept by two wildfires.

Each stand was sampled in the following manner. An area of uniform vegetation 33 meters square was selected and within this square the sample was taken by laying out 20 quadrats at random, each a meter square. The presence of all species in each quadrat was recorded to obtain the frequency of occurrence of each species. This frequency was then calculated and expressed as per cent.

Within the 33 meter square study plot all trees, both living and dead, were recorded by size classes. The number of stems per resprouted tree was counted. Density and dominance were then determined for each tree species. In addition, the percentage of cover or canopy of the trees was estimated visually for each study plot. A presence list was made of all species found in the stand.

Evaluation of results and the effects of fire is based primarily on quantitative frequency data since they are more indicative of changes than is a comparison of presence lists.

Results

The vegetational composition of undisturbed bracken-grasslands is evident from the list of 21 prevalent species (Table 1). This list was obtained by calculating the average number of species sampled (21) in each of the 12 unburned stands. All species were arranged in a descending order of their average percent frequencies and the top 21 were selected as prevalents. The average percent frequency for a species was obtained by totaling its percent frequency in all stands and dividing the sum by the number of stands sampled. The prevalents of the burned stands were similarly determined. A total of 63 species was encountered in the entire sampling.

In the unburned stands the five species with the highest average frequencies are bracken fern, sweet fern, sweet blueberry *(Vaccinium angustifolium)*, *Carex* sp., and wintergreen *(Gaultheria procumbens)*. Bracken fern and sweet fern are the dominant species, the first and most widespread dominant being bracken fern.

Six grasses, Kentucky bluegrass *(Poa pratensis)*, rice grass, false melic *(Schizachne purpurascens)*, wild chess, slender wheatgrass,

TABLE 1. LIST OF 21 PREVALENT SPECIES CHARACTERIZING THE COMPOSITION OF UNDISTURBED BRACKEN-GRASSLANDS IN NORTHEASTERN WISCONSIN

AVERAGE FREQUENCY	SPECIES
52.9%	*Pteridium aquilinum*
51.7%	*Myrica asplenifolia*
49.6%	*Vaccinium angustifolium*
42.5%	*Carex* sp.
42.1%	*Gaultheria procumbens*
37.1%	*Waldsteinia fragarioides*
36.7%	*Poa pratensis*
36.3%	*Rubus*-blackberry
32.9%	*Oryzopsis asperifolia*
31.2%	*Schizachne purpurascens*
31.2%	*Solidago missouriensis*
29.2%	*Convolvulus spithameus*
23.3%	*Aster macrophyllus*
22.9%	*Bromus kalmii*
20.8%	*Apocynum androsaemifolium*
19.6%	*Agropyron trachycaulum*
17.9%	*Aster sagittifolius*
17.1%	*Fragaria virginiana*
16.7%	*Diervilla lonicera*
14.2%	*Muhlenbergia racemosa*
13.3%	*Amelanchier* sp.

and marsh Muhly *(Muhlenbergia racemosa)*, comprise 29% of the prevalent species.

Prevalent forbs include common goldenrod, low bindweed *(Convolvulus spithameus)*, large-leaved aster *(Aster macrophyllus)*, and arrow-leaved aster *(Aster saggittifolius)*. All of these species, except low bindweed which usually grows under the dense canopy of bracken fern, are known or strongly suspected to be active in antibiotic production (Cottam and Curtis 1951, Curtis 1959).

Prevalents generally associated with forest are wintergreen and barren strawberry, both achieving maximum presence in northern dry forest, and bush honeysuckle *(Diervilla lonicera)*, achieving maximum presence in boreal forest (Curtis 1959). The existence of forest species in adjacent openings is not uncommon and many species are found in openings and are able to survive even after the tree canopy has been removed (Bray 1958).

Among the shrubs, sweet fern and sweet blueberry are extremely high in average frequency. Juneberry is scattered throughout the grasslands and blackberry *(Rubus* sp.) is common on the ridges.

Subjecting the bracken-grassland to prescribed fire causes some changes in the prevalent species (Table 2). Species characterizing the burned stands are sweet blueberry, sweet fern, *Carex* sp., bracken fern, and barren strawberry. The two dominants now are sweet blueberry and sweet fern.

TABLE 2. PREVALENT SPECIES LIST FOR BURNED BRACKEN-GRASSLANDS

Average Frequency	Species
57.3%	*Vaccinium angustifolium*
52.7%	*Myrica asplenifolia*
44.3%	*Carex* sp.
44.0%	*Pteridium aquilinum*
35.7%	*Waldsteinia fragarioides*
35.3%	*Poa pratensis*
33.3%	*Convolvulus spithameus*
33.0%	*Rubus*-blackberry
31.3%	*Schizachne purpurascens*
26.0%	*Oryzopsis asperifolia*
21.3%	*Amelanchier* sp.
19.7%	*Solidago missouriensis*
19.3%	*Aster sagittifolius*
17.7%	*Aster macrophyllus*
17.7%	*Muhlenbergia racemosa*
17.3%	*Apocynum androsaemifolium*
17.0%	*Bromus kalmii*
16.3%	*Gaultheria procumbens*
13.0%	*Agropyron trachycaulum*
12.3%	*Fragaria virginiana*
11.3%	*Prunus pumila*

The prescribed fires set on each area were variable, ranging from extremely hot ones to those burning with difficulty or in a spotty manner. Because of this variation, valid comparisons could not be made between individual fires, between areas with differing fire histories or between burns of varying ages even though such factors influence community composition. A general and more adequate comparison was made by summing the results of each species in all the burns and comparing these results with those of the controls. That is, the percent frequencies obtained for each species from all of the burned stands and those obtained from all of the control stands were totaled and averaged to provide two comparable average percent frequencies for each species.

The average percent frequency of each control species was compared to the corresponding frequency in the burns to divide species into increasers, decreasers, and neutrals, depending upon their response to fire. Increasers were those species with an average frequency at least 5% greater in the burns than in the controls. If a species decreased in average frequency 5% or more after burning, it was considered a decreaser. Species that differed less than 5% in average frequency were classified as neutral species. These limits were set arbitrarily, thus permitting the categorization of gross obvious fluctuations caused by fire. In order to evaluate these categories, a statistical test, Student's t-test, was applied to each species to see if there was a significant increase or decrease at 95% confidence limits (Simpson *et al.* 1950).

Table 3 lists the increasers, decreasers, and neutrals. The majority of the species fall into the neutral category (76.5%) and the remaining species are classed as decreasers (17.6%) and increasers (5.9%).

Examination of the average relative frequencies reveals that few sharp changes occurred after burning. Of the three species classed as increasers, none changed greatly. Juneberry had the highest increase (8.0%) since it is a vigorous resprouter after burning.

TABLE 3. SPECIES GROUPED AS INCREASERS, DECREASERS, OR NEUTRALS, DEPENDING UPON THEIR RESPONSE TO FIRE

Increasers		Decreasers	
Ave. Freq. Difference	Species	Ave. Freq. Difference	Species
+8.0%	*Amelanchier* sp.	—25.8%	*Gaultheria procumbens*
+7.7%	*Vaccinium angustifolium*	—12.6%	*Lysimachia quadrifolia*
+5.5%	*Lactuca scariola*	—11.5%	*Solidago missouriensis*
		— 8.9%	*Pteridium aquilinum*
		— 7.7%	*Diervilla lonicera*
		— 6.9%	*Oryzopsis asperifolia*
		— 6.6%	*Agropyron trachycaulum*
		— 5.9%	*Bromus kalmii*
		— 5.6%	*Aster macrophyllus*

Neutrals			
Ave. Freq. Difference	Species	Ave. Freq. Difference	Species
+4.1%	*Convolvulus spithameus*	— 4.8%	*Fragaria virginiana*
+3.8%	*Comandra richardsiana*	— 3.5%	*Apocynum androsaemifolium*
+3.6%	*Monarda fistulosa*	— 3.4%	*Viola adunca*
+3.5%	*Muhlenbergia racemosa*	— 3.3%	*Rubus*-blackberry
+2.0%	*Hieracium aurantiacum*	— 2.4%	*Andropogon scoparius*
+1.9%	*Populus tremuloides*	— 1.6%	*Erigeron annuus*
+1.8%	*Carex* sp.	— 1.4%	*Waldsteinia fragarioides*
+1.4%	*Aster azureus*	— 1.4%	*Poa pratensis*
+1.4%	*Aster sagittifolius*	— 1.4%	*Solidago nemoralis*
+1.1%	*Salix discolor*	— 1.1%	*Corylus americana*
+1.0%	*Myrica asplenifolia*	— 0.8%	*Aster ciliolatus*
+0.9%	*Maianthemum canadensis*	— 0.6%	*Melampyrum lineare*
+0.6%	*Anemone quinquefolia*	— 0.6%	*Danthonia spicata*
+0.6%	*Hieracium scabrum*	— 0.5%	*Prenanthes alba*
+0.2%	*Campanula rotundifolia*	— 0.4%	*Prunus pumila*
+0.2%	*Pinus banksiana*	— 0.4%	*Rosa* sp.
+0.1%	*Schizachne purpurascens*	— 0.1%	*Agrostis hyemalis*
+0.1%	*Berteroa incana*	— 0.1%	*Hieracium canadense*
+0.1%	*Physalis virginiana*	— 0.1%	*Prunus pensylvanica*

Sweet blueberry increased 7.7%, becoming the most prevalent species after burning. This agrees with the findings of other workers (Ahlgren and Ahlgren 1960).

Among the decreasers, wintergreen showed the greatest reduction in frequency (—25.8%). This species and large-leaved aster are most common in northern pine-hardwood and boreal forests (Curtis 1959) and would not be expected to be adapted to continual fires. Whorled loosestrife *(Lysimachia quadrifolia)*, generally found in the dense shade of bracken fern, is also reduced in frequency after burning, perhaps as a result of the reduction in frequency of bracken fern. Other authors have demonstrated that bracken fern increased in frequency and actually takes over after burning (McMinn 1951, Martin 1955). This increase occurs in burned forest areas and is considered a response to the increased light resulting from a decrease in the tree canopy. In the bracken-grasslands, however, the tree canopy is only fragmentary and here the slight decrease in frequency is thought to be a direct response to fire. The same is true for bush honeysuckle.

Three of the native grasses listed as decreasers are slender wheatgrass, wild chess, and rice grass.

Although almost one-fourth of the species were placed into subjective increaser or decreaser categories, none of the species showed a statistically significant increase or decrease at the 95% level except the decreaser wintergreen.

Most of the common and characteristic bracken-grassland species are neutrals. Within the neutral category, the species are sub-divided into those exhibiting increased frequency and those exhibiting decreased frequency within the 5% limits. None of these fluctuations are statistically significant at the 95% level. Twenty-eight of the species are considered as modal species for Wisconsin bracken-grasslands by Curtis (1959) since their presence values are highest in this community. An additional 13% are listed as prevalents by Curtis. Shrubs such as hazel *(Corylus americana)*, sweet fern, sand cherry, rose (*Rosa* sp.), blackberry, and willow are listed among the neutrals. In addition, tree reproduction frequencies are given. Fifteen percent of the neutrals are grasses and 62% are forbs, the majority of which are perennials.

Additional species were recorded in the sampling. Six species, *Arctostaphylos uva-ursi, Pinus resinosa* seedlings, *Trientalis borealis, Senecio pauperculus, Solidago gigantea,* and *Steironema ciliata,* were present in the control sample but absent after burning. These species were uncommon in the control sample and were eliminated by fire from the burned sample.

Three other minor species, *Chenopodium album, Erigeron canadensis,* and *Panicum capillare,* absent in the controls, were found invading the burned stands. These are weedy species characteristic of disturbed sites.

Effects of Fire on Tree Layer

The sampling procedure used in evaluating the timber growing on the elevated portions of the bracken-grasslands is described in the Methods.

Estimations of canopy cover revealed that the unburned study plots had an average canopy of 22.4% which was reduced to an average cover of 4.3% after burning.

White birch is one of the major tree species. The majority of birch on unburned sites had coppiced trunks with an average of two stems per tree and 26 trees per acre. After burning, they root-resprouted into "bush-like" trees with an average of four stems per tree and 18 trees per acre. The average basal area per acre was decreased 90%. Mortality occurred in 31% of all the birch sampled because they were killed by burning or were decadent prior to burning and thus unable to resprout.

Hill's oak *(Quercus ellipsoidalis),* quaking aspen *(Populus tremuloides),* and black cherry *(Prunus serotina)* resprouted after burning. Hill's oak maintained 30 trees per acre before and after burning but had an 82% reduction in average basal area. Mortality occurred in 40% of the aspen sampled (reduced from 20 to 12 trees per acre) but the remaining living trees resprouted vigorously to produce only a 1% decrease in the average basal area per acre. Fire lowered the density of black cherry from 12 to 4 individuals per acre (66% mortality) with a corresponding 82% decrease in basal area.

Red maple had also been encroaching on the grasslands but usually failed to resprout after burning. It was reduced from 26 to 2 trees per acre (94% mortality) with an 88% decrease in average basal area.

Red and jack pine did not resprout and individuals of small diameter were eliminated by fire. However, large open-grown pines escaped destructive crown fires and survived surface fires with only slight damage, such as charred trunks, burned lower branches and basal wounds. Red pine had an 18% reduction in density (from 18 to 15 trees per acre) and a 26% decrease in basal area per acre. Jack pine was reduced 24% (from 5 to 4 trees per acre) with a 28% decrease in basal area per acre.

The total average percent mortality for all tree species was 38.2% with a total average percent decrease in average basal area per acre of 59.2%. These figures were obtained by summing the averages for each tree species and dividing this sum by the number of different tree species.

Discussion

The results of this study indicate that burning does not cause major vegetational changes or modifications since it does not substantially alter species composition. The majority of plant frequencies (76.5%) were unaffected by fire and these species are classed as neutrals. If this community requires repeated fires for maintenance, a greater response would be expected when fire is finally returned after 25 or more years. However, the number of species that increased is negligible (5.9%) and the number that decreased is relatively small (17.6%). In addition, none of the fluctuations of average relative frequency are extreme and only one species showed a statistically significant difference with burning. Only a few unimportant species are eliminated by fire or invaded the burned areas.

Since bracken fern and several grasses decreased in relative frequency, burning tends to be detrimental to these species. These dominants would not be expected to dip in frequency following burning if they are characteristic of a fire-type.

Burning had other effects not measured in the frequency studies. These include resprouting and early spring plant growth, the production of increased height in grasses and forbs, and the increase in flower, fruit, and seed stalk production. This was accomplished by the removal of accumulated mulch and by the fertilizing effect of the ash (Ehrenreich and Aikman 1963). Even if the vegetation is not drastically altered in average percent frequency by fire, there is an increased production of foods utilized by sharptailed grouse (Grange 1948).

Although bracken-grasslands do not need fire to be maintained, many of them burn readily when swept by wildfire. Since this community is an open grassland with little protective tree canopy, extremely dry and combustible conditions occur, particularly in spring and fall. The heavy accumulation of mulch, which typifies grasslands, provides ideal fuel and the open rolling terrain permits fires to burn freely. Examples are the recent wildfires near Dunbar and Commonwealth, Wisconsin. Even though fires have not been recorded since 1930 (Wisconsin Conservation Department 1930–1960) for many of these areas, fire-charred stumps, "cat-faced" trees, coppiced stems, and dense even-aged stands of jack pine in the timber bordering these grasslands are evidence that these areas not only originated after logging and burning, but were also burned again. This is by no means universal; some bracken-grasslands show no signs of burning other than the one initial post-logging fire.

Bracken-grasslands appear fairly stable (Curtis 1959). However, this study revealed that shrubs and trees are encroaching on many areas. Here fire is beneficial in retarding this advance by reducing the height of the shrubs and by eliminating or reducing the advancing deciduous trees to "bushes." Fire destroyed young reproduction of jack pine, red pine, and balsam fir *(Abies balsamea)*.

Several theories are proposed to explain how bracken-grasslands are maintained as open grasslands, even when completely surrounded by forest. Of importance is the competition between grasses and tree seedlings, often referred to as "eternal enemies" by the silviculturist and forest nurseryman. Wilde (1958) for example, points out the importance of thoroughly removing existing grass sod cover to insure successful establishment of pine plantings. Since bracken-grassland has a heavy sod formed by grasses, sedges, and fern, and since sod cover physically impairs the establishment and early growth of invading tree seedlings, bracken-grassland sod is considered a significant factor in the maintenance of these openings.

Another factor having strong influence on invading trees and resulting successional changes is bracken fern. This species occurs in solid stands, usually waist to chest high and produces a dense canopy under which few other species can exist. Occasionally, shade tolerant plants such as hooked violet and whorled loosestrife continue to grow under the fern canopy, but pioneer tree seedlings cannot successfully compete with the bracken fern. A few species, like slender wheatgrass, survive by growing above the solid layer of fern.

In addition, the antibiotic production of bracken-grassland species might contribute to the maintenance of these treeless grasslands, since many are known or suspected of producing antibiotics, thus inhibiting the growth of species (Curtis 1959).

Another explanation is the apparent activity of frost in lowlying areas and depressions as a result of cold air drainage and accumulation (Stoeckeler 1963). This does not apply to all grasslands since many occur on level plains or rolling uplands such as the Kohler Flats and adjacent "stump prairies." However, in areas containing deep depressions, bracken fern and trees are absent in these pockets which are dominated only by grasses and sedges. The explanation for this absence is the cold air drainage and resulting "frost pocket" effect occurring during the growing season.

Bracken fern and tree reproduction are particularly susceptible to summer frosts. Signs of frost damage and suppressed growth were observed on trees invading depressions and heavy frosts were observed on clear nights throughout the summer on several areas.

Even though any one theory might be used to explain the maintenance of bracken-grasslands, in actuality a combination of several of the above factors probably accounts for the relative stability of this community.

Also of interest is the origin of bracken-grasslands. One of the areas studied existed prior to white settlement and might be of the same origin as southern Wisconsin prairies (Curtis 1959). The rest came into existence after clear-cut logging followed by fire. Often these post-logging fires were extremely hot due to the accumulated slash, heavy understory of resprouts, and rapid growth of released plants. Such hot fires could easily eliminate any remaining trees and sprouts and completely destroy the existing understory plants by killing rootstocks and seeds. This would permit an open invasion of grasses and sedges without competing with species already established. In addition, since many of these areas developed hardpans while under the influence of forest trees, the elimination of the total vegetation resulted in the appearance of surface waters during the wet season which were normally removed by stands of transpiring vegetation. This harsh environment, fluctuating seasonally from wet to dry, was best adapted to sedges, grasses, and finally bracken fern. In areas where logging and fire took place in boreal forest and northern pine-hardwood types, few tree species survived since they were either unable to sprout after logging or were susceptible to fire or both. Thus the tree vegetation was essentially eliminated, leaving the "stump prairies" of today.

Summary and Conclusions

1. The vegetational composition (including prevalent species) of burned and unburned bracken-grasslands in northeastern Wisconsin was determined using quantitative frequency data. Stands are dominated by bracken fern, sweet fern, sweet blueberry, and *Carex* sp.

2. Fire is considered to have little effect on the vegetational composition, since it does not substantially alter species composition. The majority of species (76.5%) are not changed in average relative frequencies and the remaining species (increasers and decreasers) do not show statistically significant fluctuations. The lack of invaders in the burned stands indicates burning has not modified environmental conditions or the successional stage.

3. Some of the bracken-grasslands are unstable in that there are trees encroaching on the grasslands. Fire definitely retards the advance of these trees and will even expand the grassland areas. Fire reduced the average canopy cover of encroaching trees from 22.4% to 4.3%, produced a total average mortality of 38.2% for all trees, and resulted in a 59.2% average decrease in basal area per acre.

4. Fire was observed to have beneficial effects. It stimulated resprouting and early spring growth, increased height of herbaceous growth, and increased flower, fruit, and seed stalk production because of the removal of the heavy suffocating mulch and the production of fertilizing ash.

5. Since fire is not usually considered to be important in bracken-grassland maintenance, other theories are discussed. It is concluded that several factors operate in combination to maintain these grasslands as treeless openings, the most significant being the inability of tree reproduction to become readily established in grassland sod and the inability of trees to become established under the dense, shade-producing canopy cover of bracken fern.

6. Most of the bracken-grasslands in this study are considered to have originated from logging followed by intense fires. These hot fires eliminated the existing vegetation, resulting in increased surface water, and converted sites to pioneer and unstable types best suited to sedges, grasses, and ultimately bracken fern.

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AN EVALUATION OF WATERFOWL REGULATIONS AND LOCAL HARVESTS IN WISCONSIN

*James C. Bartonek, Joseph J. Hickey, and Lloyd B. Keith**

Restrictions on waterfowl hunting have existed in this country since 1710 (Palmer 1912), but it was not until 1913 that nation-wide regulations were set up by the federal government, under the Migratory Bird Law (Lawyer 1919). Many types of regulations with various degrees of restriction have been established, but not all have enjoyed equal success. Bellrose (1944), Van den Akker and Wilson (1951), and Hickey (1955) have made both local and nation-wide analyses of changing regulations upon waterfowl harvests. The purposes of the present study are to present an historical resumé of waterfowl regulations up to 1939, and to evaluate the effects of certain of these regulations on local waterfowl harvests in Wisconsin.

This and all similar studies of waterfowl harvests and regulations are subject to limitations imposed by local differences in hunting conditions and practices, waterfowl species and populations, proficiency levels and ethics of hunters, regulations and climatic conditions. Conclusions and management recommendations derived from local studies may be applicable only in these areas or others with similar conditions. On the other hand, state-wide or regional studies may yield data of limited management significance, as they tend to give a generalized picture and often ignore important local problems.

Through the kindness of Chandler and Robert Osborn we have been able to study the hunting diaries of A. L. Osborn and obtain information relevant to his hunting methods. These diaries constitute a 32-year record (1907 and 1909–39) of waterfowl-shooting events on a small island in Lake Winnebago, Wisconsin. Osborn's kill and that of his companions, along with varied comments on the day's hunt, were faithfully recorded for each hunting-day. Osborn, an owner and operator of a sawmill in Oshkosh, bought the island in 1905. The island was approximately 10–15 yards wide and 100 yards long, and it lay about a quarter-mile from the mainland. According to Chandler Osborn (pers. comm.), the only vaca-

* All three authors are affiliated with the Department of Wildlife Management, University of Wisconsin–Madison.

tion that he ever knew his father to take was during the duck season. A. L. Osborn died in the spring of 1940—a veteran duck-hunter, 81 years old. His chronicle presents many interesting facets of human behavior that influence bird harvests, but which are not readily discerned by such methods as roadside bag-checks or hunting-questionnaire surveys.

Osborn kept remarkably complete records on the numbers of persons hunting and the number of birds bagged (usually by species) at this site. During some seasons he recorded shooting hours, weather conditions, numbers and kinds of birds seen and shot at but missed, crippled birds, and remarks pertaining to hunting conditions in general. In extracting information from the Osborn journals, we tabulated and considered all harvest data on the basis of "party hunting" (i.e., assisting other members of the party to fill their individual bag limits by shooting birds for them) so that the "prestige" bias (i.e., a hunter over-estimating his kill by including birds that were shot by his companions) (Cronan 1960) might be eliminated. These harvest data were then evaluated in terms of concurrent regulations, certain hypothetical regulations, and the behavior of the hunter.

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Historic Development of Waterfowl Regulations

During the early 1800's a great number of states provided no legal protection for waterfowl. Palmer (1912), in listing the chronology of game laws in the United States, indicated that the first waterfowl regulation occurred in 1710, when Massachusetts prohibited the use of boats or canoes with sails or canoes disguised with vegetation for hunting waterfowl. In 1832, Virginia prohibited night-shooting on water and the use of big guns for market hunting. Rhode Island in 1846, followed by Michigan in 1859, were the first to prohibit spring-shooting of waterfowl; however, both states later repealed the law. Palmer also listed these other "firsts": 1872, Maryland provided "rest days" for waterfowl; 1875, Arkansas prohibited market hunting; 1887, bag limits were established in the Dakotas; and 1904, Louisiana had a 5-year closed season on wood duck *(Aix sponsa)* (scientific names obtained from A.O.U. check-list, 1957).

Wisconsin was among the earliest to pass prohibitive regulations on waterfowl hunting. In 1860, wood ducks were protected from December 1 to the first Tuesday in July (Laurence R. Jahn, *in litt.*).

Scott (1937) said that in 1870 the wood duck, teal, and mallard *(Anas platyrhynchos)* were protected during 7 months of the year in 11 southern Wisconsin counties; and the sale of these species was prohibited. According to Lawyer (1919), during this same year only 6 other states had some form of restrictions on spring-shooting. Wisconsin's county restrictions may well have been designed to protect only those species which were locally common nesters, because regulations indicate that it was not until 1899 for other species of ducks, and 1913 for geese, that the same protection was given.

Among the first Wisconsin regulations to appear were those that restricted market hunters. In the late 1870's, duck hunting from steam, sail or sneak boats, and sunken batteries was prohibited in certain areas, and ducks could not be hunted from 8 PM to 3 AM (Scott 1937). In 1887, birds could be shot only with a weapon discharged from the shoulder, and hunting from open-water or sink-boats was prohibited; the sale of all waterfowl species was prohibited in 1903.

Prior to 1913, there was little uniformity among the states regarding the harvest of waterfowl. The first federal regulation governing wildlife was the Lacey Act of 1900 which prohibited interstate commerce in birds or game killed in violation of state laws and controlled the importation and exportation of all birds and mammals. The Federal Migratory Bird Law of March 4, 1913, authorized the U.S. Department of Agriculture to set suitable seasons on migratory game, and the Bureau of Biological Survey was charged with carrying its provisions into effect. Lawyer (1919) said that this law proved very imperfect because it was incapable of enforcement; however, he estimated that fully 95 percent of the sportsmen abided by this mandate and refrained from hunting during the closed season. On December 8, 1916, the International Bird Treaty was signed with Great Britain and was implemented by the Migratory Bird Treaty Act of July 3, 1918, which superseded the law of 1913. A similar treaty was signed with Mexico in 1936. In 1934, federal law required every waterfowl hunter over 17 years of age to purchase a $1 duck stamp.

Because it brought some element of uniformity to regulations throughout North America and provided for their enforcement, the Migratory Bird Treaty Act was a milestone in waterfowl legislation. It forbade the hunting, killing, exporting, importing, transporting, etc., of any migratory birds that are included in the treaty; however, the Secretary of Agriculture was given the authority to permit hunting under certain conditions for a period not exceeding 3½ months. Since 1918, under authority of this treaty and act, restrictive regulations have included: (1) modifications in lengths of seasons, bag and possession limits, shooting hours, and the number of shells in the gun; (2) prohibition of bait, live-decoys, the use of shotguns with bores greater than 10-gauge, and certain types of boats; and (3) complete or partial protection for certain species of waterfowl.

Local Waterfowl Harvests in Wisconsin

During 32 seasons Osborn recorded 8,078 ducks, 1,032 coots *(Fulica americana)* and 11 geese *(Branta* spp., *Chen* spp.) that were bagged by him and his hunting companions. Of the total number of ducks bagged, 6,751 (83.6 percent) were identified as to species (Table 1). We doubt that the "unidentified" birds were unknown to Osborn; they were probably individuals of common

Table 1. Bag Composition of 6,751 Identified Ducks During 32 Seasons, 1907 and 1909–39

Dabbling Ducks	Number	Percent	Diving Ducks	Number	Percent
Blue-winged teal	276	4.1	Scaups	4,169	61.8
Mallard	238	3.5	Redhead	513	7.6
Baldpate	139	2.1	Canvasback	506	7.5
Pintail	94	1.4	Mergansers	334	4.9
Shoveler	80	1.2	Bufflehead	125	1.8
Green-winged teal	44	0.7	Goldeneye	118	1.7
Black duck	35	0.5	Ruddy duck	44	0.7
Wood duck	23	0.3	Ring-necked duck	8	0.1
Gadwall	2	tr.	Scoters	2	tr.
Totals	931	13.8		5,820	86.1

species which he simply failed to record. He never mentioned shooting any unrecognized species, but he did note on several occasions that he shot a bird "rare" to the Lake Winnebago area. None of the several species of scaups *(Aythya* spp.) and mergansers *(Mergus* spp.) were differentiated by Osborn. Conspicuously low in numbers among the divers in his records is the ring-necked duck *(Aythya collaris)* (Table 1) which he most likely included with scaups. From data on Wisconsin duck harvests presented by Geis and Carney (1961), we determined that the ring-necked duck and scaup species were being shot at a ratio of 1.0:2.1, respectively; and, therefore, the ring-necked might be expected in greater numbers in Osborn's bag. However, this ratio might be greater today than during the early 1900's because of increased breeding range of the ring-necked (Mendall 1958).

The high percentage, 86 percent, of diving ducks, which includes mergansers and scoters *(Melanitta* spp.), reflects the divers' preference for the open waters of Lake Winnebago. Four early shooting records indicate that divers also comprised an important part of the waterfowl bag on other southern Wisconsin lakes: 45 percent on Lake Wingra 1873–96 (Leopold 1937), 66 percent on Lake Delavan 1892–99 (Hollister 1920), and 72 percent on Lake Puckaway in the 1900's (Leopold 1929). From 1921 to 1928, kills consisting of 59 percent divers were made by E. J. Nelson on Green Bay (Leopold 1931).

State-wide bag surveys indicate that divers make up a much smaller percentage of the total duck harvest. The Wisconsin Conservation Department's annual game-harvest reports from 1931 to 1939 indicate that divers made up only 29 percent of the total bag compared to Osborn's 88 percent during the same years. The percentages of the four most important species comprising the state's bag were the mallard, 36 percent; scaup species, 24 percent; green-winged teal *(Anas carolinensis)*, 9 per cent; and blue-winged teal *(A. discors)*, 9 percent. Geis and Carney (1961) in a survey of Wisconsin's 1959 season found the kill to include 29 percent divers. Their bag composition was very similar to that which we determined from Wisconsin Conservation Department's data (1931–39) with the exceptions of the canvasback *(Aythya valisineria)* and redhead *(A. americana)* which were partially protected in 1959. Species differences between the Osborn and state-wide bags respectively can be attributed to lake *vs.* largely marsh- and jump-shooting.

We averaged the daily bag for each of the 32 hunting seasons and then took a composite mean of these 32 averages. These average daily bags for Osborn and his companions were 4.8 ± 0.5 SE ducks and 0.7 ± 0.1 SE coots per hunter-day. Osborn hunted an average of 20.8 ± 1.0 SE (32) days per season, and his average season's bag was slightly in excess of 100 waterfowl. He was certainly far more successful than the average Wisconsin hunter. From state-wide data for 1934–39 (Wisconsin Conserv. Dept. 1952), we calculated the average seasonal bag per waterfowl stamp sold and found it to be 15.1 ± 1.2 SE (6) waterfowl. Voluntary hunters' reports of this type are generally regarded as being biased too high (Sondrini 1950).

The average kills of divers and dabblers per hunter-day, excluding the unidentified species of ducks, declined erratically from 1909 to 1939 (Fig. 1). There appeared to be a slight rise in average kill of the divers during the 1920's. Despite reports (U.S. Dept. Agr. 1919, Lawyer 1919, Hornaday 1927) of nation-wide increasing waterfowl populations after cessation of spring-shooting in 1914,

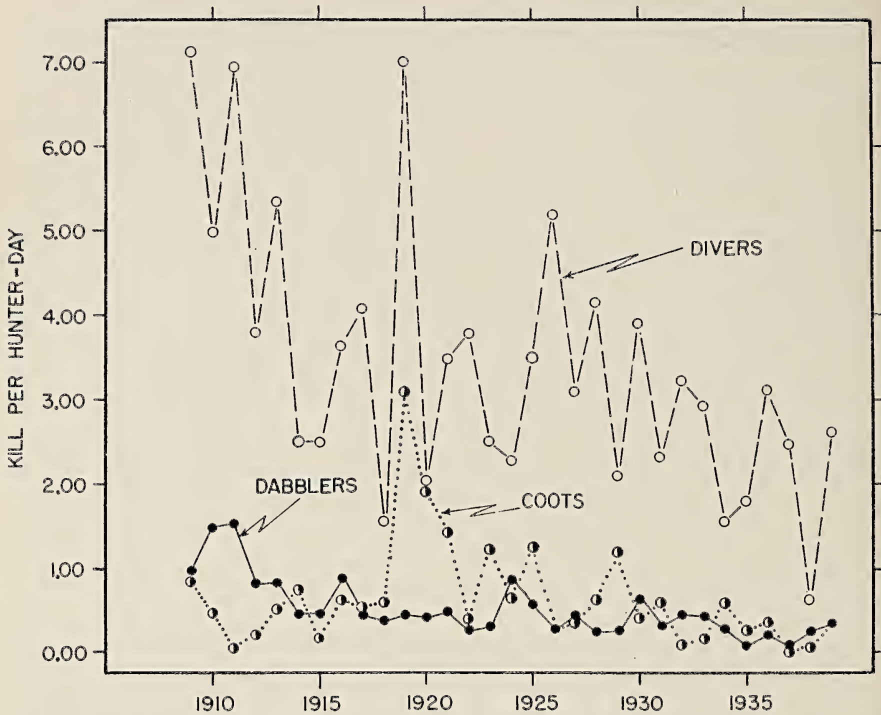

FIGURE 1. Average kill per hunter-day of diving ducks, dabbling ducks, and coots (excluding unidentified species) on Lake Winnebago, 1909–39.

Osborn did not experience any persistent change from the established downward kill trend. Nelson (1959) also noted that after 1900, Utah's waterfowl harvest was drastically reduced until a low was reached during the mid-thirties; but following this both the harvest and number of hunters "skyrocketed" until a peak was reached in 1948–49.

We can only conjecture about certain of the "highs" and "lows" among the average bags of the divers. The general decreasing trend is, undoubtedly, a combination of both shrinking bird populations and bag limits. The low bag of 1918 followed by the exceptionally high bags of divers and coots in 1919 reflected his reduced hunter-activity during World War I. Summarizing the 1938 hunt, Osborn wrote: "So ended [the] season for 1938 the most unsatisfactory one I [have] ever had. Everybody that hunted diving ducks agreed they were very scarce." Yet, according to Jahn and Kabat (1955, p. 3), "The season of 1938, when Wisconsin experienced tremendous fall rains and the three states to the northwest of us were relatively 'dry,' still stands as the most successful waterfowl hunting season experienced by Wisconsin hunters." The Wisconsin Conservation Department (1939) reported harvests of 6 species of dabbling ducks to increase from 291,642 in 1937 to 1,007,331 in 1938. During these same 2 years the seasonal bag of scaup and ring-necked ducks rose from 141,549 to only 179,860. With the slight increase in scaup and ring-necked ducks over the previous year and with canvasback and redheads permitted in the 1938 bag, we would expect Osborn's season to have been more successful. We assume his poor season to reflect local conditions; possibly, the ducks were drawn away from the larger bodies of water such as Lake Winnebago into the surrounding wet country which would provide numerous feeding and resting areas.

Very few geese were shot by Osborn, but all 11 of them were shot after 1923 and 9 of these after 1931. Laurence R. Jahn *(in litt.)* says that the establishment of waterfowl refuges by private individuals during the period of 1923 to 1939, provided local shooting opportunities for geese. He suspects that with unmolested upland feeding areas established by private efforts, geese used Lake Winnebago as a watering and roosting site.

Length of Season

During the 33 years (1907–39) spanned by Osborn's journal, there was a general trend toward shorter seasons and later opening dates (Fig. 2). From the turn of the century up to 1913, Wisconsin hunters enjoyed 122-day seasons that opened on September 1 and closed on December 31. Special 16-day seasons were permitted during the springs of 1903 and 1904. The federal law of 1913 superseded Wisconsin's liberal laws by restricting seasons to only 85 days and opening them 1 week later. These regulations persisted until 1917, when for the next 4 years the opening date was set at September 16 with an 86-day season. This September 16 opening date, along with a 96-day season beginning in 1921, continued up to and including 1930.

Low waterfowl populations during the "duck depression" years of the 1930's brought about more stringent regulations. "Rest days" for waterfowl were established by Wisconsin law on each Wednesday during the 1929–33 seasons; and in 1934, federal regulations set aside all Mondays and Tuesdays as nonhunting days. The lengths of the 1929–34 seasons were 96, 96, 31, 61, 61, and 40 days respectively; but the "rest days" reduced the actual number of hunting-days to 82, 82, 27, 52, 53, and 30.

Average daily and seasonal harvests declined with a decrease in season length (Table 2). Declining waterfowl populations and increasing hunting restrictions likely preclude any meaningful cor-

TABLE 2. AVERAGE DAILY AND SEASONAL HUNTING SUCCESS WITH WATERFOWL SEASONS OF DIFFERENT LENGTHS AND DAILY BAG LIMITS OF VARIOUS SIZES

Length of Season	Years of Hunting Seasons	Duck Daily Bag Limit	Averages	
			Ducks/ Day	Ducks/ Season
122	1907, 1909–10	25	9.5	429
122	1911–12	15	8.4	494
96[a]	1921–30	15	4.2	188
85–86	1913–20	15	5.0	256
61[b]	1932	15	4.4	303
61[b]	1933	12	3.4	302
45	1938–39	10	2.3	256
40[c]	1934	12	1.9	116
31[d]	1931	15	2.6	132
30	1935–37	10	2.8	201

on[a]Wednesdays were "rest days" in 1929 and 1930, leaving those two seasons with ly 95 days of hunting.

[b]Wednesdays were "rest days," leaving only 52 days of hunting in 1932 and 53 days in 1933.

[c]Mondays and Tuesdays were "rest days," leaving only 30 days of hunting.

[d]Wednesdays were "rest days," leaving only 27 days of hunting.

relations in the Osborn data between season length and bird harvest. However, the number of times that Osborn went hunting during a season was probably independent of these variables and was certainly not significantly correlated ($r = -0.18$, d.f. $= 30$) with the season's length. Osborn's hunts per season averaged 20.8 (C.V. $=$ 28 percent) despite variations in the season's length from 30 to 122 days which averaged 81.9 (C.V. $=$ 35 percent) days. During shorter hunting seasons, he simply hunted more frequently during the fewer days available for waterfowl (Fig. 3), his hunting activity increasing during both the weekdays and week-ends—Sundays in particular (Table 3). This phenomenon may be attributed to

TABLE 3. AVERAGE NUMBER OF HUNTS PER SEASON ON WEEKDAYS, SATURDAYS, AND SUNDAYS DURING SEASONS VARYING IN LENGTH FROM 30 TO 122 DAYS

No. of Days in Season	Years of Hunting Seasons	Average Number of Times Hunted per Season			
		Weekdays	Saturday	Sunday	Total
122	1907, 1909–12	15.0	5.0	1.0	21.0
85–86	1913–20	13.0	4.6	1.5	19.1
96	1921–30	13.8[a]	2.9	2.1	18.8
30–61	1931–39	14.3[b]	4.4	4.7	23.4

[a]Wednesdays were "rest days" in 1929 and 1930.

[b]Wednesdays in 1931–33, and Mondays and Tuesdays in 1934 were "rest days."

Osborn having more leisure-time during the years of his semi-retirement (1930 to 1940) when seasons were shortest.

Anderson (1948) found that shortening the season from 45 to 30 days had practically no effect upon the total number of man-days of hunting on rented and privately owned marshes along southwestern Lake Erie in Ohio. On the other hand, Atwood (1961) found that the number of duck stamps sold was significantly correlated with season length in 13 of the 17 states in the Atlantic Flyway, and he also found a doubtful correlation between the season length and the number of times hunted. Gale (1954), in a study of upland-game hunting in Kentucky, concluded that a reduction of less than 2 weeks in a season of more than 2 months' duration reduced neither hunting pressure nor total kill.

Bellrose (1944) found that the average daily bag in each of three Illinois duck clubs was greater during short seasons than long seasons. He attributed this to fewer "good hunting days" in a long season. Further, he felt that this phenomenon would be typical only among the northern states where freeze-up prior to the closing date would force the majority of the ducks to move south and thereby cause poorer hunting during the remainder of the season. Although Bellrose's explanation seems logical and may well be true, Osborn's daily-bag declined during those seasons (i.e., in the 1930's) which were shorter and ended earlier; this was probably a result of declining populations and the migration of blue-winged teal, wood ducks and some local mallards from the area prior to the season's opening date. In data presented by Van den Akker and Wilson (1951), we similarly observe declining average bags accompanying declining season-lengths.

Osborn and other hunters (Anderson 1948) who either own or rent their shooting areas are seemingly able to find or make time to pursue their sport. Beyond a certain point, however, shorter seasons would undoubtedly lower the average number of days that these sportsmen could hunt. Atwood's (1961) demonstration of a reduction in the number of hunters accompanying a decrease in season-length leads us to speculate as to which segment of the population stops hunting—the novice, the expert, or both. If it is the novice hunter who quits hunting, the reduction in total harvest would not be expected to be directly proportional to the reduction in hunting pressure.

Opening and Closing Dates of the Season

We consider the opening and closing dates of a season to be important influences upon the distribution of hunting pressure, the species composition of the bag, and the number of birds harvested; and the opening and closing dates are obviously associated with and dependent upon the season's length. The Federal Migratory Bird Act of 1913 authorized the Secretary of Agriculture to prescribe and fix closed-seasons on migratory game with "due regard to the zones of temperature, breeding habits, and times and line of migratory flight." The Migratory Bird Treaty Act of 1918 permitted open-seasons to be set from September 1 to March 10, but not to exceed 3½ months.

In the 32 years under consideration, Wisconsin's seasons opened as early as September 1 during 1907–12 and as late as October 21 in 1935. Closing dates varied from December 31 during 1907–12 to October 31 in 1931 (Fig. 2). Both the opening and closing dates

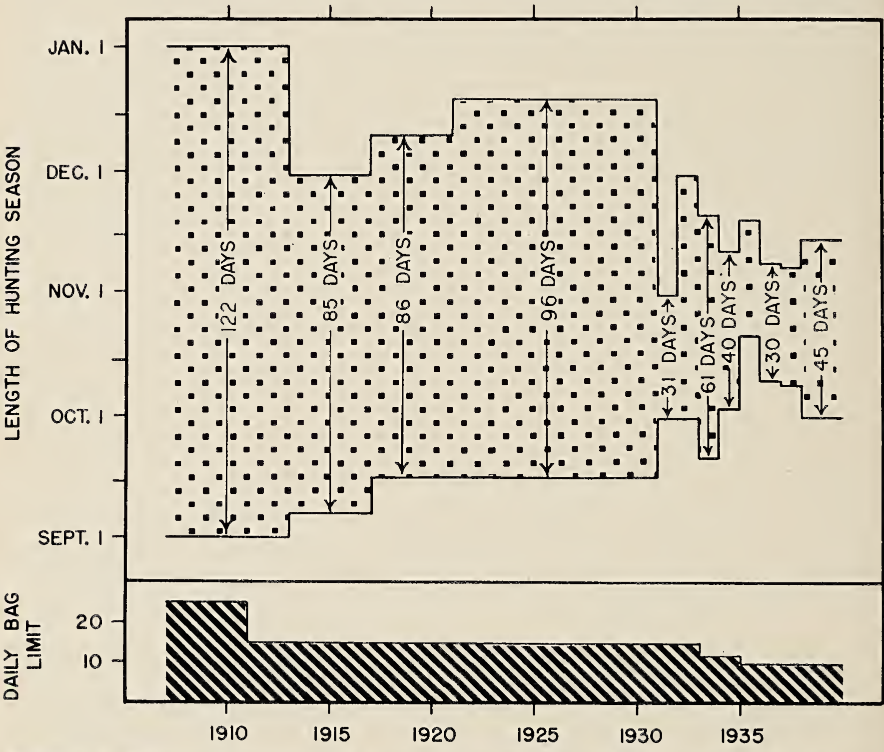

FIGURE 2. Wisconsin waterfowl hunting seasons and bag limits, 1907–39.

varied considerably during the 1930's, but the seasons generally ran from early October to mid-November.

Osborn hunted on 30 out of 32 "opening days" despite considerable variation in their timing. In one year he didn't hunt until the 7th day of the season; and in the other year, according to the date in his journal, he hunted one week earlier than the legal opening. This early hunt may be attributed to an incorrect entry in the journal.

During 1907–30, Osborn's last hunt of the season occurred almost a month earlier than the average legal closing dates. Osborn never hunted in December, and only 8 times during the last week of November, although 24 out of 32 hunting seasons remained open until November 30 or later. This early cessation of hunting was caused by Lake Winnebago's freezing up. From 1931 to 1939, when the closing dates were much earlier and the seasons shorter, Osborn hunted on the last day during 6 out of 9 years. Climatic conditions obviously restricted Osborn's opportunity to hunt when the seasons (Fig. 3) extended into late November and December. Atwood

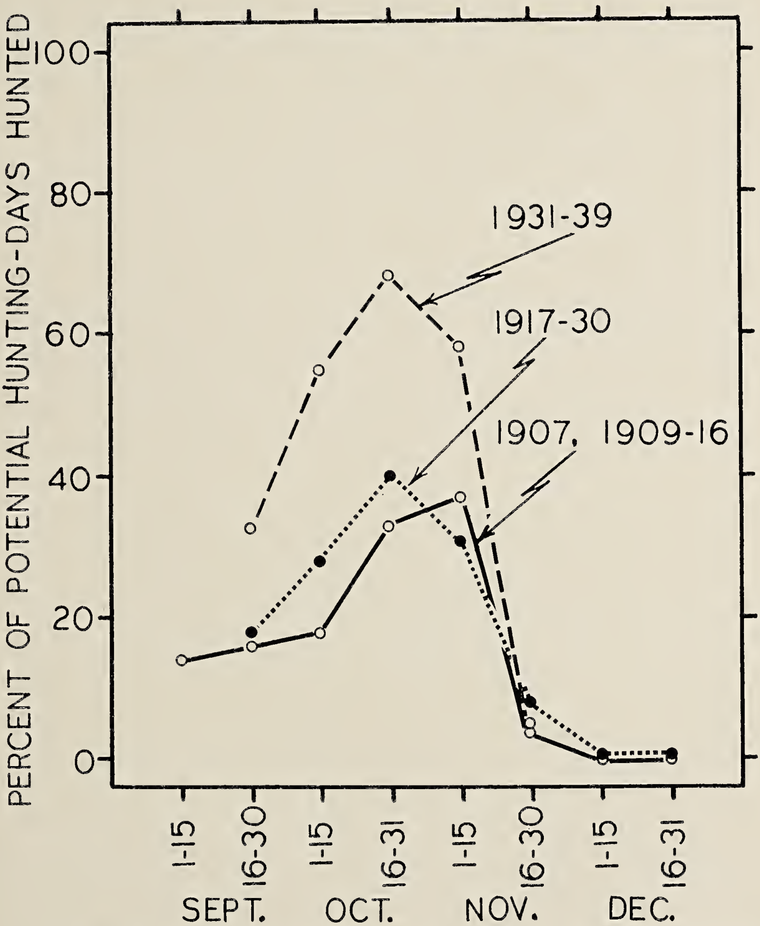

FIGURE 3. Distribution of hunter-activity by the percentage of potential hunting days that were actually hunted for three periods having different season's length and/or dates of opening and closing.

(1961) also considered climatic conditions important. He suggested that most of the hunting pressure occurred during the first part of the season in certain northern states, and a more even distribution of hunting pressure occurred throughout the season in certain southern states.

Seasonal Distributions of Waterfowl Harvest and Hunting Pressure

The seasonal distribution of hunting kill was plotted for the six most common species appearing in Osborn's bag (Fig. 4). To eliminate biases resulting from changes in season lengths and numbers of times hunted within any weekly interval, the average daily kill per week hunted was expressed as a percentage of the average kill for all seasons. As a result, we believe that Fig. 4 largely depicts the periods of species prevalence (i.e., relative abundance and vulnerability). Bellrose (1944) and Van den Akker and Wilson (1951) showed that the percentages of certain species of waterfowl comprising the bag are found in different proportions from those found in the local population. In comparing waterfowl populations and bags in the Illinois River Valley, Bellrose (1944) found that species such as the shoveler *(Spatula clypeata)*, gadwall *(Anas strepera)*, and green-winged teal were much more vulnerable than the mallard and black duck *(A. rubripes)*. While mallards and black ducks consistently comprised 84–94 percent of the Illinois population, they constituted only 59–75 percent of the bag. Lesser scaup *(Aythya affinis)* also proved much less vulnerable than canvasback, ruddy duck *(Oxyura jamaicensis)*, and ring-necked duck. Van den Akker and Wilson (1951) said that in the Bear River Refuge, Utah, snow geese *(Chen hyperborea)* favor areas not open to hunting and that deep-water ducks are less accessible to most hunters; whereas, the shovelers are probably more vulnerable and less wary.

Dabbling ducks and coots followed somewhat similar patterns of harvest on Lake Winnebago, being most frequently shot during the first part of early seasons. Fig. 4 suggests that, if hunting had been distributed evenly throughout the season, 73 percent of the blue-winged teal and 50 percent of the mallards would have been taken by Osborn within the period of September 1–15. Perhaps the high kill of blue-winged teal and mallards in the early years of Osborn's hunting reflects two factors: (1) the earlier opening of the shooting season, and (2) the larger numbers of locally raised and/or migrant teal and mallards that were present in those years.

The redhead was the first diver to appear in Osborn's bag. Even though it reached a peak of prevalence in the bag during the second week of September, it could still be taken throughout the entire season. The canvasback first appeared in the bag during the last week

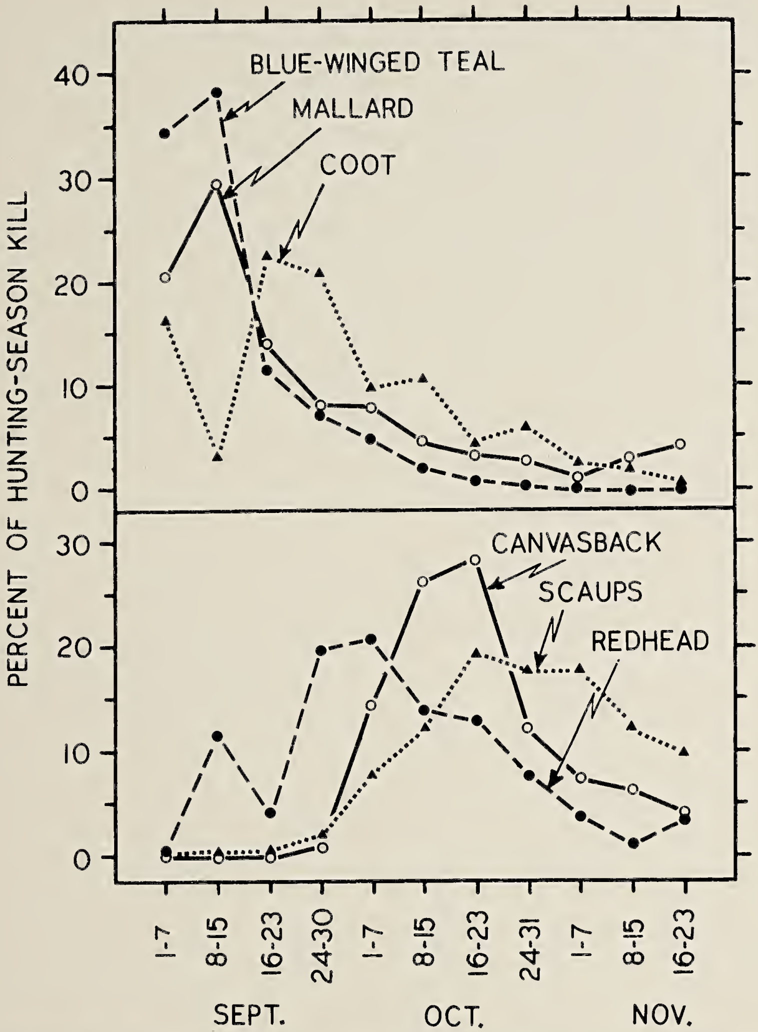

FIGURE 4. Seasonal distribution of six species of waterfowl bagged on Lake Winnebago, 1907 and 1909–39.

of September, but it was not until the following week that it was bagged in any appreciable numbers. Again, if hunting pressure had been distributed evenly, over half of the redheads (57 percent) and canvasback (70 percent) would have been bagged by October 1–7 and 16–23, respectively. The canvasback's rather sudden upsurge in the bag, beginning in the first week of October, apparently gave rise to Elliot's (1898:149) assertion regarding Puckaway Lake that the "Canvas Backs and Red Heads would always make their appearance on the 10th of October" and "no matter what the weather may have been up to that time, and even if the season had been unusually cold, these birds did not appear before the 10th." DeGraff, et al. (1961) showed that of 31 canvasbacks banded in New York and killed later in Wisconsin, about 45 percent were shot during the last week of October.

The last divers to appear in the bag in numbers were scaups and mergansers. Scaups were shot throughout October and in November until freeze-up. The mergansers usually made a sudden appearance in mid-October. Sixty percent of the scaup and 51 percent of the mergansers were harvested by the last week in October.

During 32 seasons, Osborn averaged 4.6 ducks and 0.6 coot per day (Table 4). With the exception of the last week of November the average duck bag remained high throughout the season. September 8–15's exceptionally high bag might be explained by the small sample size in terms of hunter-days. The average bag of coots per hunter-day dropped off after the last week of September, but coots were still being shot up to and including November 16–23.

TABLE 4. NUMBER OF HUNTER-DAYS AND HUNTING SUCCESS BY 7-OR 8-DAY PERIODS, 1907, 1909–39

Dates in Hunting Season	No. of Hunter-days	No. of Waterfowl Bagged		Average Daily Hunter-bag	
		Ducks	Coots	Ducks	Coots
September					
1– 7	34	165	49	4.8	1.4
8–15	7	67	3	9.6	0.4
16–23	75	275	160	3.7	2.1
24–30	60	234	130	3.9	2.2
October					
1– 7	101	432	89	4.3	0.9
8–15	237	987	226	4.2	1.0
16–23	306	1,535	110	5.0	0.4
24–31	343	1,757	147	5.1	0.4
November					
1– 7	287	1,357	54	4.7	0.2
8–15	205	791	37	3.8	0.2
16–23	83	468	5	5.6	0.1
24–30	8	10	0	1.2	....
December					
1–31	0	0	0	....	....
Totals	1,746	8,078	1,032*		
Means				4.6	0.6*

*Includes 22 additional coots for which the dates of kill were unknown.

Geis and Carney (1961), acknowledging probable sampling biases, present data for Wisconsin's 1959 season which show steady declines in the percentages of ducks killed throughout the season. Using questionnaire surveys and wing collections respectively, these authors found that the percentages of ducks shot during the first week (October 7–13) dropped from 27.6 and 52.4 percent to 12.9 and 2.9 percent during the sixth and seventh or last 2 weeks of the season. Bellrose (1944) reported that the average daily-kill per hunter on the Duck Island Preserve, Illinois, in 1914–36 also remained high throughout the season. Van den Akker and Wilson (1951) likewise noted this phenomenon on the Bear River Refuge in Utah and attributed it not to the increased bird population but rather to an increase in vulnerability when the birds concentrated on localized areas following freezing weather. However, this sustained high bag might also be due to veteran hunters who, unlike many novices, do not stop hunting after the first few "good" days of the season. This explanation was suggested in a pheasant study conducted in Utah by Stokes (1955).

Geis and Carney (1961) found that Wisconsin hunters who shot 21 or more ducks per season had 43 percent divers in their bags compared to only 18 percent for those who shot fewer than 10 ducks per season. This might be attributed to the most successful hunters being those that: (1) hunt on lakes, thereby obtaining more diving ducks; (2) hunt more frequently and thereby shoot more ducks later in the season when divers comprise a greater percentage of the bag; and/or (3) hunt in both dabbling and diving duck habitat.

The seasonal distribution of hunter-days (Table 4) and days hunted (Fig. 3) were influenced by changing dates of the season, lengths of seasons, and weather conditions. In all three periods having seasons with relatively similar lengths and opening dates (1907, 1909–16; 1917–30; 1931–39) (Fig. 3), hunting activity increased during mid-October and early-November. The noticeable lack of shooting from mid-September to mid-October coincided with Osborn's annual "chicken" and "partridge" hunting. Osborn's switching his hunting effort from waterfowl to upland game birds after the season was underway suggests that hunting pressures might be somewhat reduced by opening at least one other season (e.g., grouse, pheasants) concurrently with the waterfowl season. Jahn *(in litt.)*, in evaluating the effects of such concurrent season openings in Wisconsin, concluded that: "Opening hunting seasons concurrently reduces hunting pressures on upland-game, but not on waterfowl."

Bag Limits

Wisconsin established its first waterfowl bag limit in 1903 by permitting a bag of 15 ducks during the special spring season; no limits were imposed on the hunters during the fall season. In the 1905 and 1906 fall season, bag limits were 30 ducks or geese; and from 1907 to 1910, the limit was 25 ducks and coots, and 10 geese. Wisconsin's daily bag limit for ducks and coots in aggregate dropped from 25 to 15, 12, and 10 during the period 1907–38 (Fig. 2). Although federal regulations permitted daily bags of 25 coots during the 1918–34 and 1937–39 seasons and 15 in 1935 and 1936, Wisconsin did not permit the large coot bags until 1939; the coots were included in the "duck" bag limit. In Wisconsin a possession limit equal to the daily bag limit existed up to 1938 when it was increased to twice that of the bag limit. This larger possession limit was permissible through federal regulations since 1930.

By superimposing certain hypothetical daily bag limits upon Osborn's actual hunting kill, we attempted to appraise the effect that such restrictions would have had upon his total waterfowl harvest

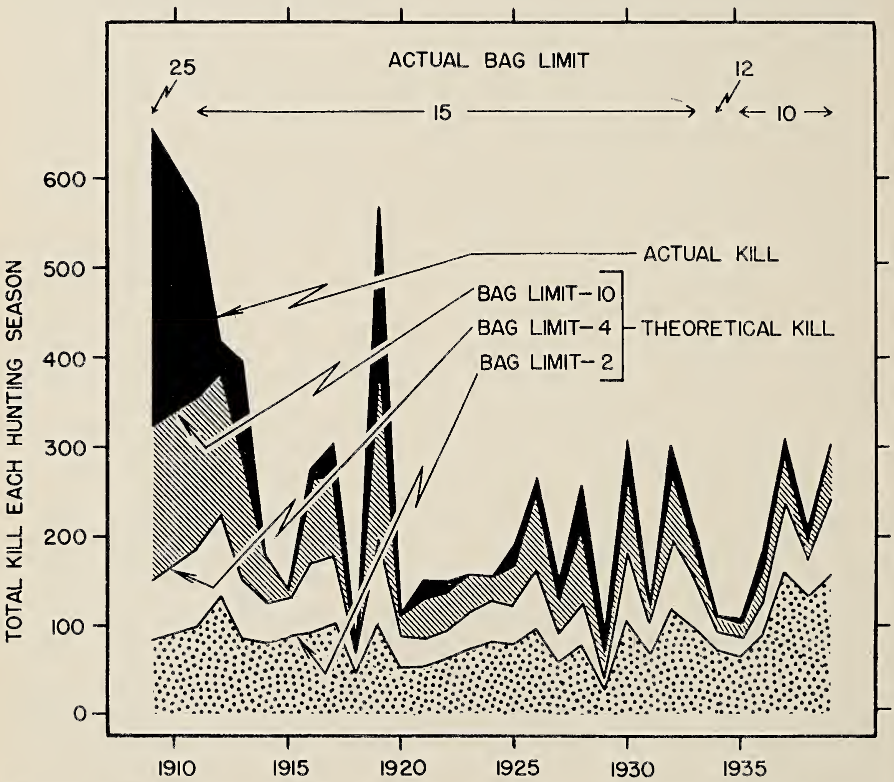

FIGURE 5. Total duck kill for each hunting season and theoretical harvests when hypothetical bag limits of 10, 4, and 2 birds per day were assumed, 1909–39.

(Fig. 5). To the best of our knowledge, Osborn's group hunted as a party and thought in terms of a party bag limit. Thus, in our analyses we have considered only the influence of decreased bag limits on the allowable daily take for the entire party.

Because of the 15-bird bag existing from 1911 through 1932, this period was used to measure the effect of a theoretical reduction in bag limits upon the reduction in harvest. During this period Osborn's average bag was 4.5 ± 0.4 SE (22) ducks per day—only 30 percent of the legal limit. A hypothetical reduction in bag limits to 10 birds had proportionately less effect upon the reduction of duck kill than did either the 4- or 2-bird limits (Fig. 6). A 33 percent

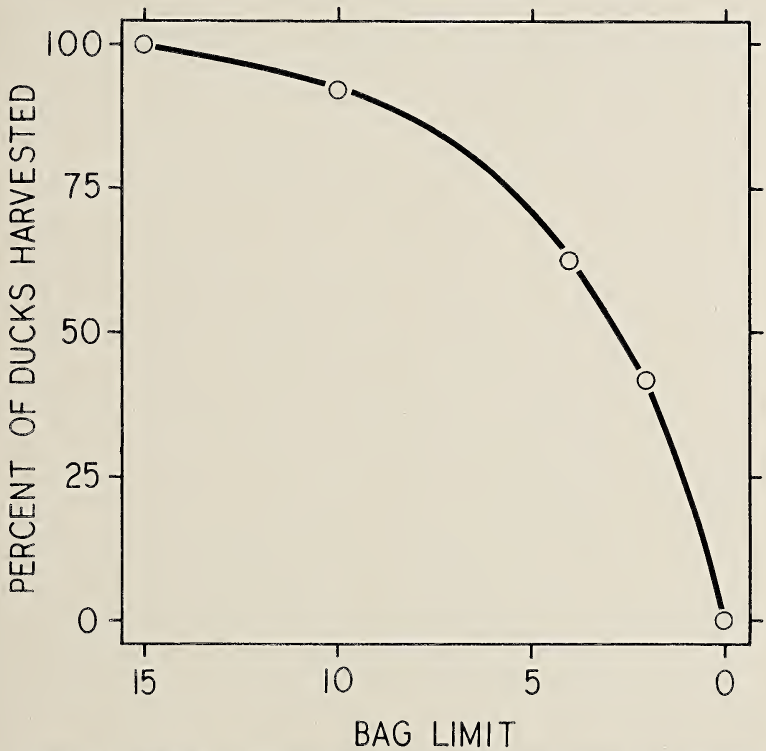

FIGURE 6. Effects of theoretical bag limits on the duck harvest when actual bag limits were 15 birds (1911–32).

reduction in the bag from 15 to 10 birds per day would have reduced the kill only 8± 4 (22) percent (95 percent level). A 73 percent bag reduction to 4 birds would have caused a reduction of 35 ± 7 (22) percent in the actual kill; and an 87 percent reduction to 2 birds per day would have reduced the harvest by 60 ± 5 (22) percent. This pattern may reflect the difficulty for even an experienced hunter such as Osborn to procure a large bag on Lake Winnebago;

or it may reflect the fact that Osborn frequently hunted only half a day. Bellrose (1944) found an increasingly greater influence on the daily bag as the bag limit was decreased from 15 to 10 birds per day. He says that the bag limit effectively restricts the individual kill of the better hunters at the best Illinois clubs. Van den Akker and Wilson (1951) conclude that bag limits are effective only in relation to the ability and honesty of the hunters and the density of the duck populations. We conjecture that a season bag limit in addition to the existing daily limit could, at least in theory, reduce the total harvest by restricting primarily the more successful hunters.

If a reduction in the bag limit does not prompt an increase in the number of hunter-days, then during years of high kill—a reflection of either bird populations, vulnerability or local concentrations—smaller bag limits could appreciably reduce the kill. Van den Akker and Wilson (1951) state that bag limits affect bag averages little when set above a certain point. In examining records of the Duck Island Preserve in Illinois, Bellrose (1944) found little difference in the kill per shooter-day from 1885 when bags were unrestricted to the early 1930's with bag limits of 15 birds. Reductions in bag limits lowered band recovery rates for canvasback throughout the nation (Geis, 1959) ; they also reduced duck harvests on Lake Erie in Ohio, and caused the hunters to shoot selectively the larger ducks such as mallards and pintails *(Anas acuta)* (Anderson 1948).

Osborn's journal contained many "truths" that few hunters are willing to acknowledge on mail questionnaires. His parties apparently exceeded their legal bag limits on 30 (= 4 percent) out of 667 days hunted during the 32 years. Twelve of the excessive limits were attained when coots were included as part of the duck bag as then prescribed by Wisconsin law. These same 12 days, however, would not have been violations under federal regulations because there was a federal bag limit on coots that was separate from that for ducks. On the remaining 18 days in which their bagged ducks exceeded both state and federal limits, Osborn's parties shot 774 out of a permissible 505 ducks, or 153 percent of their legal bag.

Osborn not only identified the harvested waterfowl as to species but frequently into the two categories of "good ducks" and "mergansers, ruddys, and hens [coots]." He never included the mergansers within his totals of "ducks killed," but he does mention "giving away" and "keeping" both mergansers and coots. Chandler Osborn (pers. comm.) said that none of the coots and mergansers were wasted, because if they were not eaten by the Osborn family they were given to their hired-man who had a large family that could always use the meat. From 1924 to 1937 A. L. Osborn gave as gifts to his guests 61 percent of the "good ducks" bagged.

Other sources indicate that not all species of waterfowl shot end up as table fare. Hochbaum (1955) observes that in Canada, when bird populations are high and bag limits relatively low, it is a common practice to discard teal and shovelers and replace these with mallards and canvasbacks. Hawkins (Kiel and Hawkins, 1953) reported large numbers of unretrieved coots which he assumed to have been mistakenly shot for ducks. Osborn gave no indication that any of his birds were wantonly wasted.

Partial and Complete Protection of Certain Species

Wisconsin's regulations have given preferential protection to certain species of waterfowl since 1860 when wood ducks were protected between December and July. In 1870 the spring shooting of mallards, teals, and wood ducks was locally prohibited. Except for 1871, these three species were protected by county or state laws up to 1913 when federal law ended spring shooting. Swans were protected in 1897.

From 1915 through 1941, the wood duck was completely protected. During 25 of these seasons, 1915–34, Osborn recorded killing only 2 wood ducks while during the 7 preceding seasons he shot 21. Thirteen of these 21 wood ducks were shot after September 24, suggesting that they were potentially available during the years of protection. On October 1, 1939, after illegally shooting one of the birds he wrote "[The] Wood duck was an accident and a very hard shot." From 1932 to 1937 the bufflehead *(Bucephala albeola)* and ruddy duck were given full protection, but during this time Osborn bagged 19 of the former and 2 of the latter.

The aggregate bag limits during 1932, 1933, and 1934 were 10, 8, and 5 respectively for canvasback, redhead, ring-necked, scaups, teals, gadwall and shovelers, with total limits of 15, 12, and 12 ducks, respectively, of any other species. During 1938 and 1939 there were 10-bird limits, of which not more than 3 in aggregate, of canvasback, redhead, bufflehead and ruddy duck were permitted. Despite these somewhat confusing regulations, Osborn violated them only twice during 134 days of hunting in the above five seasons. One violation occurred when 3 men killed 26 scaups—2 more than permitted. On another occasion, Osborn shot 1 redhead and 8 scaups when he was permitted only 8 of those species in aggregate. In addition to these 2 violations Osborn recorded that 3 of his guests killed 37 scaup and 14 canvasback—21 in excess of the aggregate limit.

In addition to the seasons of variable bags, the canvasback and redhead received complete protection during 1936 and 1937. Such protection, however, did not reduce their kill (Table 5). Geis and Carney (1961) found Wisconsin's 1959 bag to consist of 1.0 percent canvasback and 0.9 percent redhead when only one of each was permitted in the bag. Our calculations of Wisconsin bag composition from the Wisconsin Conservation Department's annual harvest reports from 1931 to 1939 found the canvasback and redhead to comprise 4 and 2 percent of the bags respectively even though the reports for 1936 and 1937 merely indicated "closed season"

Table 5. Harvest of Canvasback and Redhead During Seasons with and without Special Protective Regulations, 1931–39

Protective Regulation With Respect to Canvasback and Redhead	Year of Hunting Season	No. Ducks Bagged/Season	
		Canvas-back	Red-head
Limit 15; no species restriction	1931	4	12
Limit 10; no species restriction	1935	16	10
Mean		10.0	11.0
10 in aggregate of 9 different species including canvasback and redhead	1932	39	5
8 in aggregate of 9 different species including canvasback and redhead	1933	28	9
5 in aggregate of 9 different species including canvasback and redhead	1934	15	1
3 in aggregate of 4 different species including canvasback and redhead	1938	11	7
3 in aggregate of 4 different species including canvasback and redhead	1939	27	2
Mean		24.0	4.8
Complete protection	1936	13	12
Complete protection	1937	27	14
Mean		20.0	13.0

under the numbers of each species shot. Bellrose (1944) found that the hunting pressure in Illinois apparently did not lessen on the canvasback and ruddy duck during 3 years of restricted bags. He noted further that even when given complete protection, the wood duck had first-season band returns of 3.4 percent in comparison to 2.3 percent from states that permitted 1 in possession. During the subsequent year when all states had a 1-wood duck limit, total returns were only 5.4 percent.

Wisconsin prohibited the shooting of coots during the 1935 and 1936 seasons. During these two seasons Osborn recorded killing 15 and 18 coots respectively.

Of the 9,121 waterfowl killed by Osborn and his associates, 269 (= 2.9 percent) were in excess of bag limits and 122 (= 1.3 percent) were protected; or, apparently 391 (= 4.3 percent) of the birds killed during the 32 years of records were in violation of regulations.

Van den Akker and Wilson (1951) recognized the inability of the majority of hunters to identify species, and questioned whether legislative protection of a species that was infrequently taken in the bag could materially affect its rate of harvest. Anderson (1948), nevertheless, reported that certain experienced individuals hunting on privately owned marshes along Lake Erie could identify ducks sufficiently well, and would selectively shoot birds by size, species, and sex during seasons having small bag limits.

We suggest that these endangered species might be better protected through regulation-zoning in time and place—but without any special restrictions on the duck species. In zones where endangered species constitute an appreciable percentage of the bag, the season could be closed entirely or adjusted to miss peaks of migration. Where these species constitute minor percentages of the bag, more liberal seasons could be permitted.

Three-Shell Limit

Objections to repeating guns made by Cottam (1935) were that in the hands of a good shooter they facilitated large kills, while in the hands of a poor shooter they increased crippling losses. Rather than prohibit the use of repeating shotguns, federal regulations in 1935 limited the number of shells in a shotgun to three.

Obsorn was apparently aware of this new regulation because on October 21, 1935, he wrote: "Jack could shoot only 3 times (under the law). He killed two . . . and one got away." In 308 hunter-days during the 5 years prior to the 3-shell limit, Osborn and his associates reportedly crippled 23 birds, and in 441 hunter-days during the 5 years following the regulation 29 cripples were allegedly lost. There was no significant difference between rates of crippling in the 5 years before and after the regulation. During 24 seasons, Osborn recorded just 1 bird lost per 50 bagged. This crippling ratio is much lower than those found in most reports of crippling losses. Bellrose (1953) summarized the findings of many research workers and determined the minimum average crippling loss for these studies to be 22.5 percent. Osborn's exceedingly low crippling rate suggests that he may have failed to record all lost birds.

Decoys

In a survey of game in the north-central states, Leopold (1931) indicated that heavy baiting and large numbers of live decoys were used on overflows, river sloughs, marshland, and cornfields for the best mixed-species shooting. Bluebill (scaup) shooting was done primarily on deeper waters where only wooden blocks were used.

In spite of the unrestricted use of live decoys in nearby Illinois as late as 1932 (Bellrose 1944), Wisconsin limited their use to 25 per person as early as 1905. This state regulation lasted until 1921, when the number of decoys was increased to 50 per person, but of this number, no more than 5 could be live. The first federal regulation on the use of live decoys limited their number to 25 during the seasons of 1932–34, and in 1935 federal regulations brought an end to this practice.

Live decoys, or "squawkers" as Osborn occasionally called them, were used by him from at least 1911 to 1917. In subsequent years there were no further remarks found in his journal concerning their use. The number of decoys was probably small because he once mentioned that 3 live decoys were put in among the balsawood decoys. He never indicated that bait was used.

Comparisons of the numbers of dabbling ducks in the bag, expressed as percentages, show very significant differences between the period of live decoy use (1913–17) and two periods of nonuse (1918–22 and 1935–39) : these percentages are 15, 9, and 10 percent, respectively. These differences, however, are believed to reflect the date of season opening rather than the use of live decoys. The 1913–18 period had 4 out of 5 seasons that were 9 days earlier than the 1918–22 seasons and from 3 to 6 weeks earlier than the 1935–39 seasons. By disregarding the kill during the first 9 days (September 7–15) of 4 seasons during the 1913–18 period the percentage of dabblers in the bag dropped from 15 to 9 percent. When this adjusted bag for 1913–18 is used, no significant differences are found among the three periods. Bellrose (1944) in comparing two seasons of similar length and dates on the Illinois River valley found that mallards comprised 84 percent of the bag during the preregulation year of 1933, and only 64 percent during the postregulation year of 1941. Because the ban on baiting and live decoys came at the same time, Bellrose was unable to evaluate each regulation independent of the other factor. Osborn's data suggest that small numbers of live decoys did not increase the kill of dabbling ducks on Lake Winnebago.

Conclusions

We regard hunters' diaries as tending to report the bags of the more successful members of the hunting community. With this bias in mind and with awareness that the Osborn diary is probably representative of only the larger-lake conditions of eastern Wisconsin, we draw the following general conclusions:

1. During the period of this study, hunting pressure by Osborn was not reduced by reduction in season lengths to 30 days. This finding may be influenced by the fact that the shorter hunting seasons occurred in those years when he had retired from business and may have had more opportunity to go hunting.
2. Opening and closing dates importantly affected the species composition of Osborn's seasonal bag, in this locality.
3. Concurrent upland-game and waterfowl seasons certainly affected the distribution of Osborn's hunting effort.
4. The termination of hunting in the present study by freezing weather (and not regulations) in 25 out of 32 years was typical of waterfowl hunting in other parts of the northern states.
5. On the basis of waterfowl harvests at this one site from 1911 through 1932 when bag limits were 15 per day, reductions of bag limits to 6 would have only a slight effect (less than 25 percent reduction) on the numbers of waterfowl shot each year. A 50 percent reduction could not be achieved until the bag limit was reduced to 2.
6. Closed hunting seasons on endangered species of ducks between 1907 and 1939 appeared to have little effect on the harvest of such species as the canvasback and redhead, but they appeared to reduce the harvest of wood duck. Special restrictions involving the identification of species also had little effect.
7. In this relatively open-water locality, the use of live decoys did not increase the bag of dabbling ducks.

Summary

This study presents a resumé of waterfowl regulations and evaluates their influence upon the harvesting of 8,078 ducks, 11 geese, and 1,032 coots on Lake Winnebago, Wisconsin, by A. L. Osborn and his friends from 1907 to 1939. The 86-percent representation of diving ducks in this bag was also typical of other Wisconsin lakes but was much higher than state-wide bag averages. The effects of decreasing waterfowl populations and more stringent hunting regulations were evident in the declining trend of average daily bags from 1909 to 1939. Reductions in season-lengths from 123 to 30 days had no significant effect upon the number of days Osborn spent hunting. Lake Winnebago's freezing frequently ended duck shoot-

ing more than a month before the legal closing date. From mid-September to mid-October, hunting activity was diverted from waterfowl to upland game birds. The seasonal distributions of waterfowl species in the bag show that blue-winged teals, mallards, coots, and redheads were most frequently taken in September; canvasbacks, scaups, and mergansers reached their peaks of prevalence in mid-October and November; and the geese were shot in October. Weekly averages of the daily-bag remained high from September 1 to November 23. Hypothetical bag limits of 10, 4 and 2 ducks per day were applied to the data for birds harvested under a 15-bird limit; these limits reduced the harvests 8, 35 and 60 percent, respectively. Of the 9,121 waterfowl killed by Osborn and his companions, 269 (= 2.9 percent) were in excess of bag limits and 122 (= 1.3 percent) were protected. Regulations did not effectively prohibit or limit the numbers of canvasback, redhead, bufflehead and ruddy duck bagged; but they appeared to be effective in the case of the wood duck. Reported crippling losses were only 1 bird per 50 bagged; the 3-shell law did not change the crippling losses for these hunters. The use of live-decoys did not increase the percentages of dabbling ducks in the bag.

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YELLOW BASS IN WISCONSIN[1]

*William T. Helm**

The yellow bass *(Roccus mississippiensis* (Jordan and Eigenmann)) is a recent addition to the fish populations in Wisconsin waters. It is native to the Mississippi River system, but not to the Great Lakes drainage. Recent collections have disclosed its presence in various streams and lakes of the Great Lakes drainage.

Forbes and Richardson (1920) reported it to be a southern fish, extending northward in the Mississippi River Valley as far as St. Louis. C. Willard Greene (1935) recorded it at two locations on the Mississippi River in Crawford County, Wisconsin. Oliver Gibbs, Jr. (Carlander, 1954) reported catching yellow bass in Lake Pepin during the 1860's. Recent collections (WCD Lake Survey Reports) in the Mississippi River have shown yellow bass to be common as far north as LaCrosse and Trempealeau Counties, and to be present as far north as Lake Pepin. Currently, it is known to be in 22 lakes or ponds in six river systems within the state of Wisconsin, exclusive of the Mississippi River itself. In addition, the yellow bass was also present in Lake Mason until the entire fish population was removed in 1955. Lakes and streams from which specimens have been obtained or from which yellow bass have been reported by reliable sources are recorded in Figure 1.

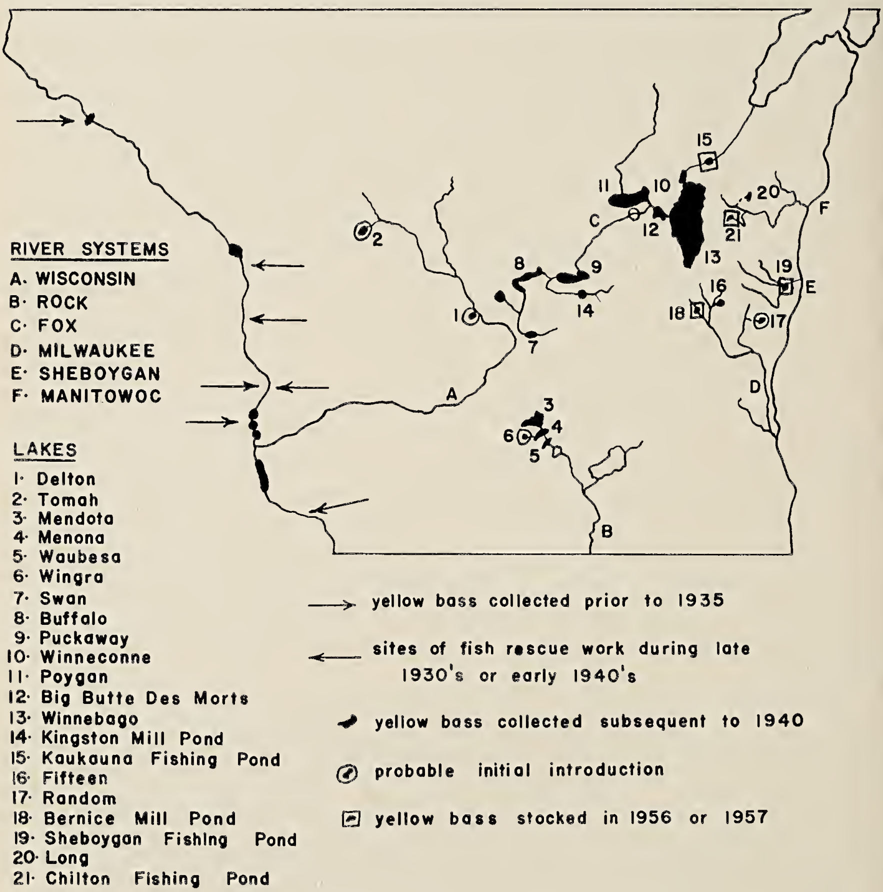
Specimens or reliable reports were obtained from lake survey and rough fish control activities of the Wisconsin Conservation Department, and from two research projects at the University of Wisconsin Hydrobiology Laboratory. The reports of the rough fish control section were available in a continuous series since 1936. Unfortunately, many fish were not identified with enough reliability to permit appraisal of their early distribution. Bass, crappies, sunfish, and white bass apparently constituted catch-all categories. In some reports yellow bass were excluded because "they were not very abundant."

All available evidence on the introduction or expansion of yellow bass into Wisconsin waters is circumstantial, but the following explanation appears most tenable. The Wisconsin Conservation De-

[1] Much of this material was presented in a Ph.D. thesis entitled "Some notes on the ecology of panfish in Lake Wingra with special reference to the yellow bass (University of Wisconsin–Madison)." Sincere appreciation is expressed to the Wisconsin Conservation Department for providing funds for this research.

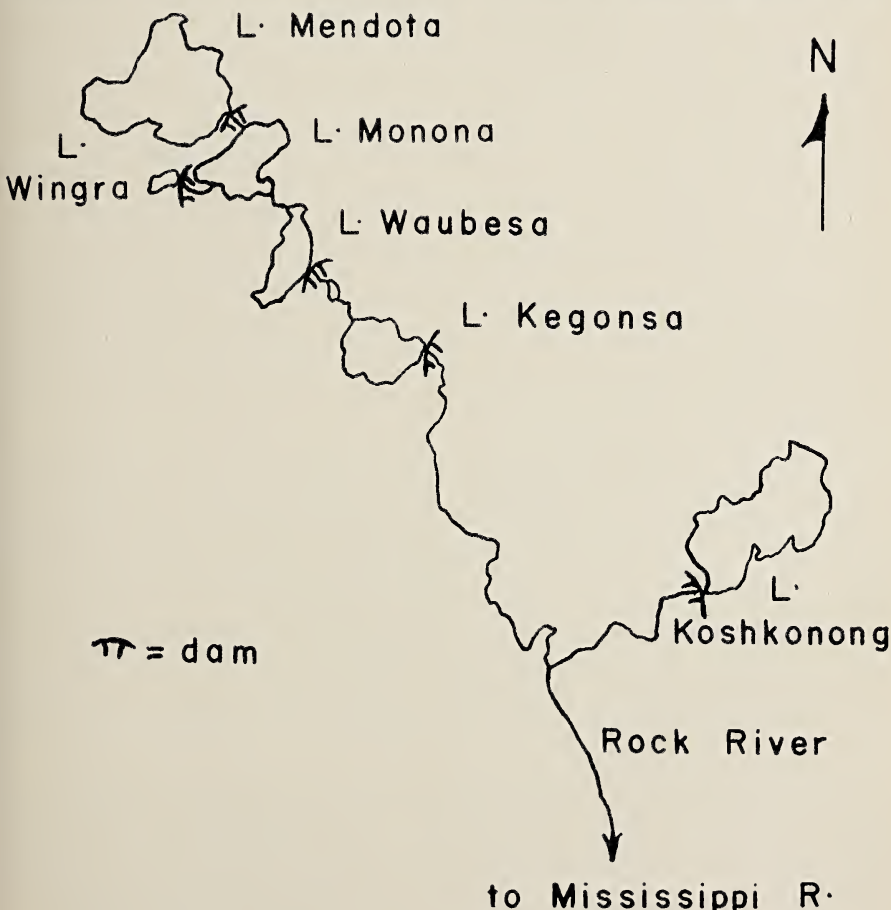
* William T. Helm is Assistant Professor of Wildlife Resources, Utah State University.

partment, similar departments of other states bordering the Mississippi River, and the Federal Government undertook extensive "fish rescue" work in the late 1930's and early 1940's. This involved the salvage of fish stranded in shallow sloughs when the Mississippi River receded, and the subsequent release of these fish back into the river itself or the stocking of some of them into various lakes. Attempts to determine which species of fish were introduced into various lakes by this procedure have been almost entirely futile. Transferred fish were usually recorded as bass, panfish, etc., without further identification (WCD planting receipts). Some of the collections containing fish designated as "panfish" or "bass" were obtained from areas in the Mississippi River where yellow bass had been previously reported (Fig. 1). Since southwestern Wisconsin



is on the northern edge of its distribution as reported by Greene, the yellow bass was probably rather scarce in areas where Wisconsin salvage crews were working. Carlander lists three stations in Wisconsin (LaCrosse, Lynxville, and Genoa) at which U.S. Bureau of Fisheries crews operated during the 1930's, and one (Cassville) at which Wisconsin crews worked during 1940. Thus, while yellow bass could have been captured during salvage operations, probably only a small percentage of the catches would contain yellow bass, and it now logically would occur in only a fraction of the lakes stocked with salvaged fish.

The known distribution of yellow bass further substantiates the above explanation. If the yellow bass had entered the Madison chain of lakes from the south via the Rock River, it would have appeared first in the lowest lake in the chain, Lake Kegonsa (Fig.



2). At present this species has not been reported in either Lake Kegonsa or Lake Koshkonong, where in all probability it should have appeared had the Rock River been the route of introduction.

For the above reasons it is not possible to determine the precise time and location of introductions of yellow bass into Wisconsin waters. Based upon present distribution, WCD records, and comments of WCD personnel, it appears that yellow bass were introduced at perhaps six points as a result of the stocking of rescued fish: Lakes Tomah and Delton in the Wisconsin River system; Lake Wingra in the Rock River system; and Lakes Mason, Buffalo, and/or Puckaway, and the Fox River at Omro in the Fox River system.

No appreciable spread of yellow bass seems to have occurred from the two lakes in the Wisconsin River system. The Fox River system, however, has been almost completely infiltrated. It is difficult to determine if this is a result of extensive movement or whether it represents many points of introduction within the river system. Perhaps the most easily interpreted movement has occurred in the Rock River system in Dane County. The yellow bass was apparently introduced into Lake Wingra during the 1930's. Transfer records of rescued fish state that "bass, bullheads, and sunfish" were stocked. Records of rough fish removal in 1936 do not mention yellow bass. Lake Wingra was not seined again until 1944, at which time the yellow bass was very abundant. Dr. John Black catalogued the captured fish and estimated the numbers of each species during the seining in 1944. Prior to his work, little time was expended on careful identification of species, and yellow bass could easily have been present.

Yellow bass evidently moved either across the dam or through the locks from Lake Wingra and downstream to Lake Monona where it was first reported by a contract fisherman in 1953 (Fig. 2). Since then it has become abundant enough to sustain a limited sport fishery. At about the same time, yellow bass also appeared in the rough fish control seines in Lake Waubesa, downstream from Lake Monona, although it was never mentioned in the seining reports. Another report indicates that a few were caught by hook and line during this period. The yellow bass has never become abundant in Lake Waubesa and has not appeared downstream in Lake Kegonsa.

Upstream movement from Lake Monona to Lake Mendota was difficult, since the fish had either to swim up through very fast, shallow water or pass through a set of locks. One of these routes was apparently negotiated successfully as early as the spring of 1957 when one yellow bass was captured in a fyke net in Lake Mendota.

In 1960, 1961, and 1962, numerous yellow bass were captured in nets on the eastern shore of Lake Mendota.

Several other Wisconsin river systems also contain yellow bass, either as a result of the stocking of rescued fish or because of the stocking of children's fishing ponds in 1956 and 1957.

The extensive distribution of yellow bass in the Fox River system, the slow rate of dispersal in the Rock River system and lack of such movement in the Wisconsin River system appear to be so inconsistent that no general statement can be made regarding the ability of the yellow bass to disperse throughout various types of river systems.

Food

A knowledge of the food and feeding habits of a fish, such as the yellow bass, can help delineate its basic ecology. Reports published in the early 1900's from Mississippi and Illinois were rather brief. Burnham (1910) stated that the young feed on air and water insects, crustacea, insect larvae, and small fish; and that adults consume air and water insects, crawfish, crustacea, frogs, mollusca, small fish, tadpoles, worms, etc. Forbes and Richardson (1920) reported that the yellow bass is insectivorous and that the adults feed on aquatic larvae, small crustaceans, and terrestrial insects. The reports indicated that fish are a minor item in the diet. More recent reports from Iowa (Kutkuhn, 1955) presented a considerably different picture. There the young feed on plankton crustaceans and minute immature insects, while the adults eat fish (70% as frequency of occurrence) and to a lesser extent plankton, insects, etc.

A number of collecting devices were used by the author to obtain samples of fish from Lake Wingra between 1953 and 1957. During the first two years seines, gill nets, angling, and fyke nets were employed; later, bottom trawls were added. Passive devices such as gill nets and fyke nets collected fewer fish per unit of time than active devices such as seines and trawls.

Identification of recently consumed food organisms can often be quite precise, but such careful itemization can be extended to include the entire contents of the stomach only with great difficulty. The food categories utilized must be broad enough, therefore, that classification of small fragments of resistant material is possible. In this study 26 categories of food organisms were recorded; the 11 most often encountered are listed in Table 1. Each stomach from the 1953–54 collections was examined individually while the contents of several stomachs from the 1956 samples were lumped together for examination.

Food organisms in six categories (Table 1) were the most important during both study periods. Fish remains and scales in the 1953–54 samples were recorded as separate items; in 1956 they were lumped together as fish remains. Two categories had been established in 1953–54 because the presence of intact, undigested scales without any sign of other fish remains indicated that the yellow bass had picked up a scale or scales along with other small food, and probably had not consumed an entire fish.

TABLE 1. FREQUENCY OF OCCURRENCE (IN PER CENT) OF VARIOUS FOOD ORGANISIMS IN THE STOMACHS OF LAKE WINGRA YELLOW BASS

	1953–54		1956	
	All Stomachs Containing Food	Food Found in More than Trace Amounts	All Stomachs Containing Food	Food Found in More than Trace Amounts
Cladocera	73	34	92	84
Copepoda	51	27	92	28
Chironomidae				
larvae	30	20	68	48
pupae	26	15	52	28
Chaoborinae	18	10	16	...
Fish	13	6	20	16
Remains only	4	2	...	...
Scales only	9	4	...	...
Ephemeroptera	7	3	8	...
Hydracarina	5	3	8	...
Corixidae	4	3	4	...
Ostracoda	5	2	28	...

The possibility always exists in analyses of frequency of occurrence that some organisms may be present in a large percentage of the stomachs but never in large numbers. Such organisms then appear to be more important as food items than they actually are. Data were analysed to eliminate this error, and only food items present in more than trace amounts were included. The term trace amounts designates ten or fewer individuals of the very small organisms such as ostracods. Results (Table 1) are in general agreement with the standard frequency values. The food categories of major importance in both study periods were Cladocera, Copepoda, Chironomidae (larvae and pupae), Chaoborinae, and fish remains.

Collections of yellow bass from two lakes in east-central Wisconsin, Random Lake in Sheboygan County and Lake Winnebago in Winnebago County, and two in southwestern Wisconsin, Gremore Lake and Horseshoe Lake in Crawford County, were made by the

Wisconsin Conservation Department during 1956 and 1957 (Table 2). All of these fish were captured in seines. Unfortunately, the sample of fish from Gremore and Horseshoe Lakes was small, and the percentage values are probably unreliable. The food items, however, are of decided interest, especially since Gremore and Horseshoe Lakes are backwater sloughs of the Mississippi River while the others are inland lakes.

In general, analysis of the food organisms consumed by the yellow bass collected throughout the state indicates that plankton and chironomids are of major importance while other littoral or bottom forms and fish are less important.

Table 2. Frequency of Occurrence (in per cent) of Various Food Organisms in the Stomachs of Yellow Bass from Three Wisconsin Lakes

	Lakes Gremore and Horseshoe August, 1956	Random Lake May 2–10, 1957	Lake Winnebago August 9, 1957
Cladocera	....	57	83
Chironomidae			
larvae	30	83	....
pupae	20	51	69
Ephemeroptera	40	27	....
Fish	50	1	14
Coleoptera larvae	20	....	....
Gammaridae	....	13	10
Copepoda	....	13	....
Corixidae	10	1	....
Odonata	10	....	....

Although the food items of greatest importance did not vary appreciably, the number of food categories represented was influenced by the methods used to collect the fish. This influence of the collecting method is evident if the numbers of food categories found in the stomachs of fish collected by the various methods are tabulated (Table 3). A wider variety of foods was found in the stomachs of fish collected by gill net and seine than in those collected by fyke net, trawl, and angling. Water depth and proximity to shore were not common denominators for the differences, nor were passive and active collecting devices.

Records were kept of the number of categories represented in the stomachs of small, medium and large fish. No significant differences were noted. Data obtained on the number of categories represented in fish collected in daylight and darkness also indicated no difference. Whenever one category was definitely dominant by volume in any stomach, this fact was noted. Only representatives of the first four categories (Table 1) were consistently dominant. It is not possible to state which of the first four groups was most frequently dominant in view of the results of the time-of-feeding study reported under feeding habits, as a predominance of daytime or nighttime samples could distort the results.

Feeding Habits

Numbers of yellow bass collected from Lake Wingra with seines during 1954 and the early summer of 1955 varied with time of day. More fish were captured per seine haul between sunset and sunrise than during daylight. A study of feeding habits was initiated to determine whether the difference was correlated with increased feeding activity during some particular period of the day.

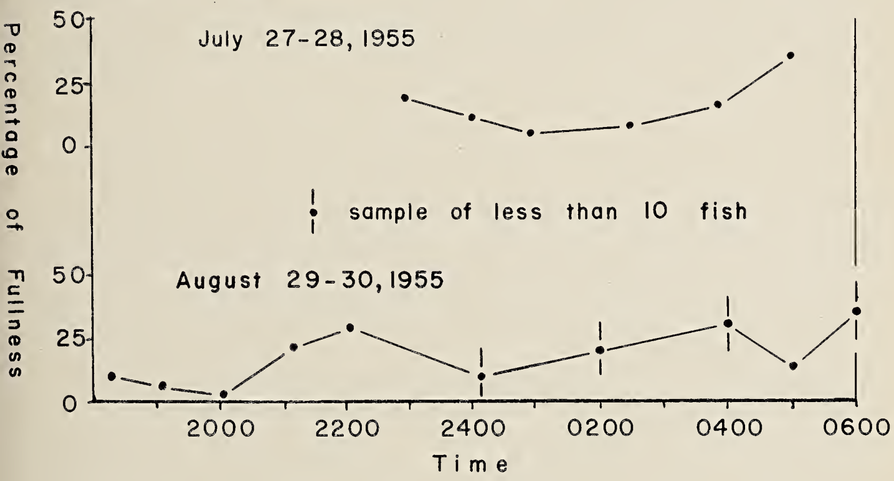
Table 3. Number of Food Categories Represented in the Stomachs of Yellow Bass Collected from Lake Wingra by Various Methods

	1953–54	1956
Seine	18	14
Gill Net	21	....
Fyke Net	11	....
Angling	10	....
Trawl	....	9
Total No. of Categories	26	14

Yellow bass were collected by seining at approximately hourly intervals, ranging from late afternoon until after sunrise the next morning on two occasions during the summer of 1955. One of the problems encountered was inability to catch sufficient numbers of fish each time the seine was drawn at a given place. Apparently the interval of one hour between hauls was too short to permit adequate numbers of fish to re-enter the seined area. The small samples caused great variation in the results of stomach analyses. A conventional shrimp-testing otter trawl was being used at the same time to collect fish for growth studies and this appeared to be a suitable substitute. Fish were collected on five occasions during 1956, and all these collections were made with an electrified version of the otter trawl. The collections were made over a total elapsed time of 55 hours.

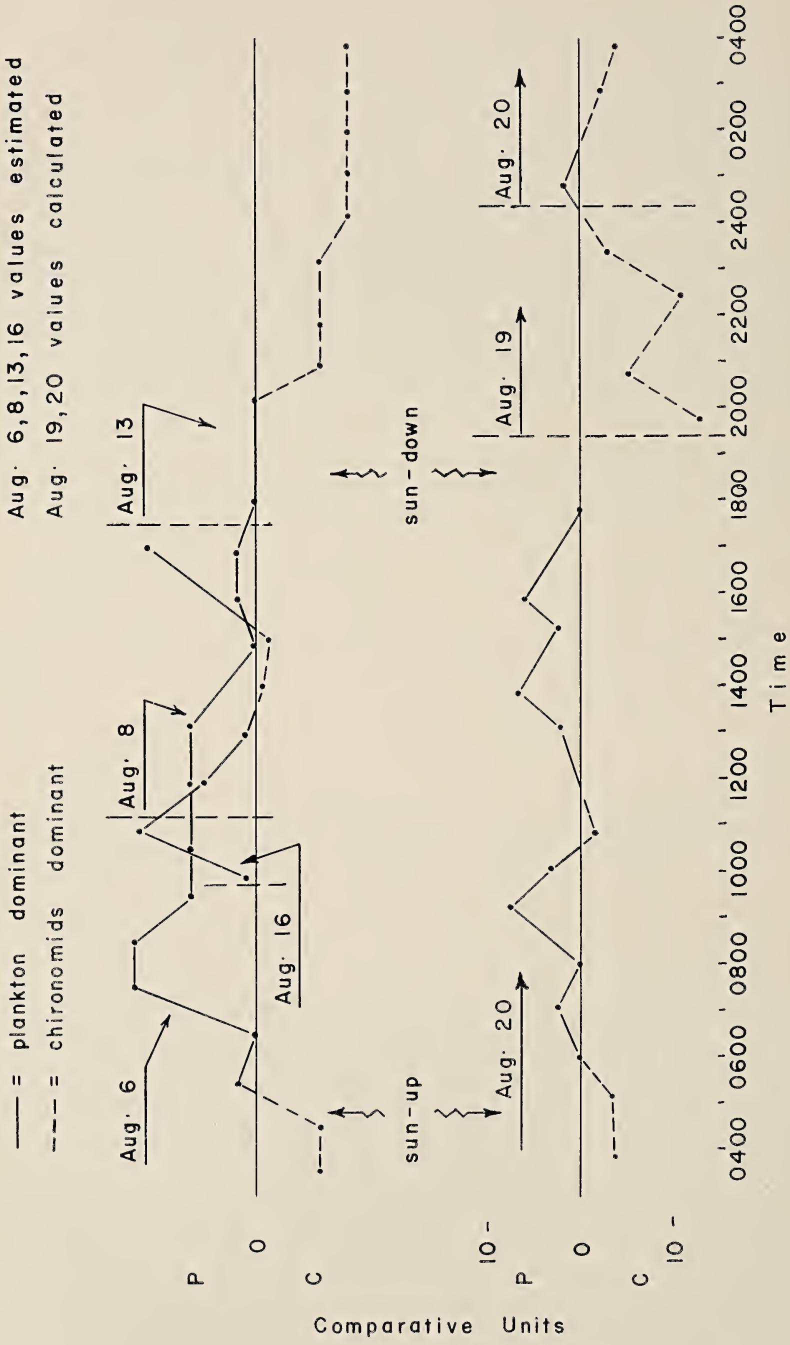
As soon as possible after collection, usually within a few minutes, the entire stomach and intestine were removed from the fish and preserved in 70% alcohol. Stomachs were opened in the laboratory and all the food was removed. The actual volume of material present was estimated as percent of fullness of the stomach. Stomachs were rated as being entirely empty, less than one-quarter full, one-quarter, one-half, or completely full. Numerical values of 0, 0.1, 0.25, 0.5, and 1.0 were assigned to the above ratings. A value given to each collection of fish was computed by determining the average degree of fullness for the entire collection.

Data from 316 fish captured during July and August 1955, are presented (Fig. 3). The July collections indicate a definite periodicity in feeding. Rather than feeding throughout the night, these fish apparently fed shortly after dark and again at daylight. August samples are not as easily analysed since some of the collections contained less than 10 fish and therefore have rather wide confidence limits. There is no well defined trend in the graph of August samples, and thus no definite conclusions can be drawn regarding periodicity of feeding.



During 1956, collections were made with a trawl at approximately 1-hour intervals extending over 8-hour periods on August 6, 8, 13, and 16, and over a 24-hour period on August 19 and 20. Stomach contents of 704 fish were evaluated as in 1955. The evidence did not indicate any prime feeding periods during which the majority of the fish feed.

In addition to estimating the degree of fullness of the stomachs an examination was made of stomach contents to assess the relative importance of different organisms at various times in a 24-hour period. A striking variation with respect to time of collection in the kinds of organisms present in greatest abundance was found (Fig. 4), although, as previously noted, the numbers of food cate-


—— = plankton dominant
– – – = chironomids dominant
Aug. 6,8,13,16 values estimated
Aug. 19,20 values calculated
Aug. 6
Aug. 8
Aug. 13
Aug. 16
Aug. 19
Aug. 20
Aug. 20
sun-up
sun-down
P
0
C
10
P
0
C
10
Comparative Units
0400
0600
0800
1000
1200
1400
1600
1800
2000
2200
2400
0200
0400
Time

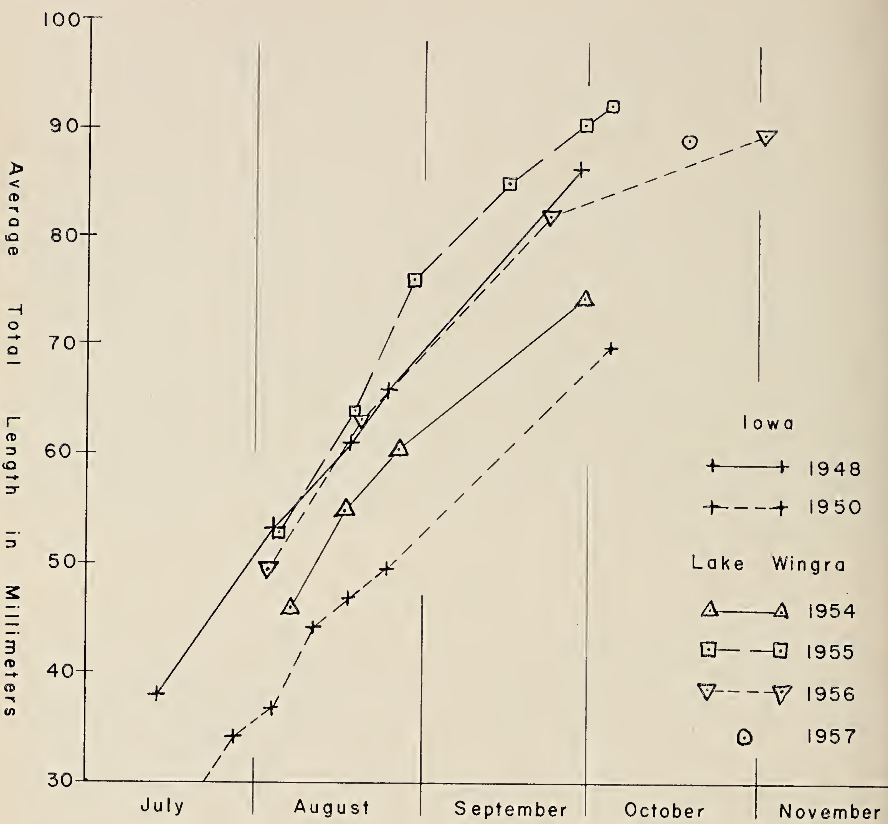
gories represented did not change. Either chironomid larvae or plankton crustaceans were the dominant organisms in most stomachs. A plankton-chironomid (P/C) ratio was calculated for each collection of fish. This ratio was determined by assigning a value to either P or C, whichever was the dominant organism in any one fish stomach, and adding the P's and C's separately for each collection to obtain a pair of values for that collection. The values assigned were based on the degree of fullness of the stomach attributable to the organism concerned: 1 if the stomach were ⅛ full; 2 if it were ¼ full; 4 if it were ½ full, etc. Thus if eight of 14 stomachs in a collection were ¼ full of chironomids with only traces of plankton ,and two stomachs were ⅛ full of plankton, a P/C ratio of 2/16 or 8 C would be obtained. Points on the graph marked with a vertical line represent very small samples (six fish or fewer). It is apparent that, with few exceptions, chironomids were dominant in stomachs collected at night and plankton was most important during daytime.

Growth

Age-group 0 (young-of-the-year) fish were collected in Lake Wingra during the summers of 1954, 1955, and 1956, and on one occasion in 1957. Growth rates of these fish compared favorably (Fig. 5) with fish of the same age from Clear Lake, Iowa (Carlander *et al.*, 1952). Iowa data from 1948 and 1950 illustrated good and poor growth. It is not possible to make any statement regarding the relative strengths of year-classes in Lake Wingra; each year of the study the hatch was sufficiently successful that large numbers were readily seined. Growth remained good through September, slowing down sometime in October each year of the study (Figs 5 and 6).

Determination of growth rates of older fish in Lake Wingra was complicated by a serious mortality of older panfish, including yellow bass, which occurred in July 1954. Collections of yellow bass taken periodically during the summer of 1954 indicated that after July very few fish older than age-group III were present, although nearly all specimens collected in July were older fish.

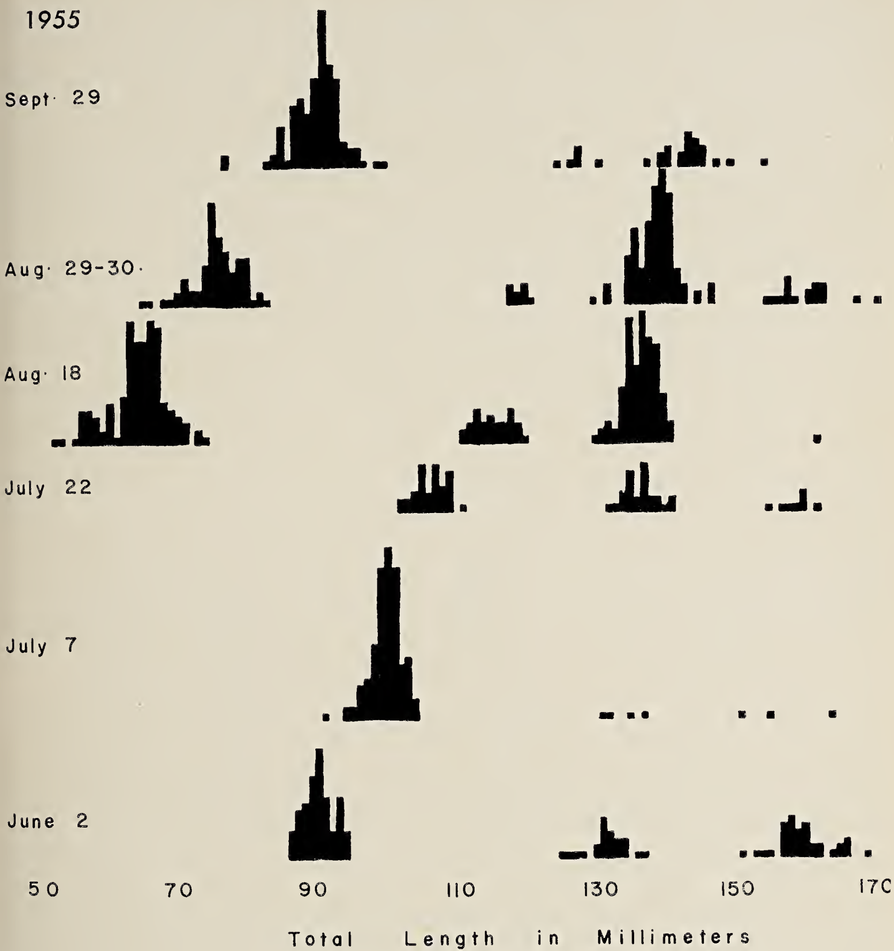
Examination of scale samples collected during 1954 revealed that only a small fraction of the yellow bass had laid down an annulus that year. Collections had been made at such short intervals in 1954 and 1955 that the growth of yellow bass throughout summer could be plotted, and age-groups could be identified in this fashion (Fig. 6). Growth of fish for 1954 and part of 1955 was easily determined by this method, but by 1956 and 1957 the length interval between



age-groups became very small. This twofold complication of lack of annulus formation and small differences in length between age groups thus prevents any meaningful presentation of growth data.

Bathymetric Distribution and Movements

Preliminary studies on the distribution of yellow bass in shallow water indicated that: (1) they were found in areas with few obstructions, i.e. outside of beds of vegetation rather than within; (2) they were found along nearly all types of shoreline as long as there was sufficient open water, but were difficult to seine on a stony bottom; (3) they were found in the area of a swimming beach, where they were very readily seined; and (4) they were generally far more abundant in shallow water during darkness than during daylight.



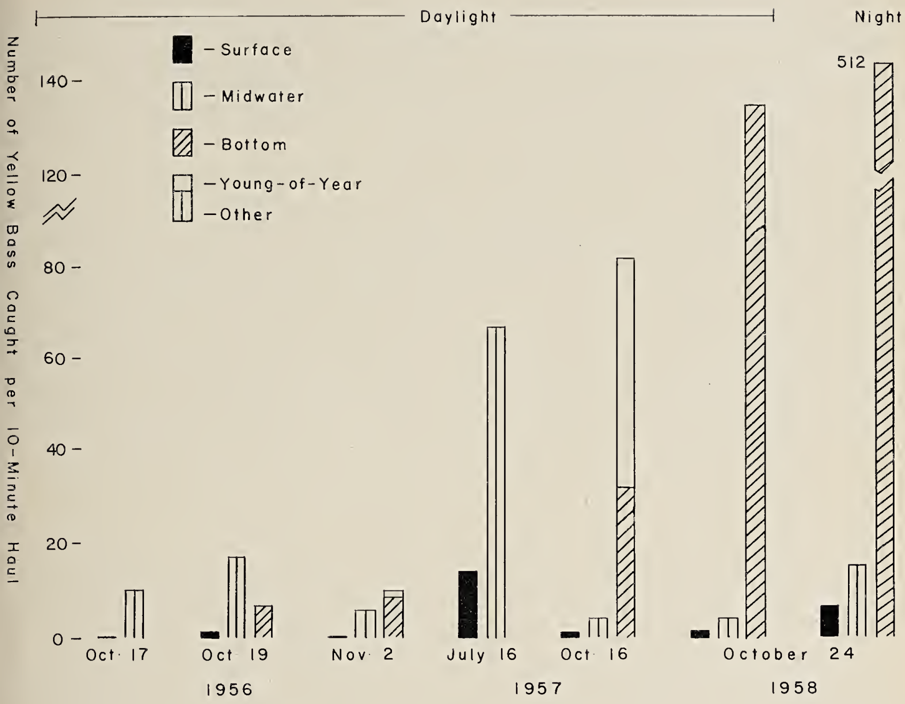
Part of the yellow bass population moved into shallow water at dusk but did not travel laterally to any extent. Seining and removal of fish from an area at 1-hour intervals during the night produced moderate numbers of fish the first few hauls, but very few thereafter. Single collections at various times on different nights showed that yellow bass remained in the beach area all night. Bottom trawling in the center of the lake at approximately 1-hour intervals over varying periods of time up to 24 hours revealed that yellow bass were present at all times. Numbers caught during darkness by this method exceeded those caught during daylight by a three to two ratio.

Age-group 0 yellow bass displayed a pattern of diurnal movement. Large numbers were captured with seines in shallow water at night, but very few were ever captured in the same areas during daylight. Bottom trawling during daylight produced many of this age-group, but trawling at night seldom produced any. This movement from deep water during daylight to shallow water at night began to change to adult behavior patterns during June of the second year of life at water temperatures of 20° C or more.

Limited information was obtained on the bathymetric distribution of yellow bass in Lake Wingra. A 16-foot shrimp-trawl was rigged to operate as a surface or midwater trawl in addition to its normal use as a bottom trawl (Massmann, Ladd, and McCutcheon, 1952). When used as a surface or midwater trawl, the size of the net opening was 3 feet vertically and 10 feet horizontally. Both dimensions were reduced slightly when the net was operated as a bottom trawl. The surface trawl under tow travelled with the cork line just beneath the surface of the lake, while the cork line of the midwater trawl travelled about 3 feet beneath the surface. Lake Wingra, throughout most of the deep water area, averages about 9 feet in depth; therefore, the multi-level trawling at three depths effectively sliced the lake into three nearly distinct layers.

Nearly all multi-level trawling was done during daylight hours, thus any changes in spatial distribution of yellow bass due to changes in light intensity, etc., have not been explored thoroughly. Seven trials of this type of trawling were made; three in 1956, two in 1957, and two in 1958 (Fig. 7). One trial each in 1956 and 1957 included only surface and midwater hauls. One trial in 1958 was made during darkness. Yellow bass, with only one exception, were never caught in large numbers by surface or midwater hauls. The exception was on a dark, rainy day when light conditions were approximately the same as after sundown on a clear or partly cloudy day. Apparently the bottom layer on the lake was the preferred habitat during daylight hours when light intensities were high. Some individuals apparently tend to move up into the middle depths and even to the surface under low light intensities. This is not a mass movement, however, since periodic bottom trawling did not reveal any major decrease in numbers of yellow bass available for capture during a 24-hour period.

Daylight catches varied greatly in October and November during the 3 years. Reproduction could account for some increase from 1956 to 1958. More than one-half of the bottom haul in October 1957 was composed of young-of-the-year, indicating good survival of that year-class, but the tremendous catch of 1958 remains unexplained.



The large numbers captured in the bottom trawl at night on October 24, 1958, probably reflected a reaction to decreasing lake temperatures.

Catches of yellow bass in the bottom trawl, as previously stated, were larger at night than during daylight by a three to two ratio. The apparent conflict with the vertical diurnal migration mentioned above can be logically explained. Behavior of yellow bass in seines was observed on numerous occasions. In every case the fish oriented toward the seine but avoided contact with it. If the lead-line was raised from the bottom when passing over an obstruction, the yellow bass in that vicinity darted through the hole and escaped. Such behavior indicates a strong reliance on vision. Light intensities at the bottom of Lake Wingra during daylight probably are sufficient to allow some yellow bass to escape the trawl. Trawling at night, however, could be expected to result in a greater rate of capture. Apparently the density of fish was not reduced sufficiently by vertical migration to offset the increased efficiency of the net at night.

Although some adult yellow bass were captured by seine in shallow water at night shortly after the ice melted in spring, daylight seining was seldom successful until the water had warmed up to nearly 15° C. Age-group I fish, hatched the previous year, were first captured in seines in the shallows at night when surface water temperatures ranged from 16 to 20° C, and during daylight when surface temperatures exceeded 20° C.

Yellow bass of all ages were present, although in reduced numbers, in shallow water in fall when water temperatures were somewhat below 10° C, but none were captured when temperatures reached 4° C. Bottom trawling in late October, when water temperatures were less than 10° C, was far more successful than when the water was warmer. Apparently the fish form fall or cold-water aggregations in deeper water. This aversion to very shallow areas during the cold water season was not always apparent, however; yellow bass were caught by hook and line through the ice in water less than 4 feet deep on many occasions during the winter.

Summary

Yellow bass had been collected at two locations in the Mississippi River in Crawford County in southwestern Wisconsin prior to 1935. By 1958 specimens had been collected or reliably reported from 22 lakes or ponds in six river systems within the State, in addition to the Mississippi River. Most of the expansion within the State appears to be the result of transferring fish from the Mississippi River, while the remainder is due to the stocking of children's fishing ponds. As a result of these stocking activities, the range of the yellow bass has been extended from the Mississippi drainage into the Great Lakes drainage.

Early reports on foods of yellow bass indicated a reliance on invertebrates, while some recent publications report greater utilization of fish. Invertebrates were the principal food item in the stomachs of yellow bass collected from five Wisconsin lakes. It was noted that method of capture influenced the number of food categories represented in yellow bass stomachs.

Collections made at various times of the day and night and in different areas of Lake Wingra indicated that yellow bass captured away from shore fed continuously, but evidence was inconclusive concerning those captured in shallow water. A diurnal fluctuation in kinds of food organisms consumed was evident in fish captured in a bottom trawl in the center of the lake.

Growth rates of age-group 0 yellow bass compared favorably with the growth of similar aged fish in an Iowa lake. Older fish grew so slowly that many of them did not produce an annulus, and neither annulus enumeration nor length-frequency analysis could be used to study growth.

Trawling for fish on the surface, at midwater depths, and on the bottom revealed that yellow bass were most abundant near bottom. There was some diurnal movement of adult yellow bass, and an almost complete movement of age-group 0 fish to shore during darkness.

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UWM AND THE PEACE CORPS: PARTNERSHIP IN INNOVATION

*Carol Edler Baumann**

When the first Peace Corps training project at The University of Wisconsin–Milwaukee commenced in January of 1963, it ushered in a new dimension to the international studies of the University which even now has not reached its full expanse. In two years, The University of Wisconsin has served as the locale for fourteen projects and for the training of over 600 Volunteers for Latin America, Asia, and Africa.[1] During this time UWM has become one of four permanent year-round Peace Corps Training Centers in the country; it has granted not only fellowships, assistantships, and tuition scholarships to returning Volunteers, but also up to twelve undergraduate credits in relevant disciplines; finally, it has incorporated into the international relations field a special sequence of courses closely geared to Peace Corps service. This, indeed, could well be only the first step toward a comprehensive and continuing relationship which might yet develop to embrace Peace Corps studies and service as an even more integral part of both the undergraduate and the graduate curriculum.

The Beginning

Following discussions in Washington, D. C., between Provost J. Martin Klotsche of The University of Wisconsin–Milwaukee and Peace Corps officials, a Special Committee on International Programs[2] met at UWM on February 28, 1963, to discuss the possibility of a Peace Corps training project in Milwaukee. The committee agreed that UWM involvement in such a project could be an appropriate and beneficial undertaking for the University, that Latin America presented itself as a geographical area in which the University was best prepared to develop such a program, and that the project would be strengthened if, added to UWM resources, the resources of the total University and other educational institutions

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* Dr. Baumann is Assistant Professor of Political Science and Director of the Institute of World Affairs, The University of Wisconsin–Milwaukee and University Extension Division.

[1] UWM alone has hosted a total of thirteen Peace Corps projects with over 550 Volunteers.

[2] Professors Frank M. Himmelmann, Henry W. Hoge, and Donald R. Shea.

in the Milwaukee area could also be utilized. This kind of cooperative approach has been followed throughout all of the Peace Corps training programs at the University.

On April 18th, Mr. Lawrence Dennis, Associate Director for Peace Corps Volunteers, visited Milwaukee and met with a number of Milwaukee area university and college representatives at The University of Wisconsin–Milwaukee. At the meeting, Dr. Fred Harvey Harrington, then Vice-President, expressed the interest of The University of Wisconsin as a whole in cooperating with various Wisconsin institutions in developing programs for Peace Corps training. Although centered on the Milwaukee campus, all University of Wisconsin Peace Corps training has since borne this marked characteristic of total University support by faculty and administration alike. The following month, Mr. Joseph F. Kauffman, Director of Peace Corps Training, sent an invitation to Dr. Donald R. Shea of The University of Wisconsin–Milwaukee to attend a Peace Corps Training Conference in Washington. In early June, Dr. Shea attended the Washington meeting on behalf of the University, and conversations there led to a subsequent statement by Mr. Dennis that it appeared likely that a program for UWM would develop sometime later that year. To clarify and formalize this somewhat indefinite commitment was the major remaining task before actual negotiations on a training contract could begin. That UWM was ready to move ahead quickly in this direction was made clear to both the Director of Training and the Associate Director for Peace Corps Volunteers.

Before mid-July, UWM officials had received a preliminary statement on a specific Peace Corps project for the development of savings and loan operations in Peru. Although the details were yet to come and a contract would still have to be negotiated, the University administration was ready to get the project nailed down. Latin America was regarded as the overseas area in which the University had the greatest academic competency, and the technical studies prescribed (savings and loan) would provide the University with the opportunity to draw on community resources in such essential areas as banking, business, and labor. By October, contract negotiations were under way, and the development of a successful project seemed assured by the endorsement of the administration and by the enthusiasm of the key faculty people involved both in Milwaukee and in Madison. The Peru Savings and Loan Project began as the first UWM Peace Corps Training Program on January 10, 1963. The next section will examine in more detail what that and subsequent programs entailed and how they led to the creation of year-round Peace Corps Training Center on the UWM campus.

Training Programs and the Peace Corps Center

Including the initial Peru Savings and Loan Project (January 10–March 23, 1963), The University of Wisconsin–Milwaukee undertook and completed thirteen Peace Corps training programs through December of 1964. These included projects for seven different countries on three continents with a total of over 550 trainees. The Volunteers were trained in such disparate skills as Community Development, Math/Science Teaching, 4-H, Credit Union Development, Rural Cooperatives, School Lunch Programs, Auto Mechanics, Nursing Education, and English as a Foreign Language—and the list is not complete.[3] Of those trainees entering the first eight projects, approximately 78.3% successfully completed their training program and graduated as full-fledged Volunteers.

One of the outstanding characteristics of the training programs is their diversity—in the areas of knowledge and technical skills included, in the sources and talents of administrative and training staff utilized, and in the background of the trainees themselves. In addition to the technical studies referred to above, the trainees study in depth the country and region to which they are assigned and so familiarize themselves with the language and customs of its people as to almost "feel at home" when they finally arrive at their Peace Corps destination. According to the Peace Corps Training Division, the aim of Area Studies is to provide the trainees with both knowledge of and respect for the culture, traditions, and sensitivities of the nationals with whom they will live and work. The training program also includes an American Studies, World Affairs, and Communism component designed to nurture an understanding of the United States and its heritage as well as some conception of the foundations and problems of international relations today.

Diversity is also reflected in the backgrounds and disciplines of the training staff and faculty. In all of the UWM projects to date full use has been made of the "total" University resources so often referred to in the early negotiations. In the first seven projects, for example, The University of Wisconsin in Madison was represented fifty-two times—second only to UWM in the number of faculty members included.[4] In the same seven projects a total of forty-seven different institutions were represented, almost half of them two or more times. Among these were colleges and universities from all over the country as well as from foreign states. The faculty representation from the University (Madison and Milwaukee) included thirty-two disciplines and departments. This broad, interdisciplinary approach, though dictated by the project format and

[3] See Appendix A for a complete list of all UWM projects (to date), with relevant technical studies, dates, number of trainees, and dropouts.

[4] UWM was represented 166 times in the first seven projects.

facilitated by a fairly specific goal, was in itself an innovation for faculties more accustomed to the departmental rather than the interdepartmental viewpoint.

Finally, the trainees themselves have contributed a cosmopolitan air to a campus less characterized in its international learnings by the composition of its student body than by its academic interests and expanding international curriculum. Again using the first seven projects for computation purposes, the following figures emerge: The trainees came from thirty-eight different states, the District of Columbia, Puerto Rico, Burma, and Germany.[5] Sixty-nine per cent had finished sixteen grades of schooling and had received their B.A. degrees. Another 4.8 per cent had received M.A. degrees, and there were three (1.4 per cent) LL.B. degrees. As a group, the trainees had obtained degrees from ninety-six different schools. The age variation extended from 18 to 65, but over 54 per cent were 22 to 24, and another 23 per cent fell between the ages of 20 and 26. Diversity has thus characterized the trainees more in geographical representation than in educational background or in age.

As for the training programs *per se*, the general format and the rudimentary elements of each are similar. The number of trainees and the number of weeks may vary, although on a national basis most projects now take approximately ten to twelve weeks and tend to average seventy-five trainees per project.[6] The program breakdown in subjects covered and time allocated has also become fairly standardized. In the more recent twelve-week programs at UWM, the total of 720 training hours (60-hour weeks of 10 hours per day) is divided in general as follows:[7]

Language	310 hours
Technical Studies	143 hours
Area Studies	100 hours
American Studies, World Affairs, and Communism	55 hours
Physical Training and Recreation	70 hours
Health	30 hours
Peace Corps Orientation	12 hours
Total	720 hours

The predominant position afforded to language, technical studies and area studies simply reflects the primary emphasis placed upon the tasks to be done and the linguistic facility so necessary to accomplish them. An understanding of the history and culture, politi-

[5] New York (26), California (24), Illinois (18), Pennsylvania (14), and Wisconsin (12), as listed, had the highest number of trainees.

[6] American Council on Education, *Special Report on Federal Programs* (Volume 1, No. 8—August, 1963), p. 2.

[7] Outside of a slightly greater emphasis on language, technical, and area studies, the UWM program compares closely with the general pattern for Peace Corps programs throughout the county. See *Ibid.*, pp. 2–3.

cal and economic systems, and the needs and aspirations of the people living in the area is also considered essential to the job at hand. Hence, area studies are correspondingly emphasized.

In Milwaukee, there have been three major developments in the content of the training programs during the initial two-year period. First, in the area of technical studies, there was a noticeable switch during and after the eighth project from a primarily lecture approach toward technical studies to an emphasis on practical, "in-the-field" training. Field practitioners involved in similar or closely related work, whether it was nursing, public health, or community development, were heavily utilized in the technical training segment of the program. Moreover, the trainees themselves were taken on relevant field trips where they not only gained practical experience in the work ahead of them, but also had the opportunity to apply the knowledge they had accumulated in the more formal phases of their training. According to Center personnel, this also afforded them both relief and release from the pressures of intensified training by allowing them to "get their hands dirty."

In addition to this new emphasis on field training, the more recent projects at UWM have included a sizable segment of "communications theory" within the technical studies field. Since the Brazil RCA project (spring, 1964), communications theory has constituted approximately fifteen hours of the total technical studies time allocation. Recognizing the language problem as of key significance in a cross-cultural situation, the communications section was obviously designed to supplement language training by alerting the trainees to the ambiguous nature of full and clear communications. The UWM program is not unique in including this, but it does emphasize the fact that total communication is more than language; that it not only requires facility with the language itself but also must take cognizance of such factors as source credibility, nonverbal communication, the impact of communication on group change, and the possibilities and limitations of the mass meda in communications.

A second development, related more to organization and administration than to content, and yet affecting the later, was the gradual combination of the American Studies, World Affairs, and Communism sections of the training program.[8] In the first four projects all three were treated as separate segments with little, if any, relationship between them. They were co-ordinated by different professors and were scheduled separately, again, with little relation to one another. By the time of the fifth and sixth projects (Ecuador 6 and Brazil 6), however, World Affairs and Communism had been com-

[8] See Syllabi of all UWM Peace Corps Training Projects, The University of Wisconsin–Milwaukee.

bined as an integral unit. American Studies remained a separate entity, but both units (American Studies as one and World Affairs and Communism as the other) were coordinated by the same person. In the seventh project (India 5a) all three were combined as the ASWAC (American Studies, World Affairs, Communism) section of the training program, and this format has since been followed. In the combined approach, an attempt has been made to relate the various political, economic, and social aspects of American society and its institutions both to the world scene and to the ideological and practical accoutrements of international Communism. Although closer integration could probably still be effected, the three topics have emerged as a more cohesive and meaningful unit.

The third change in the UWM projects resulted from the maturation of the entire Peace Corps program. With the advent of returning Peace Corps Volunteers, the opportunity arose to utilize their experience and personal insights in the training of future Volunteers. In addition to their value as adjuncts of the Peace Corps Center,[9] the returning Volunteers became invaluable participants in the orientation segments of the training program. Peace Corps Orientation is the only portion of a training program which is administered by Peace Corps, Washington, and carried out by Peace Corps personnel. Since the India 5a project (Sept.–Dec., 1963) in Milwaukee, returned PCVs have been utilized for at least six hours of the twelve-hour orientation sections. From their own personal experiences, they have been able to prepare the trainees for the actual living conditions they will face and the concrete situations with which they will have to deal. This has provided the trainees with a much more realistic picture of Peace Corps service and has thus given a more practical bent to their total training.

As salutary as all of these developments have been for specific segments of the projects, the total training program at UWM has probably benefited most from the creation of a permanent year-round Training Center. The first official proposal indicating the University's interest in the establishment of such a center was made by President Harrington of The University of Wisconsin to Mr. Sargent Shriver, Director of the Peace Corps, when he indicated that the University was prepared to make a long-term commitment to train Peace Corps Volunteers on a year-round basis for any country and in any specialty for which it had available resources. The University was convinced, however, that the most efficient and effective way to undertake such training programs would be under a long-term contract arrangement so that it could build Peace Corps training into the regular teaching loads of key

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[9] See below, p. 135.

faculty members. President Harrington therefore proposed[10] that negotiations begin on a contract to set up such a Training Center on the Milwaukee campus. The resources of the entire University would be available to staff the training programs, and some specific projects might still be based in Madison.

Negotiations followed. The rationale for a year-round center was evident not only to the University, but to the Peace Corps as well. Of all the various criticisms of Peace Corps programs which had been made during its first two years of operation, the most persistent, especially among universities, was the lack of lead-time for specific projects and the consequent necessity for "crash programs." This problem, it was suggested, could be at least ameliorated by setting up programs on a continuing basis[11] and thereby developing a permanent and experienced staff and faculty.

In assessing the year-round program in New Mexico in 1963, Rogers B. Finch, Chief of the Peace Corps Division of University Relations, wrote that such a program makes it possible for the univerity to commit appropriate facilities and staff to a project in advance and to make more efficient use of scarce foreign area and language specialists. He also indicated the Peace Corps self-interest in this when he pointed to the fact that a year-round program ensures a steady flow of trained Volunteers.[12]

Following a series of meetings and correspondence on the matter, a year contract was signed between The University of Wisconsin–Milwaukee and the Peace Corps for the period of August, 1963, to August, 1964. This in itself established UWM as a Peace Corps Training Center although both staff and facilities were at a bare minimum.[13] The primary objectives before the Center were thus twofold: first, the search for additional personnel and expanded facilities and, second, the utilization of a permanent staff and administrative organization to better facilitate the preparation and implementation of future projects. By the end of the year an apartment building on the Kenwood campus had been purchased for housing trainees, and by the following summer an expanded staff was in full-scale and continuous operation.[14]

The Center's organization has been functionally determined by its principal tasks: Training, Selection, and Returned Volunteer Counseling and Support, all serviced by a central administrative

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[10] March 20, 1963.

[11] Roy P. Fairfield, "The Peace Corps and the University," in *The Journal of Higher Education* (Volume XXXV, No. 4—April, 1964), p. 197.

[12] Rogers B. Finch, "The Peace Corps and Higher Education—Two Years of Partnership," in *Higher Education* (Volume XIX, No. 8—June, 1963), p. 5.

[13] The staff then consisted of Dr. Shea as Director, one administrative assistant, and a secretary.

[14] In terms of both budget and staff, the Peace Corps Center has become one of the larger operations on the UWM campus.

structure. Dr. Shea continued as Director but added an administrative assistant for overall Center activities. For training purposes, a separate project director plus his own secretary is now assigned to each project. Thus, even if two projects are running simultaneously, each automatically has its own director and secretarial support. Moreover, a permanent training director was appointed in January, 1964, to provide continuity from one training project to another, at least for the Latin American area. The creation of this latter position along with the Center itself has added that built-in "infrastructure" so essential to the efficient organization and running of new and different projects, otherwise largely serviced by turn-over personnel.

In the area of selection, the UWM Center currently has on its staff a full-time Field Assessment Officer for all projects, an assistant FAO, the assistance of the Director of Psychological and Counseling Services, and a half-time secretary, in addition to the psychologists assigned to each project. Although selection procedures are centrally directed from Peace Corps, Washington, and the Washington Selection Officer makes the final selections, the decisions themselves correlate closely with the midterm and final evaluations of the Selection Board. The three regularly attending members of the board for any program are the Project Director, the Field Assessment Officer and the Selection Officer, although others periodically attend.[15]

Selection, however, is based not only on the midterm and final evaluations by the Selection Board, but also on the day-to-day assessments by those most intimately connected with the trainees during their training period. Training itself is utilized as part of the selection process, and prospective Volunteers are "selected out" at any phase either before or during the training period. Before training, selection operates on both a "selection in" and a "selection out" procedure; that is, selection in takes place when the prospective Volunteers fill out the application forms, take the required examinations, and refuse or accept assignments offered. Selection out, on the other hand, takes place through the investigation of applicants, the evaluation of applications made and tests taken, and the ultimate rejection of original applicants accepted.

In a special report on the Peace Corps, published in 1963, the American Council on Education estimated that in order to send one qualified volunteer overseas, the Peace Corps has needed as many as eight applicants. Considering eligibility only, the report continued, ". . . approximately one out of four applicants are accepted for training. But not all of those invited accept, and the

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[15] For example, the psychologists on the project, a P. C. Program Development Officer, Field Representative, or Deputy Field Representative, if in the area.

proportion of refusals, while decreasing, has been as high as 50 per cent."[16] Once an assignment has been offered and accepted, however, selection does not end. If anything, it then begins in earnest. Training, itself, supposedly gives the final insight into an applicant's suitability for Peace Corps service, and about 20% of the trainees entering a training program are ultimately "selected out" for one reason or another during the training period. This procedure has resulted in the relatively high quality and low attrition rate of Peace Corps Volunteers on the job. The University of Wisconsin–Milwaukee has generally accepted the rigors of a strenuous training program as a necessary prelude to successful service overseas.

Returning to the administration of the Center itself, for its day-to-day operations, there is a full-time administrative assistant, one full-time project assistant, and two part-time personnel. A small number of returned PCVs are also employed for assistance in training, orientation, and recruitment. In July, 1964, a fourth Center function was expanded through the appointment of a Director of Psychological and Counseling Services. In addition to assistance in evaluation for selection purposes, coordination of Peace Corps recruitment, and development of Center-Community Relations, the Director assumed responsibility for the counseling of all returning PCVs who requested it as well as for the coordination of Volunteer support at UWM through assistantships, scholarships, and other stipends. This function developed as a result of the growth of the Center, the increasing number of returning Volunteers, and the utilization of UWM as the one Peace Corps Training Center with responsibility for counseling activities on a national basis.

The establishment of the year-round Center at UWM has made its impact in several areas, but nowhere as emphatically as in the way it has allowed that degree of advance planning which has facilitated the recruiting of the most appropriate and qualified faculty and personnel for the projects to be done. Most planning is now based on the assumption that at least one project will be carried out per semester and that the programming will be geared as closely as possible to the university calendar. Other additional projects will periodically be taken on, however, as well as summer programs.

In addition, UWM as a whole has experienced many of the same reactions as other institutions involved in Peace Corps training. The concrete advantages and disadvantages of such training have been elaborated upon in numerous articles[17] and are not unique to UWM. For example, "Institutions which have conducted Peace

[16] American Council on Education, *op. cit.*, p. 10.

[17] See especially Roy P. Fairfield, "The Peace Corps and the University," in *op. cit.*

Corps training projects have found the experience to be not only highly demanding of staff and facilities, but also exciting and rewarding. The opportunity to teach international relations, area studies, country studies, language, American studies, health, technical studies, and Communist tactics and techniques to a group of highly motivated trainees who will shortly be putting to use what they have learned has proved to be a new and exciting educational experience for faculty members who have participated in these programs."[18]

Of even greater relevance, however, to a training center where new projects are constantly underway and where more and more faculty become involved in them in one way or another is the remark that "The Peace Corps training program requires an interdisciplinary effort far exceeding that called for by even the wildest 'general educationists,' " for it brings together on a single team so many varied and different specialists from numerous disciplines and parts of the campus. These faculty members have ". . . gained new respect for the rich resources of expertise in their school—riches that are too frequently overlooked in the day-to-day concentration upon particular areas of specialization. Undoubtedly, some have found this 'cross-fertilization' somewhat sinful; most have found it exciting and productive."[19]

In Milwaukee, moreover, the very creation of an on-going operation has had a psychological effect on the thinking of UWM faculty and the community at large. Whereas earlier projects were conducted on crash basis with faculty participation based on a combination of incentives, including experimentation, idealism, and monetary remuneration, the program has now become firmly established and thereby somehow "respectable." There is also a growing recognition of the possibilities of a Peace Corps–University partnership which would encompass not only an incorporation of Peace Corps training techniques and topics into the regular curriculum, but also the joint devlopment of the training projects themselves and of new research proposals.[20]

Training as Education

In addition to the generally admitted advantages and disadvantages of Peace Corps training from the university viewpoint, perhaps the greatest significance of the Peace Corps programs at The

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[18] Rogers B. Finch, "The Peace Corps and Higher Education—Two Years of Partnership," in *op. cit.*, p. 4.

[19] Robert W. Iversen, "The Peace Corps—A New Learning Situation," in *The Modern Language Journal* (Volume XLVII, No. 7—November, 1963), p. 302.

[20] The Peace Corps itself expressed its confidence in the quality of training at the UWM Center and in its long-range potential by a renewal of the initial commitment with a million dollar contract in April, 1964.

University of Wisconsin–Milwaukee will be their long-term effect on the courses and curriculum of that institution. Only a modest first step was taken in September, 1964, when a general revision of the interdisciplinary Major in International Relations included as one option of specialization the study of underdeveloped areas as of special relevance for Peace Corps aspirants. Events in June and July of that year foreshadowed an even closer relationship between the Peace Corps and UWM with far-reaching implications for course content, the curriculum, and the standard four-year time sequences.[21]

Of related, but more immediate concern, however, was the question of how Peace Corps training compared and contrasted with regular college classes and whether, in fact, training could validly be considered as education at all. There were some who obviously did not think so. Emphasizing the problems of unequal motivation, background, and potential, one writer argued, "Even when a university creates a diversified program to take these several variations into account, it is so intensified as to preclude maximum absorption of the lectures and the reading. Surely learning requires some seasoning time."[22] Because the question related not only to educational theory, but also to the practical problem of accreditation for returning Peace Corps Volunteers, it deserved further consideration.

In autumn, 1963, a brief study was made by the author in the general area of Peace Corps Training in World Affairs[23]—a comparative analysis of World Affairs studies in two Peace Corps Training Projects (Panama/Colombia—Spring, 1963, and India: Andhra Pradesh—Summer, 1963) and in two UWM International Relations semester courses (Political Science 375—Fall, 1962, and Spring, 1963). The study was designed to determine the relative equivalents between Peace Corps training in World Affairs and University courses in International Relations in terms of total hours taught, subjects included and readings assigned, and attainments (by examination) reached. It was hoped that the analysis would provide an objective, though limited, basis both for an evaluation of Peace Corps academic training (i.e., area studies, language, and perhaps technical studies, in addition to ASWAC) according to University standards and for the possible future accreditation of returning Peace Corps Volunteers with UWM credits.

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[21] At the time of writing, these plans were yet in the formative stages, but there were clear indications of novel developments in this direction. See below, pp. 145–148.

[22] Roy P. Fairfield, "The Peace Corps and the University," in *op. cit.*, pp. 199–200. An opposite viewpoint is expressed by Robert W. Iverson, "The Peace Corps: A New Learning Situation," in *op. cit.*, p. 304.

[23] Unpublished report by Dr. Carol Edler Baumann. Fall, 1963.

Although the World Affairs sections of the Peace Corps projects differed from their International Relations course counterparts in time allotment, subject range and focus, and instructional technique, certain "constants" were provided to facilitate comparison:

1. The conceptual framework and pedagogical approach (from general to particular, from theoretical abstractions to practical problems) were the same.
2. The text assigned for the India: Andhra Pradesh Peace Corps project was also used as *one* of the International Relations course textbooks.
3. The instructor who taught the International Relations courses also coordinated the Peace Corps sections and lectured for some of them.
4. The examinations for both were basically the same (essay and identification) and were graded according to identical standards.

After an examination of the comparative "contact time" in the Peace Corps World Affairs studies and in the International Relations semester courses, the following conclusion was reached:

> "The hours allocated to World Affairs in Peace Corps training comprise approximately 70% of the time included in an average university 3 credit semester course. In a straight transfer from time to credits, therefore, (assuming a comparable level of instruction and substance) a Peace Corps World Affairs Section, by itself, would be equal to at least 2 credits."[24]

A similar analysis was then made of the course contents as evidenced in lecture topics and text assignments. The following conclusions emerged:

> "The content of the World Affairs Section varied from the semester courses in International Relations in both range and depth. More topics were included in the International Relations courses but certain subjects were examined more fully in the Peace Corps projects. In terms of the total substance of the two, the Peace Corps training was more highly concentrated in the sense that a greater quantity of material was covered by lecture and by reading in a shorter period of time. Translating this into credits, the World Affairs Sections would again equal at least 2 credits, or more accurately, approximately 2.5 credits."[25]

Finally, some detailed attention was given to the course examination results as one indication of "learning." Obviously, longer range retention of the subject matter could not be tested; however, retention over an extended period of time is not usually tested in the

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[24] *Ibid.*, p. 6.
[25] *Ibid.*, p. 6.

United States even in the case of the undergraduate college student. It is only at the Master's degree or Ph.D. level that comprehensive examinations embracing course work offered over a period of years are given. Hence, the contention that ". . . learning requires some seasoning time" may or may not be the case, objectively speaking, but it is no more relevant to Peace Corps training than to regular academic courses in terms of long-range retention.

With regard to examination results on the immediate subject matter, however, some controlled testing pointed to roughly parallel attainments in the Peace Corps sections and in the regular International Relations classes. The examinations for Peace Corps and those for the University were basically the same in format and in type of questions, though they necessarily differed in content. In both cases they were composed by the same person and graded according to precisely the same standards.

A tabulation of examination grades and relevant percentages follows:[26]

WORLD AFFAIRS SECTION, PANAMA/COLOMBIA

Total number of examinations taken 48

Grades	Number	Percentage of Total
A	4	8.3%
B	13	27.1%
C	22	45.8%
D	8	16.7%
F	1	2.1%

WORLD AFFAIRS SECTION, INDIA: ANDHRA PRADESH

Total number of examinations taken 38

Grades	Number	Percentage of Total
A	3	7.9%
B	10	26.3%
C	15	39.5%
D	8	21.0%
F	2	5.3%

[26] *Ibid.*, pp. 4–5.

INTERNATIONAL RELATIONS, I SEMESTER, 1962–63

Total number of examinations taken.................................... 18

GRADES	NUMBER	PERCENTAGE OF TOTAL
A.	4	22.2%
B.	7	38.9%
C.	5	27.8%
D.	2	11.1%
F.	0	0.0%

INTERNATIONAL RELATIONS, II SEMESTER, 1962–63

Total number of examinations taken.................................... 24

GRADES	NUMBER	PERCENTAGE OF TOTAL
A.	3	12.5%
B.	7	29.2%
C.	11	45.8%
D.	3	12.5%
F.	0	0.0%

The greatest variations in grades between the Peace Corps trainees in World Affairs and the International Relations students arose in the A and F categories; the percentage of A's in Peace Corps training was smaller than that in the International Relations courses, and the percentage of F's was greater. In assessing the significance of this deviation, however, it is essential to recognize that whereas a majority of these particular Peace Corps trainees had had little or no college or university experience, the International Relations students were all of junior or senior standing at The University of Wisconsin–Milwaukee. The Junior-Senior grade curve is generally skewed toward the higher grades, while the Freshman-Sophomore curve is more consistently bell-shaped. The former would thus reflect the actual grades of the International Relations students and the latter more closely approximate the grades of the Peace Corps trainees who, as a group, were more comparable, academically speaking, to Freshmen-Sophomores than to Juniors-Seniors. The differentiation in grades, then, could be more accurately attributed to differences in academic background than to relative academic attainments.

When the above was then applied to the purposes of the analysis (an evaluation of Peace Corps training according to University standards and for the possible accreditation of returning PCVs with UWM credits), the following assessments on attainment were made:

> "According to the results of the examinations given, the trainees themselves adequately absorbed and retained the subject matter presented to them despite the pressures of concentrated training techniques. Although they achieved fewer high grades than the International Relations students, the latter were of junior or senior standing and most of them had been exposed to related material. In class discussions, moreover, the trainees displayed a higher learning motivation than their student counterparts as well as a keener interest in fully understanding both the substance and the significance of the topics examined."[27]

From these assessments of time, content, and attainment the conclusion developed that the academic level of the training was parallel to that of university classes in comparable subjects in terms of both contents provided and attainments reached. Thus, for purposes of university accreditation for Peace Corps training, it appeared both academically sound and logically consistent with the service-minded traditions of the University, to recommend: "1. For a separate World Affairs Section of from 25–30 hours, 2 undergraduate credits could be given. 2. For World Affairs combined with Communism in a section allocated 40–45 hours, 3 undergraduate credits could be given. 3. For the newly combined American Studies, World Affairs and Communism Section of from 60–80 hours, 4 or 5 credits would not be excessive."[28] An even more modest accreditation was ultimately requested of the pertinent colleges at UWM and granted by their faculties.[29]

If an argument can thus be made for accreditation in the relatively small ASWAC portion of the training program, it can equally be made for the language segment which is the largest single component of a training project. At UWM it comprises about 26 to 27 hours per week or 43% to 45% of the total training time. This is in addition to meal-time discussions with "informants"[30] and free-time conversations among the trainees themselves. At least one-third of the language training time is spent in the language laboratory where intensive utilization is made of repetitive instructional methods through taped drills and other exercises. Native informants are also used for individual drilling. Although no new techniques as such are utilized in the UWM language training program, the well-established methods of oral drill are applied more intensively; in fact, there are few examples of language training throughout the country where oral techniques are utilized as much as in Peace Corps projects.

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[27] *Ibid.*, p. 7.
[28] *Ibid.*, p. 7.
[29] See below, pp. 142–143.
[30] Natives of the country or area for which the trainees are being trained.

In terms of comparative language attainments, however, no comparable tests can actually be made because of the different emphases in training for Peace Corps and in teaching regular college classes. In the usual college introductory language course, for example, there are five hours per week—four consist of traditional grammar and vocabulary and one consists of oral drill. In Peace Corps training the emphasis is purely on oral facility and the largest proportion of the training is geared to the purpose of developing a basic oral communication in a foreign language. Hence, in the Spanish and Portuguese programs at UWM, the trainees are so well trained in the oral components of the language that they achieve as good as or better grades than the teaching majors in the department in the MCA Oral Proficiency Test.[31] These factors have led the language departments most concerned to recommend the granting of at least eight credits for Peace Corps language training.

Accreditation for returning Peace Corps Volunteers did not present a major problem for UWM. The request itself was a modest one: twelve undergraduate elective credits to be given for successful completion of both training and overseas service; eight of these would be regarded as language equivalents and four in recognition of training in Area Studies and ASWAC. Those faculty members involved in the Peace Corps training programs were generally convinced of the merits of such action, and others were either favorably inclined or apathetic. Few were opposed.[32] In fact, it was recognized that accreditation would affect only a small percentage of the Volunteers, many of whom already had degrees previous to their training experience and others who simply were not interested in pursuing further college studies.

On April 7, 1964, the faculty of the College of Letters and Science of The University of Wisconsin–Milwaukee authorized ". . . granting a maximum of twelve undergraduate elective credits for Peace Corps training and service. Eight of these credits would normally be given in recognition of language training and four credits for training in area studies, international relations, communism, and American institutions."[33] (Similar motions had already been passed as endorsements of the idea by the Committee of Advisors for the Major in International Relations, by the Departments of Political Science and History, and by others.) Following upon this action by the College of Letters and Science, the School of Education and

[31] These oral tests are designed for language teachers, and their norms are based on grades achieved by teachers attending the summer teaching institute of the NDEA.

[32] Some opposition was based on the argument that such accreditation for Peace Corps training and service would act as "the thin edge of the wedge" in similar requests for other less deserving and less academically respectable types of training and/or service.

[33] Minutes of the meeting of the College of Letters and Science, UWM, April 7, 1964.

the Division of Commerce of UWM adopted similar motions. Thus, by mid-May of 1964, The University of Wisconsin–Milwaukee in all its major divisions had accredited Peace Corps training and service with twelve elective undergraduate credits. Graduate accreditation was to be determined on an individual basis by the departments concerned.[34]

The UWM involvement with the returning Volunteers extended beyond the granting of college credits for training, however. Their overseas experience and the unique contributions they could make to campus life was also recognized by the provision of several tuition scholarships and a number of graduate teaching assistantships and fellowships. For the academic year 1964–65 the fellowships and assistantships which were available included: fifteen full undergraduate and graduate tuition scholarships, two teaching assistantships in the Peace Corps Training Center, teaching assistantships in the College of Letters and Science, internships in the School of Social Work, one fellowship in the Department of Urban Affairs, ten research and teaching assistantships in the School of Education, and one research assistantship in the Institute of World Affairs.[35]

As of mid-July, 1964, approximately fifty applications and numerous inquiries concerning graduate work had been made to The University of Wisconsin–Milwaukee by returning Peace Corps Volunteers. In the School of Education alone, twenty-nine applications were made, of which twenty-seven were eligible for admittance. Of these, eight teaching assistantships, eight full-tuition scholarships, and three waivers of out-of-state tuition were awarded; two awards were declined. Three teaching assistantships were awarded in Social Work and one in Urban Affairs. The departments of Political Science, Psychology, and Botany each awarded one waiver of tuition, and the Institute of World Affairs appointed a returned Peace Corps Volunteer as an undergraduate project assistant. The Peace Corps Center also appointed one full-time and one part-time PCV as undergraduate assistants.

The Expanding Partnership

As indicated in the preceding sections, The University of Wisconsin–Milwaukee has developed a close and expanding relationship with the Peace Corps in their two years of association. In training, UWM has become a year-round training center with projects con-

[34] Both the School of Education and the School of Social Work at UWM will consider Peace Corps training and service in appropriate specialities as the equivalent of required field service for graduate credits.

[35] Dr. Fred Harvey Harrington, "Opportunities for Returning Peace Corps Volunteers at The University of Wisconsin." January 31, 1964.

ducted on a continuing and regularized basis. This has facilitated advanced planning and coordination for the projects themselves and has provided sufficient lead time for obtaining the best qualified lecturers, coordinators, and other specialists. In its policies toward returning Peace Corps Volunteers, the University has shown both an interest in their academic aspirations and a recognition of their unique experience by granting accreditation for completed Peace Corps training and service as well as by providing various assistantships and tuition scholarships for the continuation of academic studies.

This initial relationship from the viewpoint of UWM has been based largely on a concept of public service and less on the concrete advantages of self-interest. The long-range benefits to universities of Peace Corps training both in terms of faculty expansion and diversification and in terms of university-wide awareness of and involvement in international studies and programming are generally admitted,[36] but less easily defined in concrete ways. Of growing concern, however, has been the interest at UWM and elsewhere to develop the Peace Corps partnership concept in the areas of curriculum content and sequence, instructional techniques, and research activities. These developments would be in addition to the continuation of specific training projects and service for returning PCVs.

This widening of the horizons has been based partly on the recognition that on a national scale the Peace Corps has now become an accepted element of American foreign policy and a major instrument of American service abroad. It has yet to become fully integrated into the full flow of the American academic mainstream, however, as an interim career for which the universities must assume some responsibility. That responsibility is threefold: first, to prepare eligible and interested students for a period of Peace Corps service abroad; secondly, to utilize Peace Corps training and experience itself as part of a sequence of courses which will both provide an academic degree and prepare the interested student for a longer-range career of international public or private service; and, thirdly, to help to reintegrate the returning Volunteer into American society and to provide him with an opportunity to continue and extend his education should he so choose.

The first and third of these tasks have been generally recognized and partially assumed by American colleges and universities. As previously indicated, The University of Wisconsin–Milwaukee alone has mounted thirteen projects in which over 550 Volunteers have been trained. These separate Peace Corps projects have been conceived of, however, as supplemental to and not part of the regular

[36] Roy P. Fairfield, "The Peace Corps and the University," in *op. cit.*, pp. 190–192.

academic curriculum of the University. Moreover, until the summer of 1964 there seemed to be little concerted attempt to intertwine Peace Corps training any more integrally into the curriculum except for the options provided in the International Relations Major.[37]

There had, of course, been various discussions and suggestions on how to improve Peace Corps training in general, and many of them, both directly and tangentally, impinged upon the question of how Peace Corps training could, if at all, be more intimately joined with regular academic course sequences. In early April, 1964, The University of Wisconsin and the Peace Corps co-sponsored with The Johnson Foundation a "think session" to critically evaluate the philosophy, content, and effectiveness of past training programs. This conference, held at Wingspread outside of Racine, Wisconsin, included members of the academic community from numerous universities, Peace Corps personnel, and representatives of other allied areas who, because of their experience or interest, might be able to contribute to it.

The Wingspread "think session" in terms of both participants and subject matter was clearly geared to training problems, especially as they related to University-Peace Corps relations and new approaches to their development. Out of the conference came several suggestions—many based on the recognition that training is probably the key to the ultimate success or failure of the Peace Corps and that such training must not only be based on University service but also provide some concrete benefits to the University in the areas of research and instruction. A subsequent conference in Oklahoma pointed up many of the same views.

Although at Wingspread many of the conference participants were agreed on the desirability of establishing some academic sequence of courses designed to prepare students for future Peace Corps service, there was little consensus as to its format or content. Some favored a two-year Junior-Senior program; others, a more comprehensive and total approach encompassing not only training, but also recruiting, volunteer support, overseas faculty and administrative participation, and joint research proposals. UWM leaned strongly toward the latter view.

Since April, along with The University of Hawaii, The University of Wisconsin–Milwaukee has been in the process of negotiating just such a "total" partnership. A meeting between Director Shriver of the Peace Corps, President Harrington of The University of Wisconsin, and President Hamilton of The University of Hawaii

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[37] See above, p. 137.

in July, 1964, culminated in an informal agreement which attempted to relate the Peace Corps effort more effectively to the entire University function, including instruction and research as well as service. Although the details of the agreement have not yet been worked out, it anticipates new educational sequences for international service, new curricular degree work at both the B.A. and the M.A. level, and joint research programs.

In their joint news release, the Peace Corps Director and the two university presidents agreed that ". . . the full range of university resources should be applied to educate young men and women for the peace corps and for participation in other international activities."[38] Despite the lack of specific details, it was clear that the arrangement would contemplate new undergraduate and graduate curricula geared not only to Peace Corps training, but to general international service. Such a course of study would be of value to any student considering international service—whether with the United States Government, international organizations, business concerns, labor unions, religious bodies, or other organizations with foreign interests. Such a service-oriented concept would of necessity move the University toward practical or vocational education to a degree not previously contemplated in any of its foreign or domestic programs.

In addition to curricula development, the partnership would involve summer study-service internships in domestic social problems and applied research by University faculty both in Peace Corps related subjects and in the general problem areas of international service. Negotiations were also undertaken to develop a program of Peace Corps visiting professorships which would be designed to utilize the overseas experience of top Peace Corps administrators for University teaching and research programs. For the Peace Corps, the advantages were obviously tied to the steady stream of well-trained Volunteers which might be expected to flow from an on-going program built in to the regular curriculum of an expanding university. For UWM, the advantages were likewise clear: the opportunity, through the Peace Corps experiment, to develop an entirely novel curriculum geared to international service and, through such an on-going curriculum and the research opportunities tied to it, to involve the faculty ever more intimately in the international programs of the University. Financial support for the program was expected to come from the Peace Corps, the universities concerned, and private foundations.

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[38] *The Milwaukee Journal,* September 26, 1964.

Appendix A

Peace Corps Projects at UWM
(January, 1963–December, 1964)

Project	Technical	Dates	No. of Weeks	No. of Trainees	Selected Out
Peru	Savings and Loan	Jan. 10–Mar. 23, 1963	10	27	1
Colombia	Rural Cooperatives	Mar. 29–June 6, 1963	10	35	6
Panama	Rural Cooperatives	Mar. 29–June 6, 1963	10	17	3
India 4	Agricultural Extension Mathematics/Science Teaching Home Economics Education Nursing Education	June 14–Aug. 30, 1963	11	39	6
Ecuador 6	Credit Union Development	Aug. 31–Nov. 23, 1963	12	32	6
Brazil 6	4-S (4-H) Clubs	Aug. 31–Nov. 7, 1963	10	41	14
India 5a	Nursing Education	Sept. 27–Dec. 20, 1963	12	17	3
Peru 12	Auto Mechanics School Lunch Programs Community Development	Jan. 3–Mar. 19, 1964	11	53	13
Brazil RCA	Community Development Public Health	Mar. 20–June 11, 1964	12	53	16
Brazil 12	Community Development Public Health	June 17–Sept. 9, 1964	12	79	24
India 8	Mathematics/Science Teaching Teaching English	June 19–Sept. 9, 1964	12	70	12
Kenya	Rural Community Development Ag. Extension and Cooperatives	Sept. 25–Dec. 17, 1964	12	39	2
Brazil	Ag. Extension/4-S (4-H)	Aug. 28–Nov. 13, 1964	11	27	10
	University Teaching	Aug. 28–Dec. 22, 1964	16	26	7

The possibilities of new course content and sequences especially geared to Peace Corps training and service have only recently advanced to the threshold of serious consideration. The same may be said of University participation in the planning stages as well as in the training sequences of Peace Corps projects. Finally, the opportunities for joint Peace Corps-University research projects appear most fruitful and deserving of further and more detailed exploration. It is specifically in these areas of project planning, curriculum development, and cooperative research that the UWM-Peace Corps relationship may ultimately become a true partnership in innovation.

CHARACTERISTICS AND GENESIS OF SOME ORGANIC SOIL HORIZONS AS DETERMINED BY MORPHOLOGICAL STUDIES AND CHEMICAL ANALYSES[1]

*John E. Langton and Gerhard B. Lee**

Cultivated organic soils in southeastern Wisconsin commonly exhibit granular, dark-colored, well-decomposed (muck) surface horizons. Similar horizons have also been observed in uncultivated soils in which the water table has been lowered by some means. In either case it appears that aeration of the sedge peat parent material is a necessary prerequisite to the formation of such layers.

Of particular interest in many organic soils are the granular muck layers found below the present water table. In some cases these are surface layers which have been inundated by the failure of a drainage system or the construction of dikes. In other cases these horizons are buried beneath less decomposed, oftentimes very fibrous peat, presumably of more recent origin.

Morphologically the buried muck layers appear to be similar to contemporary muck surface horizons. It appears therefore that these are relict horizons formed in an aerobic environment during an earlier period when they constituted the surface layer of the peat deposit.

The purpose of the present investigation has been to compare the characteristics of contemporary surface horizons, of muck texture, with morphologically similar buried horizons, as an aid to the identification and classification of such layers, and in order to elucidate their genesis more fully.

Review of Literature

Soil consisting primarily of organic material is commonly referred to as peat or muck, depending upon its degree of decomposition (Soil Survey Staff, 1951). Peat is defined as relatively raw

[1] Contribution from the Department of Soils and the Soil Survey Division, Wisconsin Geological and Natural History Survey, University of Wisconsin–Madison. Supported in part by the Research Committee of the Graduate School from funds supplied by the Wisconsin Alumni Research Foundation. The authors also wish to acknowledge their use of laboratory facilities made available in part by funds supplied by the National Science Foundation. Paper read at the 94th annual meeting of the Wisconsin Academy of Science, Arts, and Letters. Published with the approval of the Director, Wisconsin Agricultural Experiment Station and the Director of the Wisconsin Geological and Natural History Survey.

* Mr. Langton is a Research Assistant, Soil Survey Division, Wisconsin Geological and Natural History Survey. Mr. Lee is Associate Professor of Soils, University of Wisconsin–Madison.

plant material with easily identifiable plant parts while muck is described as decomposed plant material in which the identification of plant remains is difficult or impossible by ordinary means.

Soils formed from organic materials are often referred to as peats or mucks depending on their color, degree of decomposition, or in some cases, local custom. Among soil scientists these soils have also been called Organic Soils, Organosols, or Bog Soils. Recently (Soil Survey Staff, 1960) they have been called Histosols (hist, Gk., *histos,* tissue; sol, *L. solum,* soil). Histosols are defined as being at least 12 inches (30 cm.) thick and consisting of at least 30 per cent organic matter if the mineral component is clay and at least 20 per cent organic matter if the mineral component is sand.

Soil scientists in Holland, Pons (1960), Van Heuveln, Jongerius and Pons (1960), and Jongerius and Pons (1962), describe peat formation as a geogenetic process in which the parent materials of organic soils are being accumulated. They contrast this process with the pedologic processes of "ripening" (soil formation) which are initiated by drainage and aeration of a peat deposit. Ripening involves both physical disintegration of plant parts and their biochemical decomposition (moulding). The latter, according to these investigators causes the formation of a "distinct" surface horizon as peat and other material is repeatedly ingested and excreted by soil fauna. Abundant nutrients, low acidity, adequate moisture, and aerobic conditions are believed to encourage faunal activity and accelerate the moulding process. Two kinds of moulded horizons have been recognized.

One of these, the "moder" horizon, is described as consisting mostly of fecal excrement from soil fauna such as mites, (Collenbala), Diptera and white pot worms (Enchytralidae). Moder formation is most common in oligotrophic peats containing very little clay, having a pH of 5 or higher, and a carbon-nitrogen ratio greater than 17. It does not, however, involve the intimate binding of organic particles necessary to form inseparable humus-mineral complexes as in the case in mull formation. Jongerius (1957) recognized two kinds of moder, namely a small variety 25–60 u in diameter (Collenbala, Diptera), and large moder 150–600 u in diameter (Enchytralidae). Large and small moder, together with fragments of plant tissue and organic colloids sometimes form large, loosely aggregated granules called "mull-like moder" by the Dutch workers.

The second moulded horizon is "mull", described as consisting mainly of earthworm excrement approximately 2 mm. in diameter (Enchytrae, and possibly Julidae). Mull formation occurs most commonly under aerobic conditions in eutrophic or mesotrophic peats which contain some clay and are near neutral in reaction. Mull has a carbon-nitrogen ratio of less than 17. The size and shape of mull aggregates may be altered by a change in environment, for example, continued aerobic conditions cause mull aggregates to coalesce into composites, while prolonged anaerobic conditions may cause mull aggregates to disperse into small granules.

Materials and Methods

Location of Samples

Samples of present-day surface horizons from cultivated organic soils were obtained from the University Marsh at Madison, and from the northern part of the Horicon Marsh in Dodge County. Buried horizons were sampled in the Eldorado Marsh, Fond du Lac County, and the Cherokee Marsh, north of Madison. The sample from Eldorado Marsh was buried by approximately 8 inches of peat. The Cherokee Marsh sample was obtained at a depth of 38 to 48 inches.

Morphology

Soil horizons were described according to methods given in the Soil Survey Manual (Soil Survey Staff, 1951). Color designations are according to the Munsell Color System.[2] Depth to ground water was measured at the time of sampling.

Thin sections were prepared by the method described by Langton and Lee,[3] using Carbonwax 6000, a polyethylene glycol compound as the impregnating compound. Both a wide-field, low-power stereoscopic microscope, and a petrographic microscope were used to study the micro-fabric of the various horizons. Photomicrographs were made with a 35 mm. camera connected to the microscope by a Micro-Ibso (Lietz Inc.) attachment.

Chemical Analysis

Soil pH was measured with a Beckman Model G pH meter, using standard electrodes, on field-moist samples that had been saturated and then allowed to equilibrate for 20 minutes. Ash content was determined by igniting a small sample (1.5 g.), in a muffle furnace at 525° C for a period of six hours. Prior to ignition, samples were dried and ground to pass a 20 mesh sieve, then oven-dried again at 110° C. Total organic and ammonium nitrogen was determined by the Kjeldahl method, organic carbon was determined by the procedure of Walkley and Black. Both methods are described by Jack-

[2] Munsell Color Co., Inc., Baltimore 18, Md.

[3] Langton, J. E. and Lee, G. B. 1964. Preparation of thin sections from moist organic soil materials. Manuscript.

son (1958). Soluble organic matter was determined according to the procedure described by Dawson,[4] using a saturated solution of sodium pyrophosphate.

Results and Discussion

Macromorphology

Macromorphological characteristics are summarized in Table 1. All samples were of muck texture and were black in color. Two of them (Horicon and Eldorado), were reddish in hue (5 YR) as compared to the more yellow (10 YR) hues of the other 2 samples. The reason for this difference or its importance, if any, is not known at the present time. All horizons exhibited granular or subangular blocky structure; where blocks were present they were weak and could easily be broken into granules. The Eldorado Marsh sample, in particular, exhibited strong, primary granularity.

Micromorphology

Primary constituents from both surface samples included a few, finely disintegrated brown fragments of plant tissue, a few black fragments consisting of humified plant tissue, opaque mineral particles and/or charcoal, and brown amorphous material. Secondary (faunal) aggregates in the University Marsh sample (See Fig. 1) included small (20–80 u dia.), and large (150–600 u) moder aggregates, and dark brown mull (0.5–1.5 mm.).

The Horicon Marsh sample showed a similar but even higher population of secondary aggregates. An estimated 35 per cent (by volume) of this horizon consisted of moder.

Primary constituents in the buried horizons were similar to those of the surface layers, consisting of a few, finely disintegrated, brown fragments of plant tissue, some black fragments, and brown amorphous material. Secondary aggregates in the Eldorado sample consisted mainly of moder and mull-like moder, the latter being especially well-rounded (See Fig. 2). The Cherokee sample contained proportionately more mull and less moder (See Fig. 3).

Chemical Characteristics

Data shown in Table 2 indicate that all horizons were remarkably similar in most chemical characteristics. All of them were slightly acid; pH values fell within the range observed in mucky surface horizons of other organic soils in southern Wisconsin.

[4] Dawson, J. E. 1960. Personal communication.

TABLE 1. MACROMORPHOLOGICAL CHARACTERISTICS OF SURFACE (CULTIVATED) AND SUBSURFACES (BURIED) MUCK HORIZONS

Sample Site	Depth	Color	Texture	Macrostructure	Depth to Ground-water
University marsh	0–18″	Black (10YR 2/1)	Muck	Subangular blocky; blocks break into moderate medium granular peds	36″
Horicon marsh	0– 8″	Black (5YR–7.5YR 2/1)	Muck	Subangular blocky; blocks break into moderate medium granular peds	70″
Eldorado marsh	8–12″	Black (5YR 2/1)	Muck	Strong fine granular	0″
Cherokee marsh	38–48″	Black (10YR 2/1)	Muck	Subangular blocky	0″

TABLE 2. CHEMICAL CHARACTERISTICS OF SURFACE (CULTIVATED) AND SUBSURFACE (BURIED) MUCK HORIZONS

Sample Site	pH	Organic Carbon	Nitrogen	Ash	C/N	Solubility in $Na_4P_2O_7$	Ash/N.
		%	%	%		%	
University marsh	6.7	37.5	2.46	30.1	15.2	>¾	12.2
Horicon marsh	6.3	28.0	3.03	31.8	9.2	>¾	10.5
Eldorado marsh	6.2	35.5	2.48	30.0	14.3	>¾	12.2
Cherokee marsh	6.0	32.0	2.95	22.6	10.8	>¾	7.7

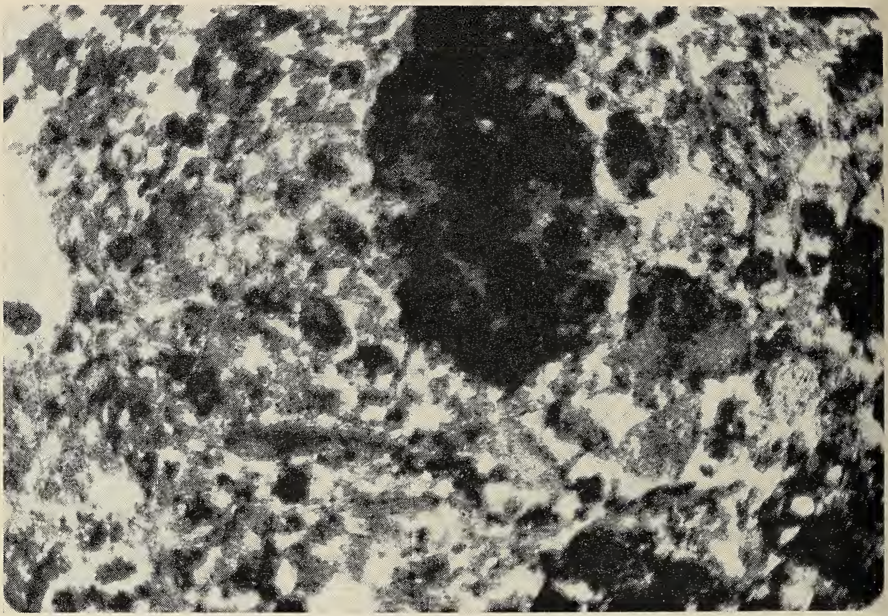

FIGURE 1. Small and larger moder, and a single mull aggregate in surface horizon of University Marsh soil (X100).

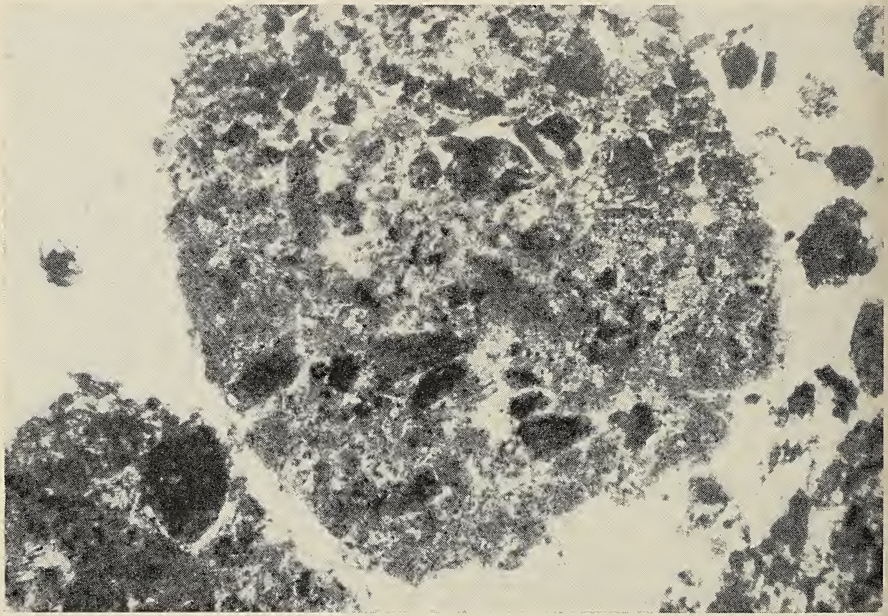

FIGURE 2. Mull-like moder aggregates in subsurface (buried) horizon of Eldorado Marsh soil (X100).

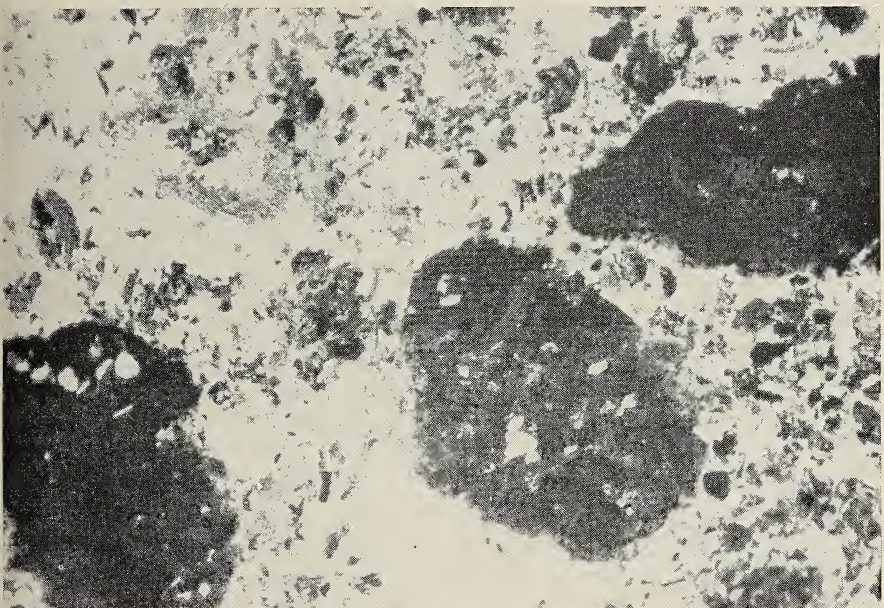

FIGURE 3. Mull and a few moder aggregates in subsurface (buried) horizon of Cherokee Marsh soil (X100).

Organic carbon values for the four samples are equal to approximately 65 to 75 per cent of the carbon content in common sedge peats. Carbon loss due to the metabolic activities of soil fauna has been used to estimate the extent of moulding and humification (Waksman and Starky, 1931). Assuming uniform botanical composition and no carbonates, carbon content should show an inverse relationship to degree of humification. On this basis the four hozizons appear to be decomposed to a similar degree.

In Holland, the nitrogen content of moder and mull has been determined to be approximately 2.4 to 3.0 per cent and 4.0 per cent respectively (Van Heuveln, Jongerius and Pons, 1960). Nitrogen content in the samples studied ranged from 2.46 to 3.03 per cent supporting micromorphological evidence that these soils contain considerable moder. Carbon-nitrogen ratios of all samples were less than 17 which is typical of Dutch soils that contain mull.

Considerable ash was found in all samples. Ash/nitrogen ratios were also high, indicating a high degree of mineralization, additions of clastic sediments, or both. Wilde and Hull (1937) found that certain wood, moss and sedge peats had ash/nitrogen rations of 2.7, 3.4, and 1.6 respectively.

Solubility in sodium pyrophosphate ($Na_4P_2O_7$) is a measure of biochemical decomposition. Relatively undecomposed peat ordinarily contains less than ¾ per cent organic material soluble in saturated $Na_4P_2O_7$ while muck contains ¾ per cent or more. All of the samples studied were within the muck range.

Summary and Conclusions

Morphological and chemical characteristics of surface (cultivated) and certain subsurface (buried) muck horizons have been investigated in the field and laboratory. Field and macromorphological studies have shown these horizons to be similar, suggesting that the buried horizons were relict surface soils. Evidence obtained by micromorphological studies and chemical analyses lend support to this hypothesis.

Recent studies in Holland have shown that granular, dark-colored surface horizons form mainly by faunal activity following drainage and aeration of a peat deposit. Moder is produced by arthropods such as mites while mull is formed by earthworms. Mull formation occurs only under aerobic conditions in certain eutrophic or mesotrophic peats. Results of the present investigation indicate that granular muck horizons in southeastern Wisconsin are formed in a similar manner following drainage by natural or artificial means.

The occurrence of buried muck layers, of the type formed at the surface under aerobic conditions, suggests a change in hydrologic conditions subsequent to their formation. Renewed peat formation may have occurred because of flooding by beaver dams, or the clogging of natural drainageways. However, the widespread occurrence of buried surface horizons might also be indicative of climatic changes during the development of the soil or peat deposits in which they are formed.

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A SENSITIVE FLUORESCENT INDICATOR FOR IDENTIFYING AND DETERMINING THE CONCENTRATION OF THE ALUMINUM ION IN MINERALS AND SOILS

*John G. Surak, Robert A. Starshak and Daniel T. Haworth**

Since the chemical and physical properties of a soil characterize the way in which a soil can be used, elemental analysis is resorted to in order to determine a few of these properties. It is also known that the clay fraction controls most of the important properties of a soil. These clay minerals are principally secondary, hydrated crystalline ferro-aluminum silicates.[9, 10]

The "aluminon" (ammonium salt of aurin tricarboxyllic acid) method for aluminum determination as standardized by Smith et al[6] has been a popular method used in soil chemical analysis. Interferences by cations and anions are extensive with the aluminum-aluminon complex. Jackson[6] lists these interferences and gives the precautionary procedures which should be followed to minimize or to eliminate the effects of these diverse ions.

Feigl[3] lists several reagents which yield reactions with the aluminum ion. All of these reagents, 8-hydroxyquinoline and its derivatives; dithiozones; dithiocarbamate; thiourea; EDTA; morin; alizarine and others, have a common feature, namely, that they all are chelating agents. Our investigation for another complexing agent which would react in a characteristic manner with the aluminum ion, led us to study the properties of PAN [1-(2-pyridylazo)-2-naphthol].

PAN as an analytical reagent has had a rather brief history. It was first used by Liu[8] as a chelating agent for the heavy metals. Cheng and Bray[2] published the characteristics of PAN and several of its complexes, Flaschka et al[4] investigated the use of PAN as an indicator in EDTA titrations. PAN is a brilliant orange compound whose melting point is 126–7°C. It is insoluble in water but is readily soluble in organic solvents, such as: alcohols, ketones, benzene, and carbon tetrachloride. The metallo-complexes formed by PAN show solubilities similar to that of PAN. Betteridge et al[1] reported that the pK_a of PAN is 12.3, indicating the PAN is a weak acid.

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PAN belongs to the category of aryl azo dyes, the structures of the complexes formed by divalent and trivalent metal ions with PAN show the tridentate character of this reagent as a chelating agent, figure 1. The color of the metallo-PAN chelates is generally red; however, the color may vary from yellow-orange to pink depending upon the solvent used to dissolve the chelate precipitate, Table 1. The aluminum-PAN mixtures exhibit several properties not shared by the other metallo-PAN chelates. First, as previously noted by Cheng and Bray[2], no reaction is detectable between PAN and the aluminum ion in an aqueous solution. Secondly, a reddish solution results when aluminum and PAN are brought together in an ethanol or an acetone solution. This solution exhibits the property of fluorescence when exposed to ultraviolet radiation. None of the other metallo-PAN complexes reported, thus far, exhibits a similar property.

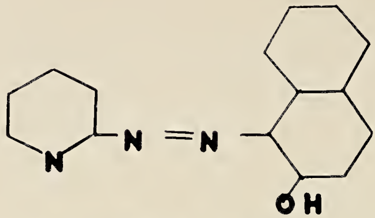
Holzbecher[5] reported a large number of aromatic compounds which formed fluorescent complexes exclusively with the aluminum ion. He observed that each of these reagents had a phenolic hydroxyl group either ortho or para to its aluminum complexing group. As seen in figure 1, PAN possesses a phenolic hydroxyl group ortho to its complexing group which is the azo group in the structure. No other element in the qualitative Group III elements, other than aluminum, has exhibited this property of fluorescence with PAN. This property of fluorescence of the aluminum-PAN complex in ethanol when irradiated with ultra-violet radiation was the basis of our investigation of using this phenomenon for the determination of the aluminum ion.

Since aluminum in clays and in mineral colloids occurs primarily as the secondary hydrated ferro-aluminum silicate, any of the standard analytical methods for the separation of the aluminum ion from the other ions associated with it in the complex may be used. The precipitate of aluminum hydroxide must be freed of iron and chromium (III) hydroxides, because iron and chromium (III) ions form chelates with PAN which tend to quench the fluorescence of the aluminum-PAN-complex. The purified aluminum hydroxide is dissolved in 3 *M* HNO_3 and the resulting solution is evaporated just to dryness. The hydrated aluminum nitrate is permitted to cool. A qualitative estimation of the concentration of aluminum ion present is conducted by dissolving one of the replicate runs in 2 ml. of 95% ethanol. To this solution, 2 drops of 0.1% (W/V) ethanolic solution of PAN is added. This alcoholic solution of Al-PAN complex is checked for fluorescence with an ultraviolet source such as 15T8-BLB black light fluorescent tube. With experience one can estimate the Al^{3+} ion concentration to as low as

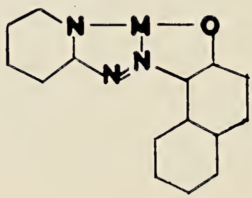
TABLE 1. COLORS OF METAL-PAN COMPLEXES UNDER ULTRA-VIOLET LIGHT

COMPLEX	SOLVENT										
	ETOH	MEOH	PROH	BUOH	AMOH	HEXOH	ACE-TONE	ET_2O	C_6H_6	CCl_4	$CHCl_3$
Cr-PAN	B	B	B	B	B	B	B	BR	Y	Y	Y
Fe-PAN	BR	BR	BR	BR	BR	BR	BR	BR	Y	Y	Y
Mn-PAN	P	P	P	P	P	P	P	P	Y	Y	Y
Ni-PAN	R	R	R	R	R	R	R	PU	P	R	Y
Zn-PAN	R	R	R	R	R	R	R	R	R	R	R
Co-PAN	L	L	L	L	L	L	L	L	Y	G	G
Al-PAN	O fluor.	O fluor.	O fluor.	O fluor.	O fluor.	O fluor.	O fluor.	Y	Y	Y	Y

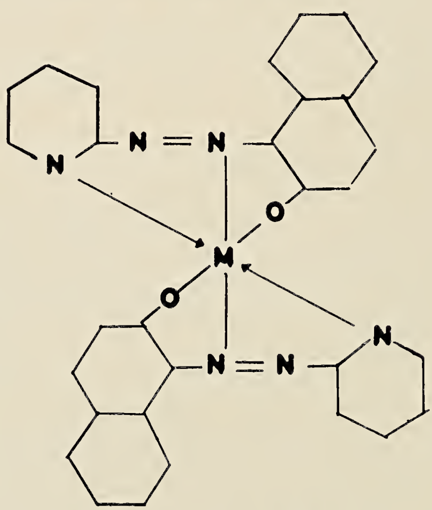
B = Blue BR = Brown P = Pink PU = Purple O = Orange L = Lavender R = Red G = Green Y = Yellow



P A N

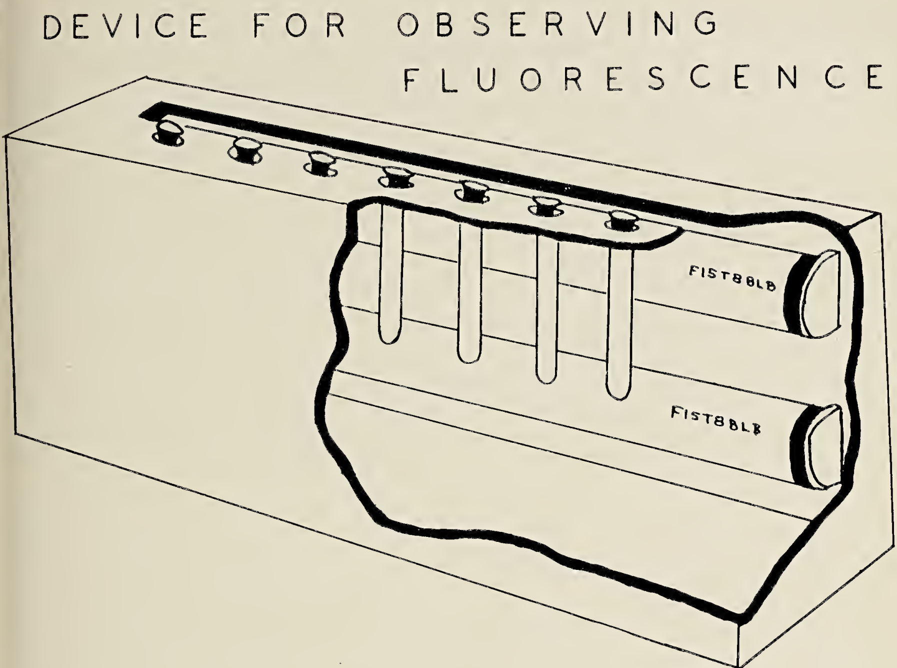


M II - P A N



M III - P A N

FIGURE 1.



10^{-3} *M*. For quantitative determinations, the desiccated aluminum nitrate unknown should be volumetrically diluted with 95% ethanol. An aliquot containing about 10^{-3} *M* of Al^{3+} ion is pipeted into a 50 ml. volumetric flask. One ml. of a 5 x 10^{-3} *M* ethanolic solution of PAN is added and this combination is volumetrically diluted to 50 ml. with 95% ethanol. The fluorescence is compared in a photofluorometer against standard solutions made by volumetrically diluting one ml. of 5 x 10^{-3} *M* of ethanolic PAN and increments of 1 to 4 ml. of 10^{-3} *M* $Al(NO_3)_3 \cdot 9\ H_2O$ to 50 ml. with 95% ethanol. The procedure was used to obtain a calibration curve in the range of 3 x 10^{-2} to 12 x 10^{-2} mg. of aluminum per 50 ml. of solution using a Coleman Photofluorometer (Model 12-B with filters No. 12–222 and 14–212). The Al:PAN ratio does not need to be constant in the standard solution because only the complex fluoresces and not the excess PAN. Standard techniques for fluorescent analysis are followed. These fluorescent techniques should be of sufficient sensitivity to determine aluminum accumulation levels in leaf tissue, seedlings, etc. Excellent results were obtained in the detection of 10^{-6} grams of Al^{+3} per ml and acceptable results with 27 x 10^{-9} grams of Al^{+3} per ml.

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POTHOLES AND ASSOCIATED GRAVEL OF DEVILS LAKE STATE PARK

*Robert F. Black**

The hundreds of hikers who annually visit the top of the East Bluff of Devils Lake have a unique opportunity to see a geologic situation that is exceedingly fascinating in its connotations. For almost a century the scientific literature has recorded the existence of potholes and associated rounded, polished, siliceous gravel on the higher part of the bluff at its very rim near the Devil's Doorway and "Shortcut Trail" to the south camp ground (Chamberlin, 1874) (fig. 1). (NE ¼, SE ¼, Sec. 24, T11N, R6E and NW ¼, SW ¼, Sec. 19, T11N, R7E). (The polished siliceous gravel is not to be confused with fresh glacial gravel of many igneous and sedimentary rocks that workers have used on parts of the trail and have brought at different times to the rim to make concrete.) The potholes are carved in bedding plane surfaces of the Baraboo quartzite *in situ* and in loose blocks of the quartzite that rest irregularly on the beveled upland surface. Polished chert-rich gravel is associated with some potholes and has been found in them (Salisbury, 1895, p. 657). More than a dozen well developed potholes are known (fig. 2). They range from single circular polished depressions a few inches in diameter and only 1 or 2 inches deep to aggregates of potholes whose individual components may be as much as 3 feet across and equally deep. Water-polished surfaces up to several square yards may be seen along the rim. Striking potholes 6 to 8 inches in diameter and twice as deep resemble artificially drilled holes as their sides are so parallel and smooth (fig. 3). Potholes above the sod are concentrated in an area 50 yds. along the bluff and 30 yds. northward from the rim and also in a narrow zone (fig. 4) for 75 ft. vertically below the rim along the Shortcut Trail; others are scattered in the woods to the north of the Shortcut Trail (fig. 2). Buried potholes and gravel may be more widespread (Salisbury, 1895, p. 655).

Down through the years most writers have attributed the formation of the potholes and associated gravels that are unlike any in the glacial deposits in the valley below to preglacial streams (Cretaceous to Tertiary) that flowed across a continuous upland surface

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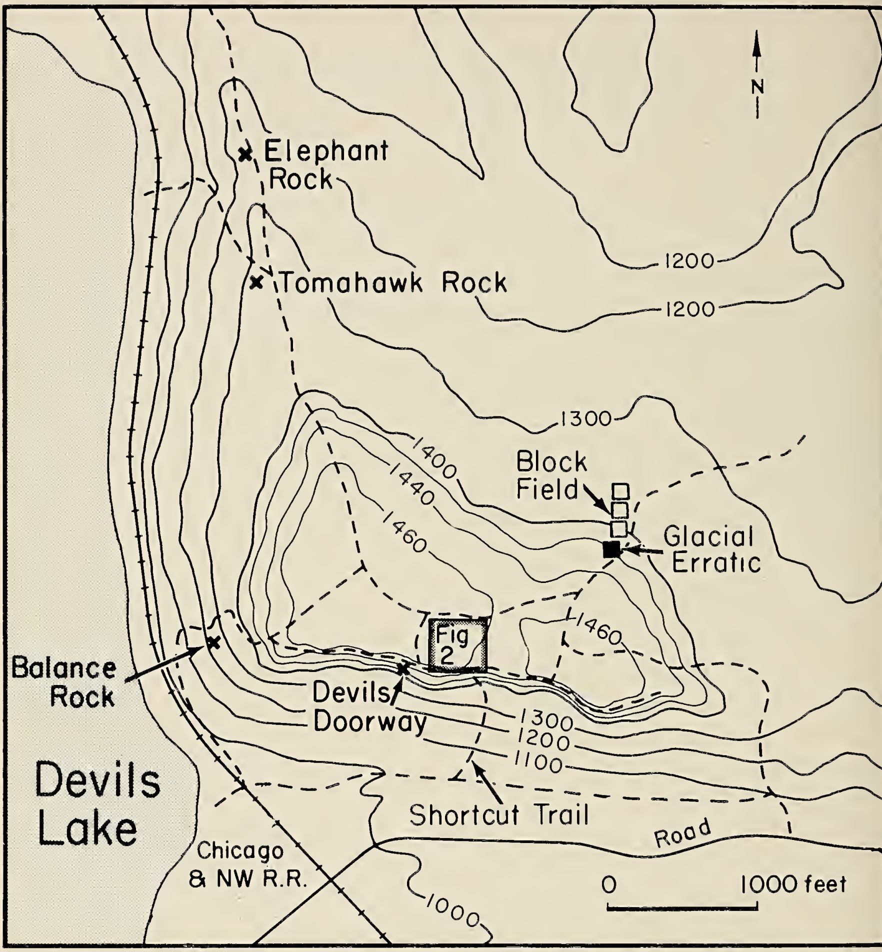

FIGURE 1. Generalized topographic map of East Bluff, Devils Lake State Park. Modified from U. S. Geological Survey Baraboo Quadrangle. Trails in part diagrammatic.

at and above the level of the rim (Salisbury, 1895; Alden, 1918, p. 99–102; Trowbridge, 1917, p. 352; Thwaites and Twenhofel, 1921, p. 296; Thwaites, 1958, p. 149; Andrews, 1958; and Thwaites, 1960, p. 38). No one seriously has considered them to be glacial, yet to the writer such an origin seems at least as plausible. It is hoped that this note will attract attention to these common features and their odd surroundings. Optimistically they will intrigue others into looking for additional evidence on their past history.

The writer in examining the locality at different times during the last several years has been struck particularly by the presence of rounded, water-polished boulders of chert and quartzite (fig. 5) 2 feet and more in diameter associated with the gravels and haphazardly lying among angular quartzite blocks without water-polished surfaces (several are shown by ▲'s in fig. 2), by the presence of potholes in loose boulders that unquestionably have been moved

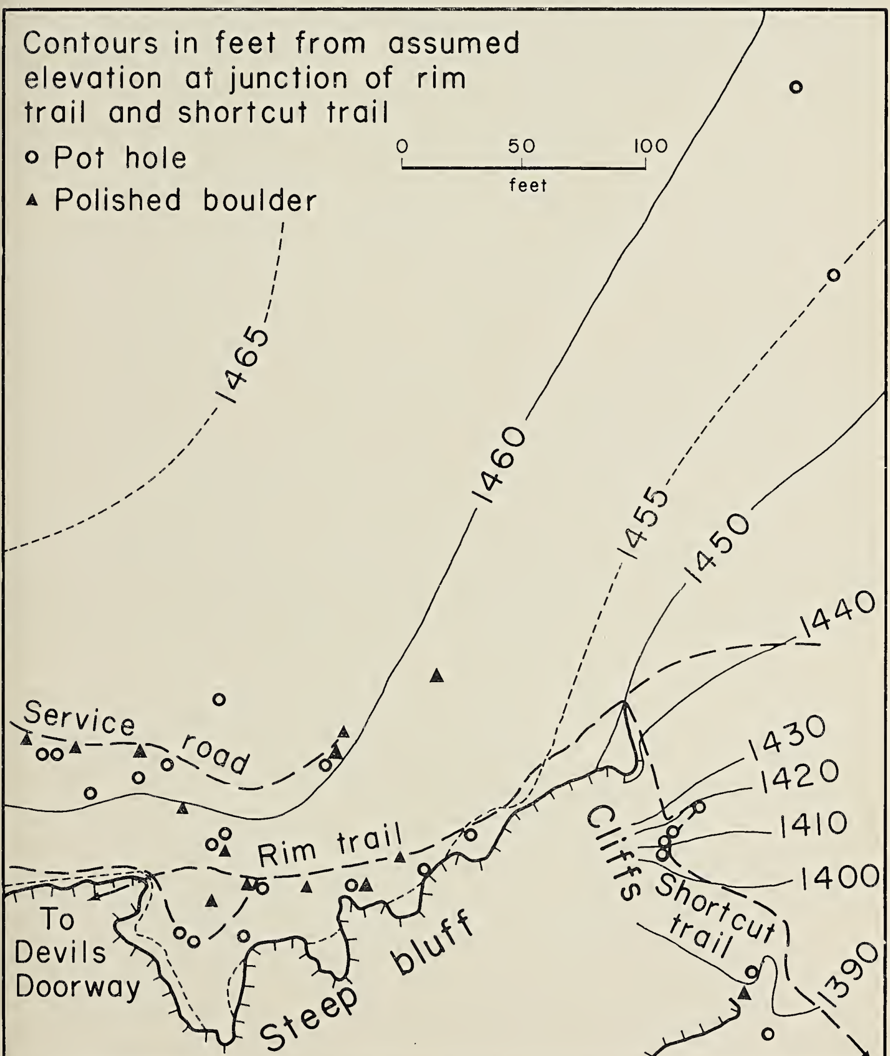

FIGURE 2. Sketch of pothole area, East Bluff, Devils Lake State Park.

FIGURE 3. Small upland-type pothole in loose block. Part of side and base are missing.

since the potholes were formed (fig. 3), by the considerable vertical range of potholes on the upland—some being several feet above the apparent bed of the postulated ancient stream, by the lack of coincidence of the flow of water with the slope of the ridge (fig. 2), and by the wide distribution of potholes on the upland but the narrowness and limited discharge of the small cascade that must have plunged over the side of the bluff along the route of the Shortcut Trail. The large chert and quartzite boulders seem identical in composition, surface polish, percussion fractures, and rounding to the small gravel in the vicinity. A continuous size range from sand to 2 foot boulders may be seen but has never been recorded in the literature. The cascade that descended the bluff at the Shortcut Trail is too small to correlate with the broad area of potholes on the upland unless they were cut at different times by a migrating stream whose course was not controlled by the bedrock beneath. Alternatively evidence of greater discharge off the upland elsewhere is not now available. The vertical range of isolated potholes on the upland suggests rather deep water, but it is difficult to explain how many potholes could get started where they are now found. In short the potholes and rounded and angular boulders of the upland are not in a normal stream channel (fig. 2) although the potholes on the south-facing slope are.

In February, 1964, while searching the woods north and east of the pothole locality (fig. 1), a block of quartzite 3 by 3.5 by 4 yds. (fig. 6) was seen tilted over another smaller block of quartzite. The large block weighs about 85 tons. It rises conspicuously above the general level of the rounded summit of the upland and is immediately uphill from an area of large joint blocks of quartzite bedrock that have moved down slope enough to create a jumbled chaos or block-stream. (The erratic is reached by following the fire road south and east from the north shore (fig. 1) or by going west and

FIGURE 4. Cascade-type pothole along the Shortcut Trail.

FIGURE 5. Rounded, polished quartzite boulder with percussion fractures among loose angular, unpolished quartzite boulders on the rim of East Bluff. View east. Highest block of quartzite in background has a pothole on top.

north on the service road at the potholes to that fire road and then east about 120 yds.) (fig. 2). Many smaller angular blocks are scattered over the upland. Hundreds of millions of years ago marine erosion of the Baraboo Range beveled the dipping strata (Thwaites, 1960, p. 37–38). However, such processes could not leave behind an isolated fresh, very angular block of quartzite to rise above the general level nor mix the rounded boulders with the angular blocks. No apparent outcrop exists above the block that is large enough to produce it. It does not seem feasible to pluck it out of the smooth upland and move it by gravity to its resting place. The block has sharper corners and less weathering effects than quartzite exposed on the west-facing bluff of Devils Lake. A convenient steep slope with just such large angular blocks lies immediately below, but how is an 85-ton block to be moved upslope? Man surely is not to blame. No conceivable force other than glacial seems possible to explain its existence. However, all previous researchers except Weidman (1904, p. 102), whose evidence has been discredited (Trowbridge, 1917, p. 357), have stated unequivocably that the location is outside the limits reached by any glacial ice.

This leaves us on the horns of a dilemma. Obviously we either lack sufficient information to explain the phenomena or previous interpretations of existing evidence are incorrect. As the smaller gravel associated with the potholes is considered the type section of the East Bluff member of the Windrow Formation (Andrews, 1958) which in turn is correlated widely in the upper Mississippi Valley with deposits of Cretaceous or Tertiary age (Austin, 1963; Frye, William, and Glass, 1964), it behooves us to look more closely at the criteria that have been used for explaining and dating them. Many of our concepts of the evolution of the land surface in the upper Mississippi Valley are at stake.

It is readily apparent to the observer that the small stream that cascaded down the south face of the East Bluff did not exist on a peneplained surface. Even with 200 feet of relief on the postulated peneplain (Trowbridge, 1917, p. 352) boulders over 2 feet in diameter seem unduly large and such cascades should not exist. Moreover,

FIGURE 6. Quartzite erratic northeast of pothole area. For location see figure 1.

the haphazard mixing of rounded and angular boulders is not normal to a stream valley. Was the stream on the upland the same one that produced the cascade on the bluff? They have been so correlated, but this is an assumption that is difficult to prove. If true, the stream hardly flowed on a peneplained surface. Moreover, how do we relate the potholes in loose blocks on the upland to those in the bedrock *in situ?* It is difficult to have beautiful holes drilled so symmetrically into a loose block that rises several feet above the bed of the stream. Why isn't the block moved during cutting? From where were the coarse stones obtained for cutting? It would be easier to have the blocks *in situ* during cutting and subsequently moved. This must have occurred to many blocks in which the sides or bottoms of potholes are missing (fig. 3), and the void is now partly occupied by a sharp unpolished corner of another block; others are turned on their sides with no rock adjacent to the void. Some of the loose blocks with potholes are on the very edge of the bluff. In figure 5 the most distant block to the right of the trail has just such a pothole. They are on the highest surfaces and surely were not cut there by any normal stream flowing on a peneplain, nor have they been moved downslope by gravity to their resting place. Moreover, it seems difficult to explain the potholes as having been produced by streams of considerable velocity running off a higher surface held up by Paleozoic rocks now removed (Thwaites, 1960, p. 38) or by an ancestral Wisconsin River (Irving, 1877, p. 508) without calling for subsequent movement of the blocks and the mixing of rounded and angular boulders. What moved them?

Because the potholes are above and outside the marked terminal moraine of Late Wisconsin (Cary) ice that existed perhaps 13,000 to 16,000 years ago and are in the classical Driftless Area of southwest Wisconsin, any thought that glaciers were involved has been in the past unthinkable. Hence, it was only logical to attempt to reconstruct substitute situations. These have not been entirely successful. Glaciation of much, if not all, the Driftless Area is called for by Black (1960) on the basis of a variety of evidence that cannot be detailed here. It includes many definite erratics, deposits stratigraphically up out of place, boulder trains, absence of old loess and residuum, reconstruction of ice surfaces, etc. Can glacial action, which directly and indirectly could easily account for the phenomena we see, be substantiated locally? At least is it unreasonable?

The Cary ice left thick coarse deposits up to about 1600 ft. in elevation in the vicinity of the radio tower (WWCF) about 3.5 miles east-northeast of the potholes, a prominent moraine up to 1450 ft. about 1.5 miles east-northeast, and the well-developed terminal moraine whose upper surface approaches 1100 ft. in the valley directly below the potholes. The potholes on the rim are about 1450–1460 ft. in elevation; the large quartzite block northeast is about 1420 ft. (Note, these elevations are derived by altimeter and from the new quadrangle maps, Baraboo and North Freedom, which replace the older Baraboo and Denzer quadrangle maps used by many earlier workers).

In continental glaciers or ice sheets that surmount the topography, debris is carried typically in the basal units of the ice and is moved up in the terminal areas through complex flow that cannot be discussed here. Nonetheless, the uppermost ice is invariably free of debris acquired from its base until such time as downwasting removes the clean ice down to the level reached by the debris. Many situations are known where a particular ridge may be crossed by an ice sheet without the basal ice reaching the top of that ridge. The debris at the terminus of a glacier then never reflects the uppermost level attained by clean ice. Hence, it seems entirely reasonable, though not proved, for clean ice to have stood on the uplands when the potholes were formed and prior to the main building of the prominent moraines nearby. If true, such ice would have access only to the residual materials on that surface. These need be only the highly siliceous material capable of surviving long weathering and the local quartzite. However, drilling reveals at least 8 feet of pebbly, sandy clay beneath the angular blocks of Baraboo quartzite that cover the surface of the upland. The pebbles are identical to those at the potholes in the type section of the Windrow formation and the clays are expandable type—not kaolin that characterizes the Windrow formation elsewhere.

Siliceous terrace gravels in many places in the Driftless area are subdivided into two groups (Thwaites, 1928) and the younger correlated with moraine in central Wisconsin that is now considered about 30,000 years old (Black, 1962) and certainly not older than the Wisconsin glacial stage (Hole, 1943). However, the actual material is composed of siliceous metamorphic rocks of Precambrain age and chert residuum with fossils from the Paleozoic dolomites (Andrews, 1958). They have been thought to have been concentrated initially during the Cretaceous or Tertiary—as far back as the last 135 million years of geologic time. It seems clear that many particles are multigenetic or have been worked and reworked at different times. The big question is when were they last reworked?

As it seems possible to have ice over the area, it remains to determine when. This cannot now be done. The absence of loess in the joints in the chaos by the large quartzite block (fig. 6) implies movement in post-Cary times. The unstable perched blocks in the block field also imply youthfulness. Igneous rocks outcropping west of Devil's Lake are fractured but not chemically altered as they would be if exposed to weathering for many millions of years. They indicate very recent exposure to weathering, possibly by glaciation which is not older than late Wisconsin. The well-jointed quartzite along the bluffs of Devils Lake lends itself to movement by frost action so great antiquity or absence of glaciation cannot necessarily be ascribed to such nearby features as Devil's Doorway and Balance Rock (fig. 1) (Salisbury and Atwood, 1900, p. 65). Features of similar size are known to have been produced in well-jointed igneous rocks since the Cary glaciation elsewhere (e.g., Devil's Chair, St. Croix River, Martin, 1932, pl. 28). Moreover, ancestral Devils Lake reached the level of the divide between the north branch of Messenger Creek (on the west side of Devils Lake) and Skillett Creek at about 1150 feet (Trowbridge, 1917, p. 366). This is about the elevation of Elephant Rock and the base of many vertical cliffs. Frost action along the shore likely was intensified at that time and would help produce some cliff features. If the clean Cary ice were not present, the Rockian ice of about 30,000 years ago surely must have been for it went well beyond the Cary limit everywhere else in the state.

Were ice to stand over East Bluff and downwaste, the highest part would be exposed first. Crevasses would open first probably along the axis of the ridge allowing meltwaters to plunge to the bottom. Thin slow-moving ice should not have removed all the residuum or pebbly, sandy clay on the quartzite, and the remainder would then be subjected to water working. The deposits of clay with chert and other siliceous materials could again be reworked in part by the ice and in part by the glacial waters. The odd distribution horizontally and vertically of potholes on the upland could be explained readily by such waters flowing off the ice into the crevasses at various times and places. So too could the movement of blocks after pothole drilling was completed, the mixing of rounded and angular blocks, and the irregular distribution of angular blocks of Baraboo quartzite on the upland, on top of the pebbly sandy clay.

Thus, in summary, the large quartzite block is interpreted as a glacial erratic that has been moved some yards upslope by clean ice that merely reworked and mixed old residuum or an ancient glacial deposit with rounded boulders and angular quartzite blocks on the upland of East Bluff. A late Wisconsin age is assigned tentatively to the glaciation mainly because of the absence of loess in the vicinity. Further it is believed possible that pothole drilling occurred by glacial waters reworking that pebbly, sandy clay whose initial concentration according to lithologies and possible other affinities in the upper Mississippi Valley may have been in Tertiary or Cretaceous times. The coarseness of the rounded boulders and the wide range horizontally and vertically of the potholes belie the existence of a peneplain across which a meandering stream flowed. The mixing of angular quartzite fragments of many sizes with the well-rounded and polished gravel and boulders must have taken place after the rounding of much of the gravel. This is considered possible only by glaciation. Certainly the East Bluff of Devils Lake is not a good type section for the Windrow Gravel.

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NOTES ON WISCONSIN PARASITIC FUNGI. XXX

H. C. Greene
Department of Botany, University of Wisconsin, Madison

Unless indicated otherwise the collections mentioned in this series of notes were made in 1963, in which case the year date is in most instances omitted. Certain records are based on infections noted on phanerogamic specimens in the University of Wisconsin Herbarium. Where it has not been feasible to obtain a separate fungus specimen the record is followed by the designation (U. W. Phan.).

General Observations

MYCOSPHAERELLA sp., which corresponds quite closely to the description of *Sphaerella (Mycosphaerella) vivipari* Wint. occurring on *Polygonum viviparum L.*, has been found on living leaves of *Polygonum virginianum* L. collected near Leland, Sauk Co., August 24. The very conspicuous orbicular spots are reddish-gray, subzonate, mostly about 2–3 cm. diam., only one or two per leaf. The perithecia are hypophyllous, rather closely gregarious, blackish, subglobose, approx. 90–110 μ diam.; asci are short-pedicellate, cylindric to narrowly subclavate, about 42–45 x 8–9 μ; ascospores are hyaline, subfusoid, straight, with median septum, about 12–13 x 4–4.5 μ. In *Sphaerella vivipari* the asci are said to be 35 x 8–9 μ, the ascospores 12–14 x 3–4 μ.

MYCOSPHAERELLA sp. is hypophyllous on conspicuous spots on the leaves of *Polygonum coccineum* Muhl. var *pratincola* (Greene) Stanf. collected at Madison, August 16. The spots are orbicular, about .5–2 cm. diam., dull purplish below, reddish and sometimes subzonate above. The perithecia are black, gregarious, subglobose, approx. 115–135 μ diam., the asci subclavate to cylindric, those appearing best matured running about 62–65 x 7.5–8.5 μ, the hyaline ascospores rather broadly subfusoid with one cell somewhat wider than the other, about 11–12.5 x 3.8–4.5 μ. Possibly parasitic. The leaves of this plant are attractive to certain chewing insects and are usually well riddled toward the end of the summer, as happened to these, so that it is difficult to determine how this might influence the development of fungi on them. This fungus does not seem referable to any of the several species of *Mycosphaerella* described as occurring on *Polygonum* and *Rumex*.

Shrubs of *Ribes missouriense* Nutt. sometimes show a striking development of ascomycetous fungi on white, bleached areas on the bark of twigs of the previous year's growth. *Didymosphaeria* sp. occurred in profusion on the twigs of such a shrub observed near Cross Plains, Dane Co., July 18. The plant seemed vigorous and not very adversely affected, so the overall degree of parasitism appeared to be slight. Various cane blights of cultivated currants and gooseberries have been reported, but that just described does not seem to be among them.

DIBOTRYON MORBOSUM (Schw.) Theiss. & Syd., the black knot of cherry, occurs commonly on *Prunus virginiana* L. in the Wisconsin area, but has been thought to develop only rarely on *Prunus serotina* Ehrh. *P. virginana* is shrubby and at most only a small tree, whereas *P. serotina* becomes a large tree, with its first branches many feet from the ground, so that the only specimens normally observable for the presence of black-knot are quite young and, as indicated, only exceptionally are infected. Recently at a location in Sauk Co., following a severe windstorm, the writer examined several large trees of *Prunus serotina* which had been uprooted and all were liberally festooned with black-knot cankers, so it seems likely that *Dibotryon* is not so very rare on black cherry after all.

RHYTISMA ILICIS-CANADENSIS Schw., collected on leaves of *Ilex verticillata* (L.) Gray near Leland, Sauk Co., July 27, has the fruiting structures filled with vast numbers of hyaline rod-shaped microconidia, approx. 3–5 x 1–1.3 μ, presumably a condition preliminary to the development of the perfect stage.

PSEUDOPEZIZA, as it occurs on *Galium* in Wisconsin, has hitherto been represented only by specimens on leaves. At Madison in October 1962, however, a specimen was collected which was confined to the stems of *Galium obtusum* Bigel. It was immature and showed no developed apothecia, so it was overwintered out-of-doors until May 1963 when it was placed in a moist chamber for several days. At the end of this time a number of the apothecia showed a fully repand condition and mature asci were present, indicating a means of overwintering, with infection of the new growth in spring or early summer. Following J. J. Davis, this has been referred to in the Wisconsin lists as *Pseudopeziza autumnalis* (Fckl.) Sacc., but the name *Pseudopeziza repanda* (Fr.) Karst. seems currently to be that accepted by most authors. It has been reported on several species of *Galium* in Wisconsin. H. H. Iltis has recently examined our specimens critically as to host determination, in accordance with present taxonomic treatment, and finds the host species to be as follows: *Galium labradoricum* Wieg., *G. obtusum* Bigel. and *G. trifidum* L. An earlier host determination of *G. tinctorium L.* is incorrect and must be deleted.

Muhlenbergia sylvatica Torr., collected in the Madison School Forest near Verona, Dane Co., September 25, 1962, bears on the culms of the lower portions of still living plants a very interesting, but still undetermined, Ascomycete which is perhaps dothidiaceous. The fructifications are black, narrowly linear, innate but strongly erumpent, and with at least a suggestion of a clypeate condition. Upon being placed in mounting fluid rounded clusters of aparaphysate asci which are still basally attached to one another are readily separated from their dark-walled, thick-celled housing. The clavate asci are approx. 65–75 x 10–12.5 μ, the hyaline, fusoid ascospores 20–25 x 6–7.5 μ. This fungus appears to have developed parasitically. It fails to fit into any of the available keys for the Dothideae, so perhaps belongs elsewhere.

PUCCINIA KUHNIAE Schw. O, I occurred in profusion on a plant of *Kuhnia eupatorioides* L. in the University of Wisconsin Arboretum at Madison, July 2. This uredinoid aecial stage seems to be rarely developed, or at any rate rarely collected, as there are no previous collections of it among numerous Wisconsin specimens in our herbarium, nor are there specimens on *Kuhnia* from any source. Our only other collection of the aecial stage is on *Brickellia lemmoni* Gray from Arizona.

UROMYCES LESPEDEZAE-PROCUMBENTIS (Schw.) Curt, was reported by J. J. Davis as occurring on *Lespedeza violacea* (L.) Pers. in Wisconsin, and there are two specimens, both collected July 25, 1904 at Waupaca, labeled as being on *L. violacea*. Recent examination of these specimens shows, however, that they cannot be *L. violacea*. The leaves appear to be those of *Lepedeza capitata* Michx., so *L. violacea* must be deleted as a Wisconsin host for *U. lespedezae-procumbentis*.

PHYLLOSTICTA ROSAE Desm. is the name which has been applied by various workers to specimens on rose from Wisconsin, and from various other sources, in the University of Wisconsin Cryptogamic Herbarium. The original description is vague and incomplete and one can only suppose that there is at best an element of guesswork in the naming. There does, however, seem to be an entity involved. The reddish-brown spots are orbicular and sharply defined. The pycnidia are epiphyllous and more or less concentrically-zonately arranged on the spots. The conidia are hyaline and fusoid, approx. 7–8 x 2–2.5 μ. The fungus is only marginally sphaeropsidaceous, since the fruiting structure approaches an acervulus.

PHYLLOSTICTA PHASEOLINA Sacc., as it appears in presumably authentic specimens, is characterized by rather thick-walled, black, gregarious pycnidia and by cylindric conidia approx. 6–7 x 2.5–3.5 μ. What is considered to be this species has been collected on *Apios tuberosa* Moench. in Wisconsin on several occasions, but in a collection made July 12 near Leland, Sauk Co., the seemingly mature pycnidia are flesh-colored on orbicular brownish spots and a small percentage of the conidia, which are in the size range of *P. phaseolina,* have a median septum, suggesting *Ascochyta,* many species of which have thin-walled flesh-colored pycnidia. In its effect on the host and in its general microscopic characters this fungus is very similar to an undetermined species of *Ascochyta* on the closely related *Amphicarpa bracteata* (L.) Fern., collected at the same station in 1962 and reported in my Notes 29.

PHYLLOSTICTA LAPPAE Sacc. was tentatively reported by J. J. Davis as occurring on *Arctium minus* Bernh, in Wisconsin, with the comment that the specimens might be referable to *Phyllosticta decidua* Ell. & Kell. In a specimen collected September 14 at Gov. Dodge State Park, Iowa Co., the pycnidia are on well-developed orbicular brown spots about .5–1.5 cm. diam. Most of the pycnidia have conidia about 6–7 x 3 μ, as described, but some contain fusoid conidia about 10–11 x 3–3.5 μ. If two organisms are present the spots would not indicate it, as they are very uniform.

PHYLLOSTICTA spp. indet. occur on 1) *Onoclea sensibilis* L. collected near Verona, Dane Co., July 3. The lesions are suborbicular, reddish-brown with ashen centers, approx. 1 cm. diam. The pycnidia are pallid brownish, very inconspicuous, gregarious, subglobose, about 75–85 μ diam., the conidia hyaline, subfusoid, 8–11 x 2.5–3.2 μ. 2) *Anemone virginiana* L. collected at Gov. Dodge State Park, Iowa Co., September 14. The spots are small, dull ashen with purplish borders. Pycnidia epiphyllous, black, suglogose, about 140–160 μ dam., the conidia hyaline with a faint greenish tinge, slender-cylindric, biguttulate, straight or slightly curved, approx. 6–8 x 1.3—1.7 μ. 3) *Rhus glabra* L. collected near Albany, Green Co., October 6, 1962. The pycnidia are scattered to gregarious on somewhat elevated sordid areas of indeterminate size. They are erumpent, black, subglobose, approx. 250–300 μ diam., with numerous hyaline microconidia 3.5–4 x .6–.7 μ. Leaves overwintered out-of-doors at Madison showed no further development after several days in a moist chamber. 4) *Scrophularia marilandica* L. collected near Leland, Sauk Co., August 24. The spots are oval, tan, purple-bordered, diaphanous, about .5–1 cm. diam. Pycnidia are subglobose, thin-walled and pallid flesh-colored, about 125–150 μ diam., the conidia hyaline, rod-shaped or subellipsoid, straight or slightly curved, mostly biguttulate, (3–) 3.5–5 x 1.5–2.3 μ. In another specimen on the same host, collected at the same time in the same general area, many of the conidia are even smaller and bacterium-like, with only a few of the size specified above. 5) *Aureolaria pedicularia* (L.) Raf., collected August 8, near Dodgeville, Iowa Co.Pycnidia are black, flattened, prominently ostiolate, about 150 μ diam., the conidia hyaline, 5–6 x 1.5–1.8 μ. On the pods and possibly parasitic. Quite similar to other collections made on pods of the related *Aureolaria grandiflora* (Benth.) Pennell and *Castilleja sessiliflora* Pursh and reported on earlier in these notes. 6) *Eupatorium rugosum* Houtt. collected near Pine Bluff, Dane Co., July 20. The spots are tiny, angled, translucent, the pycnidia somewhat flattened, sooty grayish in color, only one or two per spot, about 100–115 μ diam., the conidia hyaline, broadly ellipsoid, 2.8–3.8 x 1.8–2.2 μ.

PHOMA sp. occurs profusely on stems of *Helianthus grosseserratus* Mart. collected at Madison, Dane Co., October 10. The effect on the host appears devastating. The stems are black and rubbery, tending to lop over. The pycnidia are densely clustered around the stems in pustular areas about 2–3 inches in length. There had been no killing frost in the vicinity at this date, but the plants were stunted, had fully died back, and no good seed had been set. The pycnidia are subepidermal, rather deeply imbedded in the host tissue, globose, rather thin-walled, approx. 100–125 μ diam., while the conidia are of the micro- type, hyaline, straight or slightly curved, 5–7 x 1–1.3 μ.

NEOTTIOSPORA ARENARIA Syd. parasitizes various species of *Carex* in Wisconsin and it, or a species very similar to it, has been collected in the fall on leaves of several grasses, including *Calamovilfa longifolia* (Hook.) Hack., *Aristida purpurascens* Poir. and *Sporobolus vaginiflorus* (Torr.) Wood. var. *inaequalis* Fern. All these leaves were dead when collected, so it seems probable that the fungus developed saprophytically.

ASCOCHYTA sp. on *Polygonum hydropiper* L., collected September 5 near Connors Lake in the Flambeau State Forest, Sawyer Co., is similar in size of conidia to *Ascochyta polygonicola* Kab. & Bub. reported from Wisconsin on *Polygonum arifolium* L., but differs in having pycnidia of larger diameter, up to 200 μ. On *P. hydropiper* the lesions are dull purplish with reddish centers, somewhat oblong in shape and about 1–2 cm. long by .6–.8 cm. wide, extending mostly from one margin to the leaf midrib. The pycnidia are mostly epiphyllous, scattered to gregarious, dull yellowish-brown, and subglobose. The conidia are quite variable in size, the smaller mostly continuous, but the larger uniseptate, cylindric or subcylindric, obtuse, straight or slightly curved, mostly biguttulate, 9.5–14 x 2.8–4 μ.

ASCOCHYTA sp. occurs on a leaf of *Mitella diphylla* L. collected June 6 near Leland, Sauk Co. The lesion is circular, sordid brownish, about 8 mm. diam. with a yellowish halo. The pycnidia are amphigenous, loosely gregarious, pallid brownish, thin-walled, subglobose, approx. 110–125 μ diam. The conidia are hyaline, guttulate, mostly uniseptate, subcylindric, straight or slightly curved, about 6–10 x 2.5 μ. It seems possible that this is a more fully developed state of a fungus J. J. Davis assigned to *Phyllosticta mitellae* Peck, which I discussed in my Notes 26 (Trans. Wis. Acad. Sci. Arts Lett. 49: 89. 1960). I have not found any other report of *Ascochyta* on *Mitella*.

ASCOCHYTA on *Leonurus cardiaca* L. in Wisconsin has been referred to *Ascochyta nepetae* J. J. Davis which was described as having conidia 10–14 x 3 μ. A specimen on *Leonurus* collected near Leland, Sauk Co., July 27, has conidia up to 17.5 x 5 μ, and mostly more than 3.5 μ wide, which lends some doubt to the determination and perhaps indicates a separate entity.

STAGONOSPORA sp. on *Cinna latifolia* (Trev.) Griseb. collected near Connors Lake, Flambeau State Forest, Sawyer Co., September 5, has large, thin-walled, almost colorless pycnidia and conidia, the latter mostly 16–20 x 2.6–3.2 μ, 1–2 septate, subcylindric or subfusoid. Many of the pycnidia contain, however, only hyaline, rod-shaped microspores. This does not compare well with *Stagonospora intermixta* (Cke.) Sacc., previously reported on *C. latifolia* in Wisconsin, which has 7-septate spores, about 30–50 x 3 μ, or sometimes longer, but seems closer to *Stagonospora arenaria* Sacc., which, according to Sprague, has spores 3– (1–4) septate, 25–60 x 2.5–5 μ, often 30–45 x 3.5–4.3 μ.

STAGONOSPORA sp. occurs in small amount on leaves of *Kuhnia eupatorioides* L. collected near Black Earth, Dane Co., August 17, 1962. The spots are sordid brownish, immarginate, orbicular, subzonate, approx. 2 cm. diam. Pycnidia are epiphyllous, pallid brownish, subglobose, approx. 140–165 μ diam., the conidia subhyaline, cylindric to subfusoid, ends obtuse, straight to slightly curved or sinuous, 1–3, mostly 2–3 septate. I have found no report of *Stagonospora* on *Kuhnia* or any closely related plant.

SEPTORIA PACHYSPORA Ell. & Holw., occurring on *Zanthoxylum americanum Mill.*, was described as having spores 35–60 x 3 μ, 4–6 septate, and, in most specimens, they are about this size. In a collection made at Gov. Dodge State Park, Iowa Co., in September, however, many of the spores are much thicker, up to 7μ, and up to 9-septate, *Stagonospora*-like, but not longer than described.

SEPTORIA SANICULAE Ell. & Ev. was described on occurring on leaves of *Sanicula marilandica* L. collected by J. J. Davis at Racine, Wis. in November 1887. Davis later (Trans. Wis. Acad. Sci. Arts Lett. 9: 176. 1893) equated this with *Septoria cryptotaeniae* Ell. & Rau, stating that "*Septoria saniculae* E. & E. should doubtless be placed here, the host plant having been erroneously determined." *S. saniculae* is described as having spores spiculiform, slightly curved, about 20 x 1 μ, or less, while *S. cryptotaeniae* is said to differ primarily in larger spots, larger pycnidia, and in spores 20–30 x 1¼–1½ μ. Sydow's *Mycotheca germanica* No. 2206 is labeled *Septoria saniculae* Ell. & Ev. on leaves of *Sanicula europaea* L. and it has spots and spores in the size range described for *S. cryptotaeniae.* In the Wisconsin Cryptogamic Herbarium there is no Wisconsin specimen labeled *Septoria saniculae,* nor do any of the specimens now marked as *S. cryptotaeniae* appear to be the collection on which *S. saniculae* was based. *Septoria* sp. has recently been found on *Sanicula marilandica* collected at Gullickson's Glen near Disco, Jackson Co. This specimen has spores about 20–22 x 1 μ, but the few pycnidia noted are on extensive, indeterminate, dark brown areas of the sort usually associated on this host with *Stagonospora thaspii* (possibly also present). Thus, there *is* a *Septoria* on *Sanicula marilandica,* and furthermore it has spores very similar to those mentioned in the original description of *Septoria saniculae.*

SEPTORIA (?) sp. occurs in scanty development on small, reddish, oblong lesions on leaves of *Maianthemum canadense* Deaf. collected August 1 near Sauk City, Sauk Co. The small, light-colored pycnidia, which verge on acervuli, are not over 50 μ diam. The conidia are hyaline, uniseptate, about 17–20 x 2–2.5 μ. Plainly not *S. maianthemi* West. which has spores 50–70 x 3 μ, nor yet an undetermined *Septoria* on this host which I reported in my Notes 13 (Amer. Midl. Nat. 41: 743. 1949).

SEPTORIA sp. occurs on leaves of *Aralia nudicaulis* L. overwintered out-of-doors at Madison and brought in for study in May 1963. When collected October 2, 1962 near Pine Bluff, Dane Co., the leaves were bleached except for patchy green areas (the "green island" phenomenon) on which numerous gregarious, black, largely immature pycnidia were present. A few contained some rather poorly developed scolescospores. On the overwintered leaves most, but not all, the pycnidia have numerous spores. The subglobose pycnidia are about 125–150 μ diam., the spores hyaline, acicular, continuous, straight or slightly sinuous, 35—70 x .6—1.6 μ. Some spores are a bit shorter, but it seems questionable whether they are fully mature. *Septoria macrostoma* Clements has been reported as occurring on *Aralia nudicaulis* in Colorado. This is No. 55 in Clement's "Cryptogamae Formationum Coloradensium", issued in 1906, and apparently is represented only by the type specimen in the National Fungus Collections. According to Dr. C. R. Benjamin, who kindly loaned the specimen, publication was effected through distribution of the exsiccati, but it appears that in the case of *Septoria macrostoma* the Latin indication of host appearing on the label is insufficient to be considered an adequate description, and therefore the name is not valid. Examination of the Clement's specimen indicates that most of the pycnidia are sterile, but one mount was finally obtained which showed some spores. These were hyaline, acicular, more or less curved, approx. 50–90 x 1–1.5 u. The pycnidia are quite similar to those of the Wisconsin specimen and it seems likely that a single entity is involved. Some years ago a specimen doubtfully assigned to *Septoria* was collected on *Aralia hispida* Vent. in Juneau Co. (Trans. Wis. Acad. Sci. Arts Lett. 46: 144. 1957). This had pycnidia 115–125 μ and spores 55–75 x 1.5 μ similar in size range to the specimens on *A. nudicaulis,* but the overall aspect is quite different and it seems improbable that it is the same. *Septoria araliae* Ell. & Ev., described on *Aralia californica* Wats., has spores 18–27 x 1.2–1.5 μ and pycnidia only 70–75 μ diam. It would seem that any description of the fungus on *A. nudicaulis* should be deferred until better characterized material of the current season can be obtained, as overwintering in a wire cage may perhaps tend to cause deviations from the normal.

SEPTORIA sp. developed on leaves of *Aster lateriflorus* (L.) Britt. collected October 10, 1962 at Tower Hill State Park, Iowa Co., and overwintered out-of-doors at Madison until May 1963. As collected, the pycnidia contained no spores, were subglobose, black, approx. 140–165 μ diam., and were closely gregarious on small, angled, brownish spots on otherwise still green leaves. After overwintering the pycnidia were found to contain numerous acicular, hyaline spores, straight or slightly curved, appearing continuous, about 35–50 x 1–1.5 μ. *Septoria atropurpurea* Peck and *S solidaginicola* Peck have been reported on *Aster lateriflorus* in Wisconsin, but this fungus seems closer to *S. astericola* Ell. & Ev. so far as spore dimensions are concerned, although not in the large and conspicuous pycnidia.

GLOEOSPORIUM ROBERGEI Desm. *(Monostichella robergei* (Desm.) Hoehn.) is fairly common on both *Ostrya virginiana* (Mill.) K. Koch and *Carpinus caroliniana* Walt. in Wisconsin. In my Notes 20 (Trans. Wis. Acad. Sci. Arts Lett. 43: 170. 1954) I discussed a microconidial form on *Ostrya* noted by both J. J. Davis and me, in its possible relationship to *G. robergei* and to *G. carpinicolum* Ell. & Dearn., reaching the conclusion that, while it might be connected with *G. robergei*, it could scarcely be identical with *G. carpinicolum*. A very similar and perhaps identical microconidial fungus was collected on *Carpinus caroliniana*, September 15, 1962, in the Leopold Memorial Tract, Sect. 1, Town of Honey Creek, Sauk Co. The numerous small, flesh-colored epiphyllous acervuli are scattered to gregarious on conspicuous, brownish, orbicular blotches approx. 1 cm. diam. In section the acervuli appear to be subcuticular, about 80–110 μ diam. by about 15–20 μ in elevation. The slender condiophores are quite closely ranked and the numerous, hyaline, rod-shaped conidia are approx. 4–6 x 1.7–2.2 μ. This would appear to belong in *Cylindrosporella* Hoehn, as delineated by von Arx in his revision of *Gloeosporium*.

COLLETOTRICHUM sp., which may be parasitic, occurs on a suborbicular lesion about 2 cm. diam. on a leaf of *Jeffersonia diphylla* (L.) Pers. collected in the University of Wisconsin Arboretum at Madison, September 25, 1962. The lesion is tan with a narrow dark brown border, the whole surrounded by a yellowish halo. The numerous acervuli are gregarious and epiphyllous. The rather rigid, straight setae are clear deep brown, 1–2 septate, slightly paler near the subobtuse tip, approx. 40–100 x 4–6 μ, the hyaline conidia fusiform or subfalcate, 17–20 x 3.5–4 μ.

SPHACELOMA (?) sp. on *Stipa spartea* Trin. has been collected in the Madison area on two occasions, in 1959 and recently August 10, 1963. The first collection was sent to Jenkins and Bitancourt who failed to find good fruiting, but the second appears better developed and worthy of mention. The lesions are very small, on the order of 1 mm. x .3 mm., somewhat ellipsoid, often confluent in groups along the adaxial surface of the narrow, strongly ribbed leaf, with narrow dark border and ashen center on which the fungus is produced, and which consists of pulvinate agglomerations of dematiaceous, pseudoparenchymatous mycelium, which may or may not be basally connected with one another. In section the fungus appears intraepidermal, or perhaps even more deeply seated, and the cells are elongate and quite closely packed. Some measurements of individual mycelial aggregates are: 55 μ wide by 20 μ high, 65 x 25 μ, 35 x 25 μ and 75 x 25 μ. Hyaline, ellipsoid conidia, about 5.5–6.5 x 2.6–3 μ, are scantily produced, but none have been seen attached. The lesions are very sharply defined on the otherwise healthy green leaves and there seems to be no doubt of the active parasitism of the fungus.

MOLLISIA DEHNII (Rabh.) Karst. is a devastating parasite of *Potentilla norvegica* L. var. *hirsuta* (Michx.) Lehm. with the very numerous repand apothecia frequently almost completely covering the stems and principal veins of the host plants. In a heavy development of this, noted at Madison, August 12, 1962, most of the apothecia were in turn overgrown by a so far undetermined, subhyaline moniliaceous fungus which may well have been parasitic, as the overgrowth was closely confined to individual apothecia and did not overrun them as a group. The very numerous, globose, hyaline conidia have each a definite apiculum, marking the point of attachment, and are approx. 6–7.5 μ diam. The mycelium is irregularly dichotomously branched, hyaline distally, but tending to be grayish or subfuscous below. The overall effect is macroscopically reminiscent of the fructifications produced by lime-bearing slime-molds, such as *Physarum cinereum* Pers. I have found no reports of any parasite on *Mollisia*.

BOTRYTIS spp., possibly parasitic, occur on 1) leaves of *Ranunculus recurvatus* Poir. on large, marginal, broadly wedge-shaped, sordid grayish subzonate lesions, collected at Gov. Dodge State Park, Iowa Co., July 10; 2) large, marginal, orbicular to wedge-shaped brown lesions on leaves of *Caltha palustris* L., collected on Glidden Scenic Drive near Valmy, Door Co., June 29. The lesions have a more or less sharply defined darker border, are from approx. 1–5 cm. diam. and occur on otherwise normal green leaves; 3) a large (3.5 cm. diam.) orbicular, markedly zonate brown lesion with narrow darker border on a leaf of *Menispermum canadense* L., collected at Madison, July 25, 1962, and very sharply defined. All these lesions are similar to others noted on diverse hosts in Wisconsin through the years, but whether the same species of *Botrytis* is involved is still uncertain.

BOTRYTIS sp. developed consistently from lenticular black sclerotial structures on stems of *Vicia villosa* Roth collected October 11, 1962 near Gibraltar Rock County Park, Columbia Co., and held out-of-doors over winter at Madison. The stems were brought indoors in May 1963 and held in a moist chamber for three days, when examination showed strong growth of the *Botrytis*. The conidiophores arise from the sclerotia in compact tufts which become divergent and spreading upwards. They are dark brown, granulose, quite straight, septate, 16–18 μ diam. and 700–1200 μ or more in length, branching dichotomously, more or less elaborately, near the apex where sterigmata are produced on the slightly inflated tips of the ultimate branchlets. The conidia are grayish-hyaline, broadly obovate, 13–15 x 15–17.5 μ, with a noticeable basal protrusion at the point of attachment to the sterigma. This is evidently not identical with *Botrytis viciae* Greene (Trans. Wis. Acad. Sci. Arts Lett. 48: 114. 1958), described as occurring on leaves of *Vicia villosa*, which has larger conidia and conidiophores which are more delicate and less intricately branched. Because of the lateness of the season there was no positive indication of parasitic development on the already dead stems, but parasitism seems probable in view of the confined and restricted growth of the fungus from the sclerotia.

CRYPTOSTROMA CORTICALE (Ell. & Ev.) Greg. & Wall. (*Conisporium corticale* Ell. & Ev) occurs in the bark of hard maple pulp sticks when they are stored prior to usage by paper mills. A specimen has recently been received which developed in the storage yard of a mill at Tomahawk, Lincoln Co., in 1962. The black, powdery spores are produced in great numbers and are said to cause allergic reactions in paper mill workers who inhale them. Gregory and Waller state (Trans. Brit. Mycol. Soc. 34: 579–597. 1951) that in England this fungus actively parasitizes *Acer pseudoplatanus* L. and they further state there are indications it may be parasitic on *Acer saccharum* Marsh. (hard maple) in Wisconsin, and on hickory and basswood as well.

RAMULARIA HERACLEI (Oud.) Sacc. is very common on *Heracleum lanatum* Michx. in Wisconsin. In late August numerous small, sooty, semi-translucent, subglobose pycnidia about 75–100 μ diam., containing large numbers of hyaline microconidia, approx. 4–5 x .8 μ, were observed on old *Ramularia* spots in a specimen collected near Leland, Sauk Co. Some of this material was held over winter without any further development.

SEPTOCYLINDRIUM sp. is epiphyllous on strikingly sharp lesions on *Aster sagittifolius* Willd. collected July 18 near Cross Plains, Dane Co. The spots are rounded or somewhat angled, with wide, dark purple margins and ashen centers, and are mostly about 2–4 mm. diam., sometimes numerous on any one leaf. The catenulate conidia are hyaline, narrow-cylindric, (16–)22–38(–48) x 2.2–2.8 μ, 1–3 septate, produced from short, hyaline conidiophores, approx. 10–14 x 3–4 μ, some of which are compactly geniculate with numerous scars. The conidiophores may occur a few clustered together, or individually, and the fruiting is quite diffuse. As in other specimens of this nature the conidia quickly fall away and the material in hand is scarcely suitable for formal descriptive purposes.

CERCOSPORA LEPTANDRAE J. J. Davis, occurring in Wisconsin on *Veronicastrum virginicum* (L.) Farw. normally has conidia 20–75 x 5–8 μ, many of them subcylindric. However, in a specimen on this host collected at Madison, August 16, most of the conidia are narrowly obclavate and are quite similar to those of *Cercospora tortipes* Davis which occurs on *Veronica scutellata* L., but the conidiophores are not fascicled as in the latter species, so perhaps the recent collection represents a bridging form between typical *C. leptandrae* and *C. tortipes*.

Leaves of *Scirpus cyperinus* (L.) Kunth. var. *pelius* Fern collected August 20 at Dickey Creek, Black River State Forest, Jackson Co., bear numerous, black, seriate pycnidia (or acervuli ?) in inconspicuous rows. These structures are deeply immersed below the leaf surface, not more than 30–50 μ diam., and quite imperfectly developed above. Hyaline microconidia, about 3–3.5 x 1 μ, are borne on closely ranked very slender conidiophores which line the entire inner surface. Associated with the microconidia, but not seen within the fruiting structures, are a few hyaline scolecospores.

Aster umbellatus Mill. collected in the Flambeau State Forest near Oxbow, Sawyer Co., September 4, bears small, elevated acervuli on rounded yellowish to brownish areas on the upper surface of the otherwise still green leaves. The acervuli are about 40–60 μ diam. at the base and had produced hyaline, allantoid microconidia about 5–6 x 1.2–1.5 μ. Some of the acervuli show considerable sclerotization basally, and they are associated with what appear to be immature perithecia which are deeply sunken in the host tissue, in contrast to the more or less superficial acervuli.

Additional Hosts

The following hosts have not been previously recorded as bearing the fungi mentioned in Wisconsin.

Peronospora dicentrae Syd. ex Gaum. on *Dicentra canadensis* (Goldie) Walp. Menominee Co., near Neopit, May 26. Coll. J. A. Curtis.

Erysiphe polygoni DC. on *Aconitum noveboracense* Gray. Sauk Co., near Sauk City, August 1.

Podosphaera oxyacanthae (DC.) DeBary on *Amelanchier laevis* Wieg. Iowa Co., Sect. 17, Ridgeway Twp., June 17. Infected trees showed spectacular witches' brooms, resulting apparently from the combined effect of the powdery mildew and an infection of the conidial stage of *Apiosporina collinsii* (Schw.) Hoehn. There was no evidence of insect action in this connection. When these same trees were observed again in late August they appeared to have died. This seems to be the first record of *Podosphaera* on a species of *Amelanchier* in Wisconsin.

Uncinula salicis (DC.) Wint. on *Salix adenophylla* Hook. (cult.). Dane Co., Univ. Wis. Arboretum at Madison, October 10.

Undetermined powdery mildews in the conidial stage only have been observed on the following hosts not previously listed as bearing these fungi in Wisconsin: 1) *Alnus vulgaris* Hill. Dane Co., Madison, November 15; 2) *Viola tricolor* L. Dane Co., near Cross

Plains, June 24; 3) *Echinacea angustifolia* DC. Dane Co., Madison (Univ. Wis. Arboretum), September 6, 1962.

GNOMONIA ULMEA (Schw.) Thum. on *Ulmus carpinifolia* Gleditsch, *U. parvifolia* Jacy. and *U. pumila* L. Columbia Co., near Arlington, August 14. These trees were all in a plantation established by the state with a view toward developing climate-hardy elms which will also be resistant to Dutch Elm disease.

MELAMPSORA MEDUSAE Thum. II, III on *Populus simoni* Carr. (cult.). Dane Co., Madison, October 12.

MELAMPSORELLA CARYOPHYLLACEARUM Schroet. II, III on *Myosoton (Stellaria) aquaticum* (L.) Moench. Sauk Co.. near Leland, May 21. The telia are mostly germinated.

CEROTELIUM DICENTRAE (Trel.) Mains & Anders. I on *Dicentra canadensis* (Goldie) Walp. Menominee Co., near Neopit, May 26. Coll. J. A. Curtis.

PUCCINIA RECONDITA Rob. ex Desm. I on *Isopyrum biternatum* (Raf.) T. & G. Sauk Co., near Leland, May 7. II on *Schizachne purpurascens* (Torr.) Swallen. Sawyer Co., near Oxbow, Flambeau State Forest, September 4. Assigned here because of the small urediospores which indeed barely fall within the lower size range of this species.

PUCCINIA DIOICAE P. Magn. II, III on *Carex arcta* Boot. Lincoln Co., near Tomahawk, September 17, 1951. Coll. F. C. Seymour (13274). (U. W. Phan.). On *C. canescens* L. Oneida Co., near Woodruff, July 5, 1958. Coll. H. H. Iltis (11390). On *C. prairea* Dewey. Dane Co., Madison, October 10. On *C. umbellata,* Schkuhr. Lincoln Co., Tomahawk, May 27, 1950. Coll. F. C. Seymour (11182). (U. W. Phan.).

SPHACELOTHECA REILIANA (Kuhn) Clint. on *Sorghum sudanense* (Piper) Stapf. Columbia Co., near Arlington, September 5, 1962. Coll. E. W. Hanson.

USTILAGO MACROSPORA Desm. on *Elymus canadensis* L. Green Co., near Monticello, July 6.

CINTRACTIA CARICIS (Pers.) Magn. on *Carex aquatilis* Wahlenb. var. *altior* (Rydb.) Fern. Vilas Co., Lac Vieux Desert, July 16, 1961. Coll. H. H. Iltis.

PHYLLOSTICTA POPULINA Sacc. on *Populus deltoides* Marsh. Sauk Co., near Leland, September 26. Referred to this species with some doubt. This is said to be associated with the common *Septoria musiva* of *Populus,* but half a dozen mounts have failed to reveal any *Septoria,* although at the time of collection in the field it was supposed that the spots had been caused by *Septoria.* The large black pycnidia are up to 200 μ diam., in a few cases even more, the hyaline conidia about 4–6 x 2–3 μ, ellipsoid or subfusoid. Davis originally reported this fungus on *Populus deltoides* from Wisconsin, but later redetermined the host as *P. nigra* L. var. *italica* DuRoi, which it does appear to be.

PHYLLOSTICTA LIVIDA Ell. & Ev. on *Quercus ellipsoidalis* E. J. Hill. Dane Co., Madison, October 10.

PHYLLOSTICTA AMARANTHI Ell. & Kell. on *Amaranthus retroflexus* L. Dane Co., Madison, August 16.

PHYLLOSTICTA DEARNESSII Sacc. on *Rubus pubescens* Raf. Sawyer Co., near Oxbow, Flambeau State Forest, September 4.

ASCOCHYTA AQUILEGIAE (Rabh.) Hoehn. on *Delphinium* sp. (cult.) Dane Co., near Mt. Horeb, July 21. The host is the tall garden plant sometimes called *Delphinium "cultorum"*.

ASCOCHYTA COMPOSITARUM J. J. Davis on *Aster macrophyllus* L. Jackson Co., Gullickson's Glen near Disco, August 21. The *Ascochyta* pycnidia are associated with much more numerous, immature, black, perithecium-like bodies which are apparently identical with the structures discussed in my Notes 27 (Trans. Wis. Acad. Sci. Arts Lett. 50: 144. 1961). On *A. prenanthoides* Muhl. Sauk Co., near Leland, September 26. On *A. sagittifolius* Willd. Sauk Co., near Leland, August 24. On *Solidago flexicaulis* L. Sauk Co., near Leland, September 26. On *Rudbeckia laciniata* L. Sauk Co., near Leland, September 26. On *Tithonia rotundifolia* Blake var. *"grandiflora"* (cult.). Dane Co., near Cross Plains, September 16. This is the first instance of a Wisconsin collection of this fungus on a non-native host, but the infection is characteristic, both in type of lesion and in the fungus itself.

DARLUCA FILUM (Biv.) Cast. on *Coleosporium delicatulum* Hedgc. & Long II on *Solidago graminifolia* (L.) Salisb. Dane Co., Madison, August 27, 1962.

STAGONOSPORA BAPTISIAE (Ell. & Ev.) J. J. Davis on *Baptisia tinctoria* (L.) R. Br. Dane Co., Madison, Univ. Wis. Arboretum, August 3.

SEPTORIA PASSERINII Sacc. Microsporous on *Elymus villosus* Muhl. Sauk Co., near Leland, July 12. This the stage to which the name *Septoria microspora* Ell. has been applied and is similar to Wisconsin collections on other species of *Elymus*.

SEPTORIA PUNCTOIDEA Karst. on *Carex adusta* Boott. Jackson Co., near Millston, July 19, 1958. Coll. T. G. Hartley. (U. W. Phan.)

SEPTORIA CARICINELLA Sacc. & Roum. on *Carex foenea* Willd. Pierce Co., near River Falls, May 31, 1960. Coll. H. H. Iltis (16818). On *C. merritt-fernaldii* Mack. Oconto Co., near Mountain, June 25, 1958. Coll. H. Gale.

SEPTORIA CARICIS Pass. on *Carex pedunculata* Muhl. Manitowoc Co., near St. Nazianz, May 19, 1961. Coll. H. H. Iltis (17295).

SEPTORIA NEMATOSPORA J. J. Davis on *Carex deweyana* Schwein. Door Co., Peninsula State Park, June 16, 1957. Coll. H. R. Bennett. Also noted on specimens of this host from Adams, Ashland and Florence counties.

SEPTORIA PSILOSTEGA Ell. & Mart. on *Galium brevipes* Fern. & Wieg. (host det. H. H. Iltis). Sawyer Co., Flambeau State Forest south of Connors Lake, October 13. Coll. F. G. Goff.

HAINESIA LYTHRI (Desm.) Hoehn. on *Hamamelis virginiana* L. Sauk Co., near Leland, August 24. On *Rubus pubescens* Raf. Sawyer Co., near Oxbow, Flambeau State Forest, September 4. The *Sclerotiopsis* stage is also present in this specimen.

COLLETOTRICHUM MADISONENSIS H. C. Greene on *Carex emoryi* Dewey. Columbia Co., near Wyocena, July 18, 1961. This occurs with *Septoria caricis* Pass. in a specimen so labeled.

COLLETOTRICHUM MALVARUM (A. Br. & Casp.) Southw. on *Abutilon theophrasti* Medic. Columbia Co., near Arlington, August 14.

OVULARIA PUSILLA (Ung.) Sacc. & D. Sacc. on *Festuca elatior* L. Jefferson Co., near Lake Mills, August 31. On *Bromus ciliatus* L., Sawyer Co., near Oxbow, Flambeau State Forest, September 4.

RAMULARIA ASTERIS (Phil. & Plowr.) Bub. on *Aster prenanthoides* Muhl. Sauk Co., near Leland, July 12.

CERCOSEPTORIA VERMIFORMIS (Davis) Davis on *Corylus cornuta* Marsh. Sawyer Co., near Oxbow, Flambeau State Forest, September 4. Associated with, and evidently reaching the peak of development after most of the large *Cercoseptoria* spores have fallen away, is a microspore stage characterized by small, pulvinate, flesh-colored masses (acervuli?) of hyaline, continuous, rod-shaped conidia about 5.5–9 x .7–1 μ. These bodies are gregarious on the same large, orbicular, brownish lesions on which the *Cercoseptoria* was produced and, it seems, may possibly be the precursors of a perfect stage.

CERCOSPORA CARICIS Oud. on *Carex albursina* Sheld. Green Co., Abraham's Woods near Albany, August 27. On *C. bromoides* Schkuhr. Sauk Co., near Leland, May 21. On *C. gravida* Bailey. St. Croix Co., near Hudson, June 28, 1959. Coll. J. Patman.

CERCOSPORA CIRCUMSCISSA Sacc. on *Prunus americana* Marsh. Iowa Co., Gov. Dodge State Park, August 15, 1962. A report by J. J. Davis of this species on *Prunus pennsylvanica* L. f. appears to be in error, as the host is *Prunus serotina* Ehrh. and the fungus *Cercospora graphioides* Ell.

CERCOSPORA ELAEOCHROMA Sacc. on *Asclepias sullivantii* Englem. Jefferson Co., Faville Prairie Preserve near Lake Mills, July 23.

CERCOSPORA ARCTI-AMBROSIAE Halst. on *Ambrosia trifida* L. Iowa Co., Gov. Dodge State Park, July 10.

TUBERCULINA PERSICINA (Ditm.) Sacc. on *Puccinia polygoni-amphibii* Pers. I on *Geranium maculatum* L. Dane Co., near Verona, June 4.

ADDITIONAL SPECIES

The fungi mentioned here have not been previously reported as occurring in the state of Wisconsin.

GNOMONIELLA GNOMON (Tode) House on *Corylus cornuta* Marsh. Sawyer Co., near Oxbow, Flambeau State Forest, September 4. On *C. americana*. Sauk Co., near Leland, September 26. Both specimens are immature, but the fungus is so characteristic as to leave no reasonable doubt as to identity. The perithecia are fully separate from one another, not in a pseudostroma as in *Mamiana (Gnomoniella) coryli* (Batsch ex Fr.) Ces. & DeNot.

PUCCINIA SPOROBOLI Arth. var. ROBUSTA Cumm. & Greene (Brittonia 13: 272. 1961) is the name applied to the variety which occurs on *Calamovilfa* in Wisconsin and elsewhere. This differs from the species proper on *Sporobolus* in having much broader teliospores (19–)22–29(–35) μ vs. (14–)17–21(–23) μ, in having urediospores with (3–)5–6 germ pores vs. 3 or 4, and somewhat larger aeciospores. This has been confused in the past with *Puccinia amphigena* Diet. with which it sometimes occurs in mixtures on *Calamovilfa* (Trans. Wis. Acad. Sci. Arts Lett. 47: 124. 1958). The only known Wisconsin aecial host of *P. sporoboli* var. *robusta* is *Smilacina stellata*, as has been established by J. W. Baxter (Pl. Dis. Rep. 46(10): 706. 1962). As stated by Cummins and Greene "There is no evidence that *P. amphigena* has aecial hosts other than species of *Smilax*."

RHIZOCTONIA CROCORUM DC. ex Fr. (violet root rot) on *Medicago sativa* L. Green Co., 5 mi. E. of Argyl, October 16, 1962. Coll. E. W. Hanson, who estimates that 10–15% of the plants in a 19 acre field had been killed.

Phyllosticta ulmi-rubrae sp. nov.

Maculis conspicuis, fusco-purpureis, orbicularibus, ca. .5–2 cm. diam., saepe confluentibus, pycnidiis hypophyllis, carneis, subglobosis, sparsis vel gregariis laxe, interdum subzonatis, amplitudinibus variis, ca. 100–180 μ diam.; conidiis hyalinis, bacilliformibus, saepe biguttulatis, ca. 4–6 x 1.3–1.8 μ.

Spots conspicuous, dark purplish, orbicular, approx. .5–2 cm. diam., often confluent; pycnidia hypophyllous, flesh-colored, subglobose, scattered to loosely gregarious, occasionally subzonately arranged, variable in size, approx. 100–180 μ diam.; conidia hyaline, bacilliform, often biguttulate, approx. 4–6 x 1.3–1.8 μ.

On living leaves of *Ulmus rubra* Muhl. Tower Hill State Park, Iowa County, Wisconsin, U. S. A., October 10, 1962.

The leaves were on shoots which were growing vigorously despite the lateness of the season.

A *Phyllosticta* which is very similar, and may be identical, was collected on the same host in Dane Co. in 1959 and was discussed briefly in my Notes 26 (Trans. Wis. Acad. Sci. Arts Lett. 49: 88. 1960). *Phyllosticta ulmicola* Sacc., of which *P. melaleuca* Ell. & Ev. may be a synonym, is reported as occurring on elm in Wisconsin but should, judging from specimens examined, probably be referred to *Coniothyrium* and certainly bears no resemblance to *P. ulmi-rubrae.*

Phyllosticta pruni-virginianae sp. nov.

Maculis conspicuis, orbicularibus, purpureo-brunneis, zonatis, ca. .5–1.5 cm. diam., saepe confluentibus; pycnidiis epiphyllis, zonate dispositis, subglobosis vel fere globosis, pallido-brunneis, erumpentibus, (75–)100–160(–190) μ diam.; conidiis hyalinis, ellipsoideis, late ellipsoideis, brevo-cylindraceis, vel rare subfusoideis, 5–7 x (2–)2.5–2.7(–3) μ.

Spots conspicuous, obicular, purplish-brown, markedly zonate, approx. .5–1.5 cm. diam., often confluent; pycnidia epiphyllous, tending to be zonately arranged, subglobose to almost globose, pallid brownish, erumpent, (75–)100–160(–190) μ diam.; conidia hyaline, ellipsoid, broadly ellipsoid, short-cylindric, or rarely subfusoid, 5–7 x (2–)2.5–2.7(–3) μ.

On living leaves of *Prunus virginiana* L. Sect. 11, Town of Honey Creek near Leland, Sauk County, Wisconsin, U. S. A., August 24, 1963.

This fungus was first noted at Madison in 1959 and was mentioned in my Notes 26 (Trans. Wis. Acad. Sci. Arts Lett. 49: 90. 1960). Other specimens have been collected at Wildcat Mt. State Park, Vernon Co., September 13, 1960, and at Bohemian Valley near Middle Ridge, LaCrosse Co., August 21, 1963. The spots are not, or are only slightly confluent in the type specimen, but are notably so in the Madison and Bohemian Valley collections, so this feature is included in the description.

PHOMA HERBARUM West. on *Rumex crispus* L. Jackson Co., Gullickson's Glen near Disco, August 21. The fungus appeared parasitic on elongate pallid lesions on the still green stem of the host. Assignment to this "catch-all" species must be somewhat tentative, but the specimen corresponds fairly closely to presumably authentic examples, such as Kabat & Bubak's *Fungi imperfecti exsiccati* No. 404. In view of the considerable diversity of the forms listed under this species, it seems desirable to present here a brief descriptive note of the Wisconsin specimen: Pycnidia yellowish-brown, somewhat flattened, with a large ostiole about 30–35 μ diam. sharply delimited by a ring of blackish cells, the overall pycnidial diameter approx. (180–)200–215(–235) μ; conidia very numerous, hyaline, mostly biguttulate, short-cylindric, ellipsoid or subfusoid, straight or slightly curved, (5–)5.5–7(–8) x (2–)2.5–2.8(–3.2) μ.

Ascochyta caryae sp. nov.

Maculis variis, orbicularibus vel angulatis, ca. .3–1.2 cm. diam., centris pallido-brunneis, marginibus fuscis; pycnidiis inconspicuis, immersis, sparsis vel gregariis, flavido-brunneis, subglobosis, ca. 95–140 μ diam.; conidiis hyalinis, uniseptatis, non constrictis, cylindraceis vel late cylindraceis, vel subfusoideis nonnumquam, rectis vel curvis leniter, (6.5–)7–8.5(–10) x (2.8–)3–4(–4.5) μ.

Spots variable, orbicular to angled, approx. .3–1.2 cm. diam., centers light brownish, margins fuscous; pycnidia inconspicuous and immersed, scattered to gregarious, yellowish-brown, subglobose, approx. 95–140 μ diam.; conidia hyaline, uniseptate, not constricted at the septum, cylindric to broadly cylindric, or occasionally subfusoid, straight or slightly curved, (6.5–)7–8.5(–10) x (2.8–)3–4 (–4.5) μ.

On living leaves of *Carya ovata* (Mill.) K. Koch. Madison School Forest near Verona, Dane County, Wisconsin, U. S. A., July 3, 1963.

Five widely scattered infected trees were observed and it seems likely that an intensive search would have turned up more. There seem to be no reports of any *Ascochyta* on *Carya*. *Ascochyta juglandis* Boltsh. on the closely related walnut has pycnidia about 80 μ diam. and conidia 10–13 x 4–5 μ, often slightly constricted at the septum.

In 1952, at Madison, a well-defined ASCOCHYTA was collected on *Verbena urticifolia* L. and was characterized in some detail (Trans. Wis. Acad. Sci. Arts Lett. 42: 70. 1953), although formal description was deferred. Since that time additional specimens on the same host have been collected in 1961, 1962 and 1963 at Gov. Dodge State Park, Iowa Co., and on the property of the Wisconsin Society for

Ornithology near Leland, Sauk Co. In 1963, at the latter station, the fungus was also found on *Verbena hastata*. Since there seems to be no further doubt as to the constancy of this organism, with its conspicuous and well-characterized lesions, it is here described:

Ascochyta cuneomaculata sp. nov.

Maculis magnis, conspicuis, cuneatis, purpureo- vel obscuro-brunneis, primum in apicibus vel marginibus; pycnidiis sparsis vel gregariis, epiphyllis, inconspicuis, pallido-brunneis, subglobosis, ca. 125–185 μ diam.; conidiis hyalinis, uniseptatis, cylindraceis vel subfusoideis, ca. 7–10(–13) x 3–4.5 μ.

Lesions large, conspicuous, wedge-shaped, purplish-brown, becoming sordid brownish, mostly distal or at least marginal in origin; pycnidia scattered to gregarious, epiphyllous, inconspicuous, pallid brownish, subglobose, approx. 125–185 μ diam.; conidia hyaline, uniseptate, cylindric to subfusoid, about 7–10(–13) x 3–4.5 μ.

On living leaves of *Verbena urticifolia* L. University of Wisconsin Arboretum, Madison, Dane County, Wisconsin, U. S. A., July 2, 1952.

Since the lesions eventually involve and kill back the entire leaf, the fungus is obviously a strong parasite.

As mentioned in the note cited above, it seems probable that *A. cuneomaculata* has a *Melanopsamma* perfect stage, but this has yet to be conclusively demonstrated.

Ascochyta kuhniae sp. nov.

Maculis conspicuis, circulis, marginibus late purpureis, centris albidis vel pallido-brunneis, translucidis, parvis, plerumque 2–4 mm. diam., interdum confluentibus; pycnidiis unicis vel nonnullis gregariis in maculis, pallido-brunneis, subglobosis, ca. 120–135 μ diam.; conidiis hyalinis, uniseptatis, variis, cylindraceis vel subfusoideis, rectis vel curvis modice, interdum ad septis constrictis leviter, (7–)10–12(–13.5) x 2.7–3.5 μ.

Spots conspicuous and sharply defined, rounded, with wide purplish margins and whitish to pallid brownish translucent centers, mostly about 2–4 mm. diam., sometimes confluent; pycnidia one, or several clustered closely on the spot, light brownish, subglobose, about 120–135 μ diam.; conidia hyaline, uniseptate, variable in shape from cylindric to subfusoid, straight or somewhat curved, occasionally slightly constricted at the septum, (7–)10–12(–13.5) x 2.7–3.5 μ.

On living leaves of *Kuhnia eupatorioides* L. Sect. 6, Middleton Township, near Cross Plains, Dane County, Wisconsin, U.S.A., June 24, 1963.

The best developed pycnidia are marked by having the ostiole sharply delimited by a ring of thicker, darker cells about it. When infection occurs near the leaf margin marked curvature of the leaf is often produced at that point.

This is not identical with an undetermined *Ascochyta* on the same host reported on in my Notes 18 (Trans. Wis. Acad. Sci. Arts Lett. 42: 71. 1953). Although the conidial size is approximately that specified by J. J. Davis for the var. *parva* of his *Ascochyta compositarum,* the small, sharply defined spots are very different from those so characteristic of an *A. compositarum* infection.

Leptothyrium astericolum (Ell. & Ev.) comb. nov.

Phyllosticta astericola Ell. & Ev. Proc. Acad. Nat. Sci. Phila. 1893, p. 157

The pycnidia of this fungus are definitely not those typical of a species of *Phyllosticta* as they are imperfectly developed and of the type characteristic of the Leptostromataceae. J. J. Davis (Trans. Wis. Acad. Sci. Arts Lett. 26: 253. 1931) recognized that this organism is not a species of *Phyllosticta,* but failed to take action in the matter. Common on *Aster umbellatus* Mill. in Wisconsin. *Leptothyrium astericolum* seems distinct from *L. similisporum* (Ell. & Davis) Davis which usually occurs on species of *Solidago,* but which has also been found on *Aster macrophyllus* L. in Wisconsin. *L. astericolum* has shorter, much narrower, and more fusoid conidia.

FUSARIUM TRICINCTUM (Cda.) Sacc. emend. Synd. & Hansen on *Sorghum vulgare* Pers. Waushara Co., Hancock, Summer 1962. Coll. E. W. Hanson. Identification confirmed by W. C. Snyder. This fungus causes a head blight of the developing sorghum.

NOTES ON WISCONSIN PARASITIC FUNGI. XXXI

H. C. Greene
Department of Botany, University of Wisconsin, Madison

This series of notes is, unless stated otherwise, based on collections of fungi made during the season of 1964.

General Observations

Mycosphaerella sp. occurs on the bracts subtending the perigynia in the inflorescence of *Carex stricta* Lam. collected June 16 near Leland, Sauk Co. The perithecia are seriate, black, small, about 50 μ diam., the asci saccate, about 25 x 12 μ, the hyaline, uniseptate ascospores subfusoid, approx. 10 x 3 μ. Possibly parasitic.

Mycosphaerella sp. appears parasitic on leaves of *Apios tuberosa* Moench. collected August 18 at Nelson Dewey State Park near Cassville, Grant Co. The large, suborbicular, arid, brownish to grayish spots are conspicuously mottled, the mottling being due to narrow brown lines which form intricate patterns on the spots, which may involve most of a leaflet and be up to 4 cm. diam. The perithecia are hypophyllous, scattered to gregarious, subglobose, black-thick-walled, subepidermal, approx. 115–130 μ diam. The asci are subcylindric, about 38–42 x 6–7.5 μ, the ascospores narrowly fusoid, hyaline, obliquely arranged, approx. 10–11 x 2.5–2.7 μ. A few of the spots bear some empty pycnidia which are suggestive of *Phyllosticta phaseolina* Sacc., but in the absence of conidia this is uncertain.

Leptosphaeria sp., which may be parasitic, occurs on *Scirpus atrovirens* Muhl. collected near Connors Lake in the Flambeau State Forest, Sawyer Co., September 5, 1963. The perithecia are gregarious on dead leaf tips and on elongate brownish areas in the still green portions of the leaves. They are black, globose, thick-walled, about 150–160 μ diam. The asci are cylindric or curved-cylindric, short-pedicellate, (70–) 75–82 x 15–16 μ, the ascospores pallid olivaceous, subfusoid, 4-septate, often constricted at the septa, 38–42 x 5.5–6.5 μ.

Calicium (Pers.) de Not. is based upon a lichen and the fungus parasitic on *Polystictus pergamenus* Fr., reported as *Calicium* *tigillare* (B. & Br.) Sacc. in these notes (Trans. Wis. Acad. Sci. Arts Lett. 41: 125. 1952), is properly designated as *Mycocalicium polyporaeum* (Nyl.) Vaino.

PUCCINIA ANGUSTATA Peck II, III occurred in a very limited infection on a small group of plants of *Scirpus cyperinus* (L.) Kunth. f. *andrewsii* (Fern.) Carp. observed near Albany, Green Co., August 8. These few plants in turn were surrounded by many plants of *Scirpus cyperinus,* all very heavily infected with the same rust, suggestive of a decided difference in susceptibility between the form and the species proper.

PUCCINIA ASPARAGI DC. I was collected on *Asparagus officinalis* L. near Cross Plains, Dane Co., June 15. Uredia and telia are of course common on asparagus, but this appears to be the first collection of aecia recorded in Wisconsin.

PUCCINIA RECONDITA Rob. ex Desm. occasionally stimulates the production of spectacular globoid to pulvinate aecial galls on the slender stems of the vine, *Clematis virginiana* L. At a location near Leland, Sauk Co., June 26, many thousands of these bright orange galls were observed, ranging in diameter from 5 mm. to 2 cm. for globoid galls, and up to 2 cm. thick by 4.5 cm. long for the pulvinate. Frequently three or four, or more, galls were crowded into the space of a few inches on a stem. Except for the very limited area of contact with the gall there is no noticeable hypertrophy of the stem.

PUCCINIA PLUMBARIA Peck III has been found on the semi-evergreen summer leaves of *Phlox divaricata* L. near Leland, Sauk Co., June 26. The systemic aecial stage is very conspicuous, being produced in early May on the leaves of the vernal flowering stems, but the telia are elusive and had been sought for several years without success.

PUCCINIA ANDROPOGONIS Schw. I occurs closely associated with *Septoria pentstemonis* Ell. & Ev. on leaves of *Pentstemon digitalis* Nutt. collected at Madison, June 18, 1963. Some of the rust sori are free of the *Septoria,* but the reverse is not true in any of the leaves in the specimen.

EXOBASIDIUM VACCINII (Fckl.) Wor., on Ericaceae, produces quite varied effects on its host plants. Hundreds of infected plants of huckleberry, *Gaylussacia baccata* (Wang.) C. Koch, observed near Leland, Sauk Co., in June, were about equally divided between large, erect, mainly healthy looking specimens with the *Exobasidium* infection localized as conspicuous "bladders" on one or a few leaves per plant, and much stunted, chlorotic, usually many-stemmed plants where the fungus appeared systemic, as the lower surfaces of many or most of the leaves were completely covered by the parasite. However, the hypertrophy characteristic of more localized infections was lacking. Perhaps plants initially lightly infected may become more heavily so over the course of several years.

PHYLLOSTICTA ANEMONICOLA Sacc. & Syd. (so cited in Ellis & Everhart's "North American Phyllostictas", although *P. anemonis* Ell. & Kell. appears to be the earlier name) seems to be based on an end-of-the-season overwintering stage of *Didymaria didyma* (Ung.) Schroet., discussed by me in my Notes 26 (Trans. Wis. Acad. Sci. Arts Lett. 49: 96. 1960). This is very commonly developed on *Anemone canadensis* L. in Wisconsin and is the basis of J. J. Davis' report of *P. anemonicola* on this host. Ellis and Everhart report the conidia of *P. anemonicola* to be 5–7 x 1.25 μ, but in my experience it is sterile and indeed an examination of the Davis specimen shows no conidia, so far as observed. The writer has, on two occasions, in mid-season, collected a well-developed, characteristic *Phyllosticta* on *Anemone cylindrica* Gray at Madison. This was tentatively, and I now believe, erroneously assigned to *P. anemonicola.* It occurs on definite arid spots on the living leaves and is quite different in appearance from the indistinct spots and closely clustered overwintering bodies of *Didymaria.* The conidia are about the length specified by Ellis and Everhart, but are somewhat wider. In August 1964, near Leland, Sauk Co., a similar well-defined *Phyllosticta* was collected on *Anemone canadensis,* where the thin-walled pycnidia are loosely gregarious on rounded, sharply delimited grayish spots, with the conidia being mostly about 5–6 x 2.5–3 μ. More material for study would be desirable.

Descriptive notes on some so far undetermined *Phyllostictae* appear below, following mention of the names of the host plants on which they occurred:

1) On *Glyceria grandis* Wats., near Leland, Sauk Co., June 16. The spots are small, oval, and ashen with narrow dark brown border, the pycnidia about 115–135 μ diam., subglobose, pallid brownish, and thin-walled, the conidia hyaline, short-cylindric, approx. 4–6 x 2–2.5 μ; 2) On *Carex blanda* Dewey, near Leland, Sauk Co., May 21, 1963. The lesions are narrowly elongate, with brownish border and ashen center, the pycnidia light brown, subglobose, about 110–130 μ diam., the conidia hyaline, ellipsoid or short-cylindric, occasionally subfusoid, 4.5–6 x 1.5–2 μ. *Phyllosticta caricis* (Fckl.) Sacc. was reported by Davis as occurring on several species of *Carex* in Wisconsin, but there are no verifying specimens in our herbarium, and if there were their identification would be uncertain as the original description is inadequate, with no measurements given; 3) On *Trillium flexipes* Raf. in association with

Gloeosporium brunneomaculatum Greene, near Leland, Sauk Co., June 16. The *Phyllosticta* is on pallid, translucent, oval spots about .5 cm. diam., of the same size and shape as the much more numerous and darker *Gloeosporium* lesions. The pycnidia are gregarious, pallid brownish, very thin-walled and collapsed, probably globose when fresh, approx. 110–135 μ diam., the conidia hyaline, short-cylindric, broadly ellipsoid, or subfusoid, about 4–5.5 x 2–2.5 μ. This is plainly not *Phyllosticta trillii* Ell. & Ev., described as having conidia 10–14 μ long; 4) On *Salix cordata* Muhl. (or perhaps a hybrid of this with *Salix interior* Rowlee), near Leland, Sauk Co., August 12. This may be referable to *Phyllosticta eminens* Greene (Trans. Wis. Acad. Sci. Arts Lett. 49: 104. 1960), as it corresponds well in spore size, but the material is less well-developed than the type; 5) On *Rosa* sp., near Pine Bluff, Dane Co., August 27. The spots are dull brown with indistinct greenish mottling, immarginate or with margin not well marked, the whole usually surrounded by a yellow halo, rounded to wedge-shaped, approx. 3 mm. to 1 cm. diam., the pycnidia few, scattered, very inconspicuous and discernible only by transmitted light, pallid brownish, thin-walled, subglobose, approx. 140–190 μ diam., the conidia hyaline, subellipsoid to cylindric, mostly biguttulate, 7–11 x 2.6–3 (–3.5) μ. Definitely not *Phyllosticta rosae* Desm. which verges on a acervular form; 6) On *Desmodium illinoense* Gray, Madison, October 9, 1963. Spots small, angular, sordid—perhaps old *Ramularia* spots—the pycnidia black, closely crowded, globose, small, about 50 μ diam., the hyaline conidia approx. 2.5–3.5 x 1.3–1.5 μ. Perhaps the precursor of a perfect stage; 7) On *Lysimachia nummularia* L., near Leland, Sauk Co., June 26. The spots are dull grayish-brown, rounded, immarginate, .2–.5 cm. diam., the pycnidia pallid brownish, translucent, scattered, subglobose, about 135–175 μ diam., the conidia hyaline, broadly ellipsoid, cylindric or subcylindric, approx. 4.5–5.5(–6.5) x 2.5–3 μ. I have not found a report of any species of *Phyllosticta* on *L. nummularia;* 8) On *Viburnum lentago* L., near Leland, Sauk Co., August 19. The spots are vinaceous-cinereous, with dark purplish border, rounded, about 4–5 mm. diam., the pycnidia epiphyllous, gregarious, sooty, subglobose, about 125 μ diam., the conidia hyaline, broadly ellipsoid, approx. 5–7.5 x 2.5–3.5 μ; 9) On *Aster puniceus* L., near Leland, Sauk Co., August 12. The spots are variegated white and brownish, orbicular, about .5–1 cm. diam., the pycnidia black, few and scattered, subglobose with a prominent ostiole delimited by a wide band of thick, dark cells, approx. 200–250 μ diam. and epiphyllous, the very numerous conidia hyaline, rod-shaped, straight or slightly curved, 4.5–7.5 x 1.3–2 μ.

PYRENOCHAETA GRAMINIS Ell. & Ev., possibly parasitic, occurs on *Muhlenbergia schreberi* Gmel. collected in October 1959 near

Cross Plains, Dane Co. This was discussed at some length, as an at that time undetermined fungus, in my Notes 26 (Trans. Wis. Acad. Sci. Arts Lett. 49: 99. 1960). The Wisconsin specimen has very long appendages, whereas Ellis and Everhart describe the appendages as being rather short, but type material, on dead leaves, is quite weathered with the appendages broken off near the fruiting bodies, which may account for the difference in described length. Microscopically the contents of the fruiting structures are identical with the conidia (or chlamydospores?) being characterized by very thick, hyaline, refractive walls. It is highly doubtful that this fungus really belongs in *Pyrenochaeta*, but for the time being it has been filed there.

ASCOCHYTA sp. occurs sparingly on large, blackish, zonate lesions, about 2–3 cm. diam., on juvenile leaves of *Populus tremuloides* Michx. collected near Leland, Sauk Co., August 24, 1963. The pycnidia are sooty yellowish-brown, subglobose, the few measured running from 95–125 μ diam. The majority of the hyaline conidia are septate, the septum not always median, mostly subcylindric to subfusoid, occasionally broadly ellipsoid, straight to slightly curved, (7–)8–9(–11) x (2.5–)3–3.2(–3.5) μ. This seems close to an undetermined *Phyllosticta* collected on *Populus grandidentata* Michx., reported on in my Notes 26 (Trans. Wis. Acad. Sci. Arts Lett. 49: 88. 1960), where the conidia ran (5.5–)6.5–10(–11) x 2–2.5(–3) μ, but which had larger pycnidia and lesions even larger and more markedly zonate.

ASCOCHYTA sp.—a rather small specimen—was collected on *Sanguinaria canadensis* L. near Leland, Sauk Co., June 16. The spots are dull purplish-brown, orbicular or oval, 1–2.5 cm. diam., subzonate. The pycnidia are subglobose, thin-walled and translucent, pallid brownish, epiphyllous, scattered to gregarious, about 135–165 μ diam., the conidia cylindric or occasionally subfusoid, hyaline, uniseptate, 7–8.5(–10) x 2.6–3 μ, smaller than those of other species reported on Papaveraceae.

ASCOCHYTA sp. occurred on *Ruellia ciliosa* Pursh in the University of Wisconsin Arboretum at Madison, July 7. The spots are small, whitish and angled, the pycnidia epiphyllous, black, subglobose, about 125 μ diam., with a wide ostiole marked by a ring of darker cells. The conidia are hyaline, cylindric, subcylindric or occasionally subfusoid, often somewhat constricted at the septum, 7.5–10(–11.5) x 2.7–3.5 μ. I have found no report of *Ascochyta* on this host.

DARLUCA FILUM (Biv.) Cast. is a hyperparasite on *Puccinia asparagi* DC. I on *Allium cepa* L. var. *viviparum* Metz. collected near Cross Plains, Dane Co., May 21. Common on uredia of this rust, but not before reported on the aecia in Wisconsin.

STAGONOSPORA sp. occurs on *Equisetum arvense* L. collected at Madison, August 3. The thin-walled pycnidia are about 175–200 μ diam., the hyaline, cylindric to subfusoid, straight or slightly curved conidia are about 17–23 x 4.5–6 μ, (2–)3–4 septate. This is quite similar to an undetermined *Stagonospora* on *Equisetum hyemale* L. reported on in my Notes 21 (Trans. Wis. Acad. Sci. Arts Lett. 44: 32. 1955).

SEPTORIA sp. on *Castilleja sessiliflora* Pursh collected August 13 at Gibraltar Rock County Park, Columbia Co., occurs on small, rounded, sunken, cinereous to brownish leaf spots, 1–2 mm. diam. The pycnidia are small, grayish-black, gregarious, globose, about 65–80 μ diam., the spores 45–60 x 1.7–2.5 μ, with occasional spores perhaps slightly longer, from almost straight to rather strongly curved, tapered more at one end than at the other. These spores are quite outside the range of an otherwise similar specimen on *Castilleja coccinea* (L.) Spreng. which had spores 15–21 x 1–1.5 μ, as reported in my Notes 28 (Trans. Wis. Acad. Sci. Arts Lett. 51: 61. 1962).

SEPTORIA sp. is present in a small specimen on *Solidago speciosa* Nutt. collected near Leland, Sauk Co., June 13. The spots are narrowly oval, tan, immarginate, about .5 cm. long. The pycnidia are pallid brownish, about 125–140 μ diam., subglobose, with a well-marked ostiole defined by a ring of darker cells. The spores are hyaline, narrowly obclavate, obtuse at one end and tapered at the other, somewhat lax and flexuous, 1–3 septate, 20–38 x 2.7–3.5 μ. This is certainly not *Septoria atropurpurea* Peck, the only species of *Septoria* reported on *Solidago speciosa* in Wisconsin, nor does it resemble any other *Septoria* on *Solidago* with which I am familiar.

Artemisia species in Europe and North America bear a confusing assemblage of pycnidial or near-pycnidial forms which have been variously referred to *Septoria* or to *Cylindrosporium*. *Septoria artemisiae* Pass. was described as occurring on small, discoid spots, with the spores continuous, 30–33 x 1.5 μ. *Cylindrosporium artemisiae* Dearn. & Barth., on the other hand, has brown, angular spots which follow the veins and become confluent, while the spores are subclavate and subflexuous, 1–5 septate, 20–50 (or longer) x 3–4 μ. Specimens in the Wisconsin Herbarium present in effect a variously labeled, but intergrading series between the two extremes, with most seeming closer to *Cylindrosporium*. *Septoria artemisiicola* J. J. Davis on *Artemisia serrata* Nutt. seems to me indistinguishable from earlier collections on the same host which he labeled—in my opinion correctly—*Cylindrosporium artemisiae*. In a recent collection on *Artemisia serrata* made near Arena, Iowa Co., the fruiting structures, though rather widely ostiolate, seem referable to *Septoria* and they are borne on small, discoid brown spots about 1.5–3 mm. diam. The spores, however, are intermediate in character, although the specimen seems closest to *Septoria artemisiae* Pass., under which name it is provisionally filed.

COLLETOTRICHUM TYPHAE Greene (Trans. Wis. Acad. Sci. Arts Lett. 44: 41. 1956) is the subject of an article in Trans. Brit. Mycol. Soc. 46(3): 459. 1963 by Sutton and Sellar. The authors confirm that British material corresponds well with the Wisconsin type specimen and present the results of a cultural study as well as a study of conidial germination, in connection with which they find appressoria produced.

COLLETOTRICHUM sp., which may have developed parasitically, occurs on still living, but somewhat passé, leaves of *Anemonella thalictroides* (L.) Spach. collected near Leland, Sauk Co., July 2. The acervuli are scattered or subseriate, mostly epiphyllous, on indeterminate dull green areas. The setae are dark purplish-brown, somewhat lax and diverging, scattered in the acervulus, from about 75–200 x 4.5–5 μ, paler toward the tapered tip, the longer ones septate. The falcate conidia are of the usual *Colletotrichum* type, hyaline, about 20–23 x 3.5–4 μ. The acervuli on the leaves are quite small, but a few which occur on the old flower pedicels are larger.

AMPHICHAETA ROSICOLA Greene (Trans. Wis. Acad. Sci. Arts Lett. 47: 127. 1958) and *Monochaetia discosioides* (Ell. & Ev.) Sacc. are relegated to synonomy under the name *Seimatosporium discosioides* (Ell. & Ev.) Shoemaker by Shoemaker (Can. Jour. Bot. 42: 415. 1964).

SARCINELLA HETEROSPORA Sacc. is the name assigned, probably correctly, to a more or less superficial fungus which occurs in Wisconsin on species of *Cornus*, notably *C. femina* Mill. and *C. stolonifera* Michx. In earlier records a fungus which may be parasitic and which occurs with considerable regularity on *Corylus americana* Walt. has also been labeled *Sarcinella heterospora*, probably incorrectly. This fungus, which is strictly epiphyllous, forms small, flat, subcircular, loosely organized black colonies, about .3–.6 cm. diam. These colonies are very conspicuous and quite sharply defined and do not appear to have developed on insect droppings. They are, however, so far as can be judged from leaf sections, superficial and extra-cuticular. If there is any connection it is tenuous indeed. The component creeping hyphae are blackish-brown and multiseptate. Produced laterally on some of these hyphae are globose, grayish-black chlamydospores which are single-celled and become thicker-walled as the season progresses, but do not ordinarily become muriform.

CERCOSPORA sp., which seems quite distinctive and does not correspond with any of the species on *Ribes* mentioned in Chupp's monograph, occurs on *Ribes hirtellum* Michx., collected near Leland, Sauk Co., August 4. Unfortunately most of the material is not well matured, so the specimen is inadequate for formal descriptive purposes. The fungus is epiphyllous and subcuticular on tiny, cinereous, purple-bordered spots about 1–2 mm. diam. Very heavy blackish-brown stromata are produced, running from 40–80 μ wide by 90–110 μ high, from which the fascicled and somewhat spreading conidiophores develop. They are clear brown, becoming paler toward the tip, mildly geniculate with the geniculations widely spaced, truncate with prominent spore scar, and mostly not narrowed at tip, several-septate, approx. 100–140 x 3.5–5 μ. The conidia are hyaline, multiseptate, from very slender long-obclavate to almost acicular, truncate at base with prominent scar, 80–200 x 3–4 μ at base, 2 μ or less at tip, and strongly tapered for a long distance back from the tip.

Arabis glabra (L.) Bernh. collected near Oxbow, Sawyer Co., July 22, has conspicuous black incrustations on the still green stems and siliques caused by a non-fruiting fungus composed of very numerous subapplanate, rounded bodies, about 50–60 μ diam., with thick-walled cells, and which tend to be connected with one another by wefts of the same sort of tissue. Scarcely determinable, but plainly parasitic.

Gaultheria procumbens L., collected at the University of Wisconsin Finnerud Forest Preserve near Minocqua, Oneida Co., July 27, bears most conspicuous, epiphyllous, large gray and dark brown lesions of a "frog-eye" type. The same pattern occurs on the reverse, but is less marked. On the reverse of the lesions occur numerous, more or less superficial and indeterminate, black fungus bodies which internally are composed of a mass of delicate subhyaline mycelium from which are produced hyaline microconidia approx. 3–4 x 1–1.5 μ. Perhaps parasitic. At any rate, the structures mentioned are so uniformly present that it seems there must be some connection with the spot production.

ADDITIONAL HOSTS

The following hosts have not been previously recorded as bearing the fungi mentioned in Wisconsin.

MICROSPHAERA ALNI (Wallr.) Wint. on *Cornus rugosa* Lam. Columbia Co., Gibraltar Rock County Park, August 13. The fungus affected the outermost twigs and leaves, resulting in extra long internodes and small, poorly developed leaves.

PHYLLACTINIA CORYLEA (Pers.) Karst. on *Crataegus macrantha* Lodd. (cult.) Dane Co., Madison, September 11.

Powdery mildews, undetermined as to species, have been collected on 1) *Apios tuberosa* Moench. Iowa Co., Gov. Dodge State Park, September 12; and 2) *Cacalia muhlenbergii* (Sch. Bip.) Fern. Sauk Co., near Leland, August 19.

MAMIANA FIMBRIATA (Pers. ex Fr.) Ces. & DeNot. on *Ostrya virginiana* (Mill.) K. Koch. Sauk Co., near Leland, July 27, 1963.

VENTURIA SPOROBOLI H. C. Greene on *Oryzopsis asperifolia* Michx. Sawyer Co., Flambeau State Forest near Oxbow, July 22. In addition to species of *Sporobolus* this fungus has also been found on *Andropogon scoparius* Swall. It seems noteworthy that all the so far recorded hosts are dry-leaved xerophytes with close ribbing. The perithecia are developed between the ribs.

OPHIODOTHIS HAYDENI (B. & C.) Sacc. on *Aster puniceus* L., Sauk Co., near Leland, June 16.

MELAMPSORA PARADOXA Diet. & Holw. II, III on *Salix serissima* (Bailey) Fern. Dane Co., Madison, August 3.

PUCCINIA DIOICAE P. Magn. has been noted on these additional *Carex* species: 1) II, III on *Carex gravida* Bailey. Iowa Co., SW of Dodgeville, July 22, 1956. Coll. H. H. Iltis. This seemed atypical and a specimen was submitted to G. B. Cummins who states that it appears to be *Puccinia vulpinoidis* Diet. & Holw. (Bot. Gaz. 19: 304. 1894), described as occurring on the closely related *Carex vulpinoidea* Michx. and evidently set aside principally because of its punctate to elliptic, long-covered telia. Arthur relegated *P. vulpinoidis* to synonymy. A check of specimens on *Carex vulpinoidea* in the University of Wisconsin Herbarium shows some which have characters similar to those of the specimen on *C. gravida,* but others are quite typical *P. dioicae.* 2) ii, III on *Carex lasiocarpa* Ehrh. Waushara Co., near Wautoma, September 21, 1963. Coll. H. H. Iltis. As far as one can judge from the descriptions the principal microscopic difference between *Puccinia minutissima* Arth., previously reported on *C. lasiocarpa* from Wisconsin, and *P. dioicae* is in the short, colored teliospore pedicels in *P. minutissima* and long, colorless pedicels in *P. dioicae.* 3) II, III on *C. tenera* Dewey. Dane Co., Madison, July 6, 1960. 4) II on *C. blanda* Dewey. Sauk Co., near Leland, June 16. 5) ii, III on *C. woodii* Dewey. Vernon Co., Wildcat Mt. State Park, May 14, 1960. Coll. T. G. Hartley. On a phanerogamic specimen on overwintered leaves still attached to the plant of the current season.

PUCCINIA TUMIDIPES Peck I (uredinoid) on *Lycium chinense* Mill. Milwaukee Co., Milwaukee, May 26. Coll. & det. J. W. Baxter.

SCHIZONELLIA MELANOGRAMMA (DC.) Schroet. on *Carex communis* Bailey. Door Co., Jacksonport, June 24, 1952. Coll. R. T. Ward.

CERATOBASIDIUM ANCEPS (Bres. & Syd.) Jacks. on seedling of *Ulmus americana* L. Sawyer Co., Flambeau State Forest near Oxbow, July 22.

PELLICULARIA FILAMENTOSA (Pat.) Rogers on *Convolvulus spithamaeus* L. Sawyer Co., Flambeau State Forest near Oxbow, July 23.

PHYLLOSTICTA NEBULOSA Sacc. on *Lychnis viscaria* L. (cult.). Dane Co., Madison, July 10.

PHYLLOSTICTA DEARNESSII Sacc. on *Rubus allegheniensis* Porter. Dane Co., near Verona, September 14.

PHYLLOSTICTA PHASEOLINA Sacc. on *Amphicarpa bracteata* (L.) Fern. Sauk Co., near Leland, June 26. Also two specimens from Gov. Dodge State Park, Iowa Co., September 12. Reported with some reservations, as in the field this was strikingly similar in gross appearance to the infection produced by an undetermined species of *Ascochyta* on the same host at the Leland station in 1962 (Trans. Wis. Acad. Sci. Arts Lett. 52: 236. 1963). Both the lesions and the pycnidia are highly translucent, unlike most specimens I have seen assigned to *P. phaseolina,* but this may be a matter of the host species, or of the condition of the host leaves at the time of infection. Adjacent to one of the specimens from Gov. Dodge Park was very similar material on *Apios tuberosa* Moench. Earlier Wisconsin specimens on *Apios* assigned to *P. phaseolina* tend to have lesions opaque and pycnidia somewhat darker and thicker-walled. However, in all these specimens the conidia are very similar and in the range of *P. phaseolina* as described.

PHYLLOSTICTA DECIDUA Ell. & Kell. on *Fraxinus pennsylvanica* Marsh. Dane Co., Madison, July 17.

PHYLLOSTICTA CIRSII Desm. on *Cirsium muticum* Michx. Dane Co., Madison, August 3. The conidia are slightly smaller than the 5–7 x 2.5–3 μ of the description, but otherwise the specimen corresponds.

PIGGOTIA NEGUNDINIS Ell. & Dearn. on *Acer negundo* L. Dane Co., Madison, September 28, 1959. There are other earlier specimens from Dane and Vernon cos., but there seems to be no previous report in these notes.

CONIOTHYRIUM FUCKELII Sacc. on *Rubus occidentalis* L. Iowa Co., Gov. Dodge State Park, September 12. The fungus appears definitely parasitic and there is no sign of any preceding infection.

ASCOCHYTA POLYGONICOLA Kab. & Bub. on *Polygonum sagittatum* L. Iowa Co., Tower Hill State Park, September 17. Very similar to a collection made by J. J. Davis on the closely related *Polygonum arifolium* L. Many of the conidia exceed somewhat the 12μ maximum length of the description and many are continuous, but in other respects there is close correspondence.

ASCOCHYTA COMPOSITARUM J. J. Davis on *Parthenium integrifolium* L. Lafayette Co., near Darlington at Red Rock, August 26. On *Cacalia muhlenbergii* (Sch. Bip.) Fern. Sauk Co., near Leland, August 19. The best matured conidia are about 8–10 x 3–3.5 μ, making this one of the smaller-spored examples of a species that, in effect, may be considered an intergrading series of very closely related forms. Also on *Cacalia suaveolens* L. Same location and date. On this host the conidia are about the same size as in the specimen on *C. muhlenbergii.*

DARLUCA FILUM (Biv.) Cast. on *Puccinia minutissima* Arth. on *Carex lasiocarpa* Ehrh. Rusk Co., near Ladysmith, September 8, 1959. Coll. H. H. Iltis. On *Puccinia tumidipes* Peck on *Lycium halimifolium* Mill. Milwaukee Co., Milwaukee, November 18, 1963. Coll. J. W. Baxter.

STAGONOSPORA APOCYNI (Peck) Davis on *Apocynum sibiricum* Jacq., Iowa Co., near Blue Mounds, September 11. In earlier Wisconsin collections *A. sibiricum* was not differentiated from *A. cannabinum* L.

STAGONOSPORA ASTERICOLA (Davis) Greene *(Asteromella astericola* Davis) on *Aster paniculatus* Lam. Sauk Co., near Leland, August 12. With its clustered, more or less superficial pycnidia, reminiscent of *Rosenscheldia heliopsidis* (Schw.) Theiss. & Syd., this species does not well fit the ordinary conception of *Stagonospora.* It was placed there mainly on the basis of spore morphology and it may be that further knowledge will require its removal from *Stagonospora.*

SEPTORIA PUNCTOIDEA Karst. on *Carex intumescens* Rudge. Sawyer Co., Flambeau State Forest near Oxbow, July 21. In this specimen the spores are quite short, not more than 10 μ, the small, tan, red-bordered, elliptic spots very sharply defined.

SEPTORIA NEMATOSPORA J. J. Davis on *Carex emmonsii* Dewey. Jackson Co., near Millston, June 25, 1960. Coll. T. G. Hartley.

SEPTORIA CARICINELLA Sacc. & Roum. on *Carex communis* Bailey. Florence Co., Purdue University Forestry Camp, T39N R15E S12, June 14, 1959. Coll. H. H. Iltis. On *C. emmonsii* Dewey, Portage Co., Coddington, May 27, 1956. Coll. H. H. Iltis. On *C. umbellata*

Schkuhr. var. *tonsa* Fern., Juneau Co., Lyndon Twp., May 10, 1958. Coll. T. G. Hartley. On *C. tuckermani* Boott. Sawyer Co., Flambeau State Forest near Oxbow, July 26, 1964.

SEPTORIA CRATAEGI Kickx. on *Crataegus macrantha* Lodd. (cult.) Dane Co., Madison, September 11.

SEPTORIA VIOLAE West. on *Viola renifolia* Gray. Sawyer Co., Flambeau State Forest near Oxbow, July 23.

SEPTORIA GAURINA Ell. & Kell. on *Oenothera biennis* L. Sauk Co., near Leland, August 12. This is a very robust specimen, with the multiseptate spores measuring up to 95 x 3.5 μ and the epiphyllous pycnidia up to 200 μ diam. The host plant was growing in a rich stream bottom and was itself exceptionally large and lush.

SEPTORIA GAILLARDIAE Ell. & Ev. on *Gaillardia aristata* Pursh (cult.). Dane Co., Madison, August 15.

SEPTORIA ATROPURPUREA Peck on *Aster lindleyanus* T. & G. Sawyer Co., Flambeau State Forest near Oxbow, July 23.

LEPTOTHYRIUM SIMILISPORUM (Ell. & Davis) Davis on *Solidago uliginosa* Nutt. Dane Co., Madison, August 3.

HAINESIA LYTHRI (Desm.) Hoehn. on *Cornus canadensis* L. Sawyer Co., Flambeau State Forest near Oxbow, July 24. On *Lysimachia nummularia* L. Sauk Co., near Leland, June 26.

COLLETOTRICHUM MADISONENSIS H. C. Greene on *Carex lupulina* Muhl. Iowa Co., Tower Hill State Park, September 17.

COLLETOTRICHUM LILIACEORUM (Schw.) Davis on *Maianthemum canadense* Desf. Sawyer Co., Flambeau State Forest near Oxbow, July 21. On well-defined spots, but perhaps doubtfully parasitic.

COLLETOTRICHUM LUCIDAE H. C. Greene on *Salix pyrifolia* Anders. (*S. balsamifera* Barratt). Sawyer Co., Flambeau State Forest near Oxbow, July 22. On this host the fungus does not produce the conspicuous, large, zonate lesions that characterize it on *Salix lucida,* but it corresponds very closely microscopically.

COLLETOTRICHUM VIOLAE-ROTUNDIFOLIAE (Sacc.) House on *Viola renifolia* Gray. Sawyer Co., Flambeau State Forest near Oxbow, July 23.

ENTOMOSPORIUM MACULATUM Lev. on *Amelanchier amabilis* Wieg. (cult.). Dane Co., Madison, September 11.

CYLINDOSPORIUM FILIPENDULAE Thum. on *Spiraea menziesii* Hook. (cult.). Dane Co., Madison, September 14.

CYLINDROSPORIUM SPIRAEICOLA Ell. & Ev. on *Spiraea douglassii* Hook. (cult.) Dane Co., Madison, September 14.

BOTRYTIS CINEREA Pers. ex Fr. on *Pelargonium "domesticum"* (cult.) Dane Co., Madison, September 25. The fungus is on sharply defined spots and appears strongly parasitic.

RAMULARIA CANADENSIS Ell. & Ev. on *Carex lanuginosa* Michx. Columbia Co., Gibraltar Rock County Park, August 13.

CERCOSPORELLA CANA Sacc. var. GRACILIS J. J. Davis on *Aster lucidulus* (Gray) Wieg. Sauk Co., near Leland, August 4. That this is really closely related to *C. cana,* which occurs on species of *Erigeron,* may be questionable, but it does seem to be a well-characterized form.

CERCOSPORA BOUTELOUAE Chupp & Greene on *Bouteloua hirsuta* Lag. Columbia Co., Gibraltar Rock County Park, August 13. The conidia are subcylindric and rather short, about 35–50 μ, but were developed on a host plant growing under extreme xeric conditions in a period of subnormal moisture.

CERCOSPORA CARICIS Oud. on *Carex deflexa* Hornem. Lincoln Co., Doering, Schley Twp., May 6, 1952. Coll. F. C. Seymour. On a phanerogamic specimen in the University of Wisconsin Herbarium.

CERCOSPORA TENUIS Peck on *Galium obtusum* Bigel. Dane Co., Madison, July 10. Abundant on this host in the Univ. Wis. Arboretum. Apparently the first Wisconsin collection since before 1900 when J. J. Davis reported it (as *C. punctoidea* Ell. & Holw.) on *Galium trifidum* L. Examination of the Davis specimens indicates that the host was incorrectly determined and may have been *G. obtusum.*

TUBERCULINA PERSICINA (Ditm.) Sacc. on *Puccinia asparagi* DC. I on *Allium cepa* L. var. *viviparum* Metz. Dane Co., near Cross Plains, July 5.

ADDITIONAL SPECIES

The fungi mentioned have not been previously reported as occurring in Wisconsin.

PERONOSPORA LAMII A. Braun on *Lamium amplexicaule* L. Dane Co., Madison, May 11.

Phyllosticta dryopteridis sp. nov.

Maculis rufo-brunneis, conspicuis, immarginatis, in pinnulis totis implicatis unis vel pluribus; pycnidiis inconspicuis, sparsis, fusco-brunneis, muris tenuibus, subglobosis, ca. 75–100 μ diam.; conidiis hyalinis, brevo-cylindraceis, obtusis, 3.5–5.5 x 1.3–1.5 μ.

Spots reddish-brown, conspicuous, immarginate and involving one or more entire pinnules; pycnidia inconspicuous, scattered, sooty brownish, thin-walled, subglobose, approx. 75–100 μ diam.; conidia hyaline, short-cylindric and obtuse, 3.5–5.5 x 1.3–1.5 μ.

On living fronds of *Dryopteris thelypteris* (L.) A. Gray. In tamarack swamp on property of the Wisconsin Society for Ornithology near Leland, Sauk County, Wisconsin, U. S. A., August 4, 1964.

I have found no report of *Phyllosticta* on any species of *Dryopteris.*

Phyllosticta smilacinae-trifoliae sp. nov.

Maculis magnis conspicuisque, brunneo-cinereis vel sordido-brunneis, marginibus fuscis, angustis, vel immarginatis prope, .8–3 cm. longis x .3–1.5 cm. latis, anguste ellipticis vel orbicularibus, saepe confluentibus; pycnidiis sparsis vel gregariis, pallido-brunneis, muris tenuibus, subglobosis, magnis, ca. (120–) 140–175 (–190) μ; conidiis hyalinis, numerosissimis, parvis, ca. 3–5 x 1–1.5 μ.

Spots large and conspicuous, brownish-cinereous to sordid brownish, margins dark brown, narrow, or spots without well-defined margins, .8–3 cm. long by .3–1.5 cm. wide, in shape from narrowly elliptic to broadly orbicular, often confluent; pycnidia scattered to gregarious, pallid brownish, thin-walled, subglobose, large, approx. (120–) 140–175 (–190) μ; conidia hyaline, very numerous, small, approx. 3–5 x 1–1.5 μ.

On living leaves of *Smilacina trifolia* (L.) Desf. Flambeau State Forest near Oxbow, Sawyer County, Wisconsin, U. S. A., July 24, 1964. Another specimen was collected a few days later near Minocqua, Oneida Co.

On the basis of conidial size and leaf spotting this seems closest to *Phyllosticta smilacinae* Solheim (Mycologia 41: 627. 1949), but the pycnidial diameter, 50–85 μ in *P. smilacinae,* does not even approach that of the Wisconsin fungus.

PHYLLOSTICTA CORNI-CANADENSIS Dearn. & Bisby on *Cornus canadensis* L. Sawyer Co., Flambeau State Forest near Oxbow, July 24. The conidia, according to the description (Fungi of Manitoba, p. 138), are only .75 μ wide, whereas I find those of my specimen to be about 1.3–1.5 μ wide. However, conidia as minute as these are not easy to measure precisely with ordinary equipment and the difference may be in part at least due to the observers making the measurements. I find the length to be 3–5 μ, whereas Dearness and Bisby specify 3.5–5 μ. In other respects my specimen corresponds quite well with the description. The spots, though small, are very noticeable because of the dark margin surrounded by a purplish halo. The sooty pycnidia, about 150 μ diam., stand out sharply on the small cinereous spots.

Phyllosticta wisconsinensis sp. nov

Maculis conspicuis, fusoideis vel orbicularibus, magnis, ca. .5–2 cm. diam., subzonatis, rubiginosis cum halis purpureis; pycnidiis fuscis, epiphyllis, globosis vel subglobosis, ostiolis latis, erumpentibus, sparsis, ca. (125–)150–200(–250) μ diam.; conidiis hyalinis, angusto-cylindraceis, rectis vel curvis leniter, biguttulatis plerumque, (8.5—)10—13(—16) x 2.5—3.5 μ; conidiophorius subconicis, brevibus, ca. 8–10 x 2.5 μ.

Spots conspicuous, fusoid or orbicular, large, about .5–2 cm. diam., subzonate, rusty reddish with a purplish halo; pycnidia sooty black, epiphyllous, globose or subglobose, wide ostioles, erumpent, scattered, approx. (125–)150–200(–250) μ diam.; conidia hyaline, narrowly cylindric, straight or slightly curved, mostly biguttulate, (8.5–)10–13(–16) x 2.5–3.5 μ; conidiophores subconic, short, about 8–10 x 2.5 μ.

On living leaves of *Helianthus occidentalis* Ridd. Tower Hill State Park, Iowa County, Wisconsin, U. S. A., September 17, 1964. A small specimen of this fungus was collected on the same host in Dane Co. near Sauk City, Wis. in 1945 and was mentioned briefly in my Notes 11 (Amer. Midl. Nat. 41: 715. 1949).

The erumpent pycnidia tend to collapse upon drying. In section their inner walls are seen to be completely covered with the conidiophore layer. The wide ostioles are delimited by a narrow band of blackish cells. Two or three conidia with a median septum were observed in the type specimen, but there is no evidence that this is the usual thing and the organism seems best referred to *Phyllosticta.*

Pyrenochaeta setariae sp. nov.

Maculis angustis, ca. 2–5 mm. longis, saepe confluentibus, pallido-brunneis, marginibus angustis, fuscis; pycnidiis in seriebus, fusco-brunneis, muris tenuibus, subglobosis, ca. 100–150 μ diam.; setis fusco-olivaceis constanter, flexuosis, muris tenuibus, continuis, attenuatis tantum moderate, apicibus subobtusis, plerumque in ostiolis, 2–10, divergentibus, ca. 15–75 x 3–5 μ; conidiis hyalinis, biguttulatis, ellipsoideis late, subcylindraceis vel subfusoideis, 6–10 x 2.5–4 μ.

Spots narrow, approx. 2–5 mm. long, often confluent, pale brownish with narrow darker border; pycnidia seriate, sooty brownish, thin-walled, subglobose, approx. 100–150 μ diam.; setae uniform sooty-olivaceous, flexuous, thin-walled, continuous, only moderately tapered with tips subobtuse, mostly around the ostiole, 2–10, divergent, about 15–75 x 3–5 μ; conidia hyaline, biguttulate, broadly ellipsoid, subcylindric, or subfusoid, 6–10 x 2.5–4 μ.

On living leaves of *Setaria lutescens* (Weigel) T. F. Hubb. University of Wisconsin Observatory property near Pine Bluff, Dane County, Wisconsin U. S. A., September 5, 1964.

This is quite different from *Pyrenochaeta terrestris* (Hansen) Gorenz, Walker & Larson, reported on *Setaria lutescens* and other grasses. That species has pycnidia which are more or less rostrate, black, 120–450 μ diam., the setae light to dark brown, 1–5 septate, and the conidia 3.7–5.8 x 1.8–2.4 μ. *Pyrenochaeta setariae* seems to fall within the allowable generic limits of *Pyrenochaeta,* which limits, as treated by various authors are rather vague and elastic. As the infection progresses the leaves infected first die back completely. A few of the pycnidia have no setae, but the great majority do. The setae are not obvious from a hand lens examination as they are widely spreading and not stiffly erect.

Phomopsis cuscutae sp. nov.

Maculis nullis; pycnidiis fusco-brunneis, lenticularibus applanatisque nonnihil, ca. 200–280 μ longis x 125–180 μ latis, ostiolis latis, ca. 35–50 μ diam.; Phoma-conidiis anguste fusiformibus plusve minusve, hyalinis, guttulatis, (10–) 12–16 (–18) x 2.5–3.8 μ, scolecosporis hyalinis, continuis, flexuosis, acuminatis in extremis aliis, subobtusis in aliis, (15–) 17–20 (–24) x 1–1.5 μ.

Spots none; pycnidia sooty brownish, somewhat lenticular and flattened, approx. 200–280 μ long by 125–180 μ wide; ostioles wide, approx. 35–50 μ diam.; Phoma-type conidia more or less narrowly fusiform, hyaline, guttulate, (10–) 12–16 (–18) x 2.5–3.8 μ, scolecospores hyaline, continuous, flexuous, acuminate at one end, subobtuse at the other, (15–) 17–20 (–24) x 1–1.5 μ.

On living stems of *Cuscuta gronovii* Willd. University of Wisconsin Arboretum at Madison, Dane County, Wisconsin, U. S. A., September 1, 1964.

A small collection of this species was made at Madison in 1952 and reported on in my Notes 19 (Amer. Midl. Nat. 50: 501. 1953) as *Phoma* sp., with the suggestion that the fungus might be a *Phomopsis,* although scolecospores were not seen in the 1952 specimen. The ostioles are delimited by a wide band of blackish, thick-walled cells.

Ascochyta pellucida Bubak on *Calla palustris* L. Oneida Co., Univ. Wis. Finnerud Forest Preserve near Minocqua, July 27. Referred here with some question, as none of the conidia observed were septate. However, the large diffuse lesions are of the type characteristically produced by species of *Ascochyta,* and in dimensions of pycnidia and conidia the Wisconsin specimen conforms closely with Bubak's description. A conspicuous and destructive parasite which was affecting hundreds of plants.

Ascochyta babylonica sp. nov.

Maculis circulis vel orbicularibus, vel elongatis varie, sordido-brunneis, marginibus angustis, fuscis, ca. 2–6 mm. diam.; pycnidiis epiphyllis, gregariis, fusco-brunneis, subglobosis, ca. 100–150 μ diam.; conidiis hyalinis, subcylindraceis, rectis vel curvis leniter, subfusoideis aliquoties, septis medietatibus, non constrictis, 6–8(–10) x 2.6–3 μ.

Spots rounded, orbicular, or variously elongate, sordid brownish with a narrow dark brown border, approx. 2–6 mm. diam.; pycnidia epiphyllous, gregarious, sooty brown, subglobose, about 100–150 μ diam.; conidia hyaline, subcylindric, straight or slightly curved, occasionally subfusoid, septum median, not constricted at septum, 6–8(–10) x 2.6–3 μ.

On living leaves of *Salix babylonica* L. x *Salix fragilis* L. On Joseph W. Vilas property, Sect. 17, Ridgeway Township, Iowa County, Wisconsin, U. S. A., August 5, 1964.

There is usually only a single spot per leaf and the infection was confined to two trees. Of the various species of *Ascochyta* described as occurring on willow this seems closest to *A. translucens* Kab. & Bub., but differs in having dull brown, fully opaque spots, as opposed to wide grayish spots which are alutaceous in the centers and later become arid and shredded. The pycnidia are also somewhat larger in *A. babylonica*.

ASCOCHYTA VULGARIS (Desm.) Kab. & Bub. on *Lonicera prolifera* (Kirchn.) Rehder. Sauk Co., near Leland, June 16. This is a good match for Kabat & Bubak's *Fungi imperfecti exsiccati* No. 212 on *Lonicera xylosteum* L. In both specimens septate conidia are in the minority, but such as occur are well-marked and distinct. The authors give the conidial size as 6–14 x 2.5–4 μ. In the Wisconsin specimen septate conidia are mostly about 10 x 3 μ.

Camarosporium pteridis sp. nov.

Maculis variis, angulosis, obscuris, purpureo-brunneis, vel sordido-brunneis; pycnidiis epiphyllis, sparsis vel gregariis, immersis, nigris, muris crassis, subglobosis, magnis, ca. 250–350 μ diam.; conidiis dilute virido-olivaceis, formis variis, oblongis, subcylindraceis, vel late ovatis, muriformibus, septis dispositis variis, 33—45 x 15–20(–25) μ.

Spots variable, angled, dull purplish-brown, becoming sordid brownish; pycnidia epiphyllous, scattered to gregarious, deeply seated, blackish, thick-walled, subglobose, large, approx. 250–350 μ diam.; conidia dilute greenish-olivaceous, variously shaped, oblong, subcylindric, or broadly ovate, muriform, arrangement of septa variable, 33–45 x 15–20 (–25) μ.

On living leaves of *Pteridium aquilinum* (L.) Kuhn. var. *latiusculum* (Desv.) Underw. ex Heller. Base of "Hemlock Draw", Sect. 7, Honey Creek Twp., Sauk County, Wisconsin, U. S. A., August 31, 1964.

This is a destructive parasite which was first noted in small amount in 1963 and which, in 1964, had devastated a large patch of bracken, with entire fronds being killed back in many instances. The type locality is at the base of a gorge from which cool, moist air drains nightly and where sunlight is limited to a few hours daily, providing almost continually damp conditions. When collected the specimen material was wet and the conidia were being extruded in large cirrhi.

SEPTORIA TENELLA Cooke & Ell. on *Festuca elatior L.* Sauk Co., near Leland, June 16.

SPHACELOMA ROSARUM (Pass.) Jenkins on *Rosa* sp. (cult.). Dane Co., Madison, July 10.

Cladosporium brachyelytri sp. nov.

Maculis rufo-brunneis, anguste oblongatis, parvis, ca. 1–2 x .2–.3 mm. plerumque, saepe multis; conidiis levibus, subhyalinis vel flavidis, 1-septatis, catenulatis, cicitracibus prominentibus, subcylindraceis vel subfusoideis, (17–)20–24(–27) x 3.5–5 μ; conidiophoris claro-brunneis, geniculatis forte plusve minusve, solitariis vel paribus divergentibus, aliquoties in fasciis tribus vel pluribus, simplicibus plerumque, apicibus raro bifurcatis, saepe denticulatis, septatis, ca. 50–115 x 4–5 μ.

Lesions reddish-brown, narrowly oblong, small, mostly about 1–2 x .2–.3 mm., often many per leaf; conidia smooth, subhyaline to yellowish, 1-septate, catenulate, spore scars prominent, subcylindric or subfusoid, (17—)20—24(—27) x 3.5—5μ; conidiophores clear brown, more or less strongly geniculate, arising from the abaxial leaf surface singly or in diverging pairs, or less commonly in tufts of three or more, usually simple, rarely forked near apex, often somewhat denticulate, several-septate, approx. 50–115 x 4–5 μ.

On living leaves of *Brachyelytrum erectum* (Schreb.) Beauv. Flambeau State Forest near Oxbow, Sawyer County, Wisconsin, U. S. A., July 22, 1964.

Sprague, in his "Diseases of Cereals and Grasses in North America", lists no truly parasitic *Cladosporium,* but the very sharply defined and limited lesions of *C. brachyelytri* indicate a high degree of parasitism. Many plants in a limited area were infected.

PRELIMINARY REPORTS ON THE FLORA OF WISCONSIN. NO. 51. SALICACEAE. THE GENUS *SALIX* — THE WILLOWS*

George W. Argus
University of Saskatchewan, Saskatoon, Canada
With Illustrations by
F. Glenn Goff
University of Wisconsin Arboretum, Madison

The species of *Salix* occurring in Wisconsin have been treated in several regional floras and floras of nearby states, as well as in a preliminary report on the Salicaceae of Wisconsin by D. F. Costello (1935). The purpose of the present study is to elaborate on, to augment, and in some instances, to correct these former treatments by providing more detailed descriptions than can be presented in a flora; discussing some problems in variation; discussing some nomenclatural problems; and pointing out species relationships and the diagnostic features of closely related species. It is hoped that this study will make the species of *Salix* in Wisconsin more understandable, and encourage some much needed field study, especially of population variation and ecological modification.

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This study is based on specimens in the herbaria of the University of Wisconsin (WIS), University of Wisconsin–Milwaukee (WISM), University of Minnesota (MIN), Milwaukee Public Museum (MIL), State University of Iowa (IA) and the W. P. Fraser Herbarium, University of Saskatchewan (SASK). About 3,500 specimens were studied. Descriptions of the species are based primarily on specimens from Wisconsin. However, several species are not sufficiently represented from this area, and in these cases type descriptions and descriptions in floras were referred to in writing the descriptions. At the end of each description the number of specimens on which the description was based is noted. The species are arranged in a phylogenetic order. Only the important synonymy is given for each species, followed by a description, a brief sketch of its ecology, and pertinent discussions of variation, nomenclature, related species, etc.

Illustrations of leaves and, for some species, pistillate aments are included. The leaf and ament prints were prepared by Mr. F. Glenn Goff, all other drawings and graphs were prepared by the author. Range maps are provided for each species with dots indicating the exact location of each collection and triangles indicating the presence in that particular county. Generalized phenological data are included in the lower left hand corner of each map (cf. discussions of phenology).

Three keys to the species are provided, one to each of the following groups of specimens: staminate, pistillate, and vegetative. Characteristics which are usually present in specimens in each of these categories have been used wherever possible. In some instances reproductive characteristics alone are insufficient to separate species or groups of species and in these cases vegetative characteristics are used as well. The keys must be regarded as guides and cannot replace a careful comparison of the unknown with descriptions and herbarium specimens. The best way to gain an understanding of the willows of a particular region is to study a series of representative, correctly identified specimens and to coordinate this with field study, including the tagging and successive collection of individuals. The variation in some species of *Salix* is so great that only field study can finally clarify the taxonomic units.

Although much of the variation in *Salix* is often attributed to hybridization, it is very difficult and highly subjective to identify hybrids on the basis of herbarium material alone. An understanding of the degree and importance of hybridization in North American *Salix* will only come through experimentation and not by the indiscriminate labeling of herbarium specimens as hybrids on the basis of their supposed morphological intermediacy. Very few of the specimens that I have examined in the course of this study could be unequivocally named as hybrids. Because of our insufficient knowledge concerning the total variation of many species it is often impossible to determine whether a particular variant is simply part of the total species variability or a hybrid. For this reason I have placed "intermediate" specimens with the species they most closely resemble rather than in hybrid categories. Those hybrids which have been recognized are discussed under the primary parent. The determination of which species can and do hybridize and the morphology and fertility of the offspring are among the most important unsolved problems in North American *Salix*.

The phenology of *Salix* in Wisconsin, with particular reference to time of flowering, is an important consideration in any study of natural hybridization. For this reason, and as an aid to collectors, the flowering time of the indigenous species was recorded (Fig. 1). The distribution maps may be consulted for additional phenological data. The staminate specimens recorded to be in "anthesis" were actively shedding pollen, and the pistillate specimens recorded as "flowering" had stigmas that were apparently receptive. The species are arranged according to their approximate order of flowering with *Salix discolor* flowering the earliest and *S. syrticola* latest. Due to variation in sample size and the influence of habitat on flowering time such a sequence of species can be only approximate. However, it does indicate that there is a sequence of flowering in *Salix* and that some species flower earlier or later than others. The genus as a whole is in full flower during the period from 6–19 May, with the season extending from 8 April to 21 July.

WILLOW TERMINOLOGY

HEIGHT OF SPECIES. Although the height of woody plants should always be noted on herbarium specimens this is rarely done. As a result the heights given for the species in this treatment are based in part on the literature and in part on my field experience with the same species in other parts of their range.

BRANCHLETS. The branchlets are the current years shoot growth. Their color and pubescence vary with stage of development and the color may change markedly in drying. In this treatment the color of branchlets applies to dry herbarium specimens.

LEAF MEASUREMENTS. Leaf length, width, and length/width are based on the largest mature leaf on a branchlet. The total variation was based on measurements of one leaf per individual from all or most of the individuals bearing mature foliage. This was done in order to have comparable measurements from leaves in the same

	April				May				June				July		
	8	15	22	29	6	13	20	27	3	10	17	24	1	8	15
Discolor	2	3	3	2	2	1	—	—							
	1	4	4	6	9	7	—	1							
Humilis		2	3	2	2	2	—	—	—						
		2	2	5	9	2	—	—	1						
Glaucophylloides		1	1	1	1	1									
		1	4	1	3	—									
Amygdaloides	1	—	2	2	3	—									
	—	—	—	—	5	2									
Rigida	—	1	—	2	—	—	—								
	1	1	1	2	9	1	1								
Candida		—	—	1	1	—	—	—							
		1	2	1	4	4	—	1							
Sericea					—										
					1										
Petiolaris		—	1	3	1	—	—	—							
		2	3	4	7	11	5	5							
Pedicellaris		1	—	1	—	2	—	1	—	—	—				
		1	—	1	3	4	—	1	5	—	2				
Bebbiana	—	—	3	5	7	6	—	1	—	—	—	—			
	1	1	1	9	12	17	7	4	4	2	2	2			
Lucida	1	—	—	—	—	7	3	2	—	—	1				
	—	—	—	—	2	2	2	—	4	—	—				
Nigra					1	2	—	—	—	1	—				
					—	4	—	3	1	1	1				
Pyrifolia					—	—	—	—	1	—	1				
					1	2	3	4	2	1	—				
Interior	1	—	—	2	3	6	4	2	3	2	—	5	1	—	2
	—	—	—	1	1	5	2	3	—	2	3	1	—	—	—
Serissima							2	2							
							—	1							
Syrticola							1	—	—	—	—				
							1	—	—	—	1				

FIGURE 1. Flowering time of *Salix* native to Wisconsin based on herbarium specimens. The species are arranged in an approximate order of flowering. The top line indicates the number of staminate specimens in anthesis and the bottom line the number of pistillate specimens in flower. The dash (—) indicates no data.

general stage of development and in the same position on the shoot. Leaves of different size or shape than given for the species can be found on almost any specimen, but the most prominent leaves, at least, will be as described (cf. Figs. 3 and 9). Petiole and stipule length are based on the same leaf.

GLAUCOUS. Leaves with a waxy bloom occurring on the under surface are termed glaucous. In some species the bloom, which can be rubbed off, is absent but the leaf is whitish beneath. This condition is apparently caused by the presence of subepidermal chambers in *Salix lucida* and its relatives, and is termed "pale".

PETIOLE GLANDULAR. In some species glands occur at the distal end of the petiole (near the base of the lamina) and on the adaxial (inner) surface. These glands may be prominent and stalked or similar to those on the leaf margin. In some species they are inconspicuous, e.g. *Salix alba,* but they can be observed under adequate magnification.

PRECOCIOUS. The aments appear before the leaves in precocious species.

COETANEOUS. The aments and leaves appear at the same time in coetaneous species.

SEROTINOUS. The aments appear after the leaves in serotinous species.

AMENT LENGTH. The length of pistillate aments is based on material in early fruit, before the seeds are shed.

REPRODUCTIVE BRANCHLET. The stalk of the inflorescence from the lowermost flower to the branch is the reproductive branchlet (Figs. 4 and 6). This structure is usually termed the "peduncle" in the literature. I have avoided the use of the term because of its inaccurate application (to be discussed in a later paper) for what appears to be not a peduncle but a branch terminated by an ament. In some species (e.g. *Salix discolor*) the reproductive branchlet is very short or absent and the ament is then described as sessile (Fig. 11).

BRACTS. The foliar structure subtending each flower is a bract (scale in some literature). The foliar structures on the reproductive branchlet are leaves although they may sometimes be bract-like.

ABAXIAL AND ADAXIAL. Dorsal and ventral. If a single gland (nectary) is present in a pistillate flower it is located adaxially, between the pedicel and the rachis. If two glands are present the second is located abaxially, between the pedicel and the bract.

COLLECTING WILLOWS

For identification purposes the ideal collection of *Salix* should include a branch bearing leaves and pistillate aments. Most species are best understood in their pistillate form and the most definitive keys are to such specimens. However, it is not always possible to collect pistillate material, nor is it always desirable. In the case of an ecologist who may be required to collect sterile material during the course of a study, it is advisable to select "typical" shoots. Adequate notes are essential if the material represents sprout shoots or if the plant is growing under extreme conditions. In general, the more the specimen diverges from the "ideal" the more copious the notes should be. In most species the staminate morphology is insufficiently known, and descriptions are based on few specimens. This general lack of staminate specimens may account, in part at least, for their limited use in keys. The most valuable staminate collections are successive collections, but material bearing leafy branchlets is often adequate.

Valuable and critical information may be obtained through successive collections. Such collections are made over a period of time (usually a single growing season) from tagged plants. Each collection in the series represents a different stage in the annual development of the individual. Successive collections are especially important in the sampling of precocious species (e.g. *Salix discolor* and *S. humilis*) which often drop their aments before the leaves are produced. Most species of *Salix* show a high degree of local population variation and an adequate description of the annual local population dynamics can only be obtained through successive local population collections. This would require the tagging and repeated collections of a large number of plants in the same population. To my knowledge, work of this type has not yet been published, although it could theoretically yield significant information.

A. KEY TO STAMINATE SPECIMENS

1. Stamens 3 or more.
    2. Staminate aments slender and loosely flowered; flowers tufted and more or less whorled along the rachis.
        3. Immature leaves narrowly lanceolate, green beneath; stipules prominent. ------------------------- 1. *S. nigra.*
        3. Immature leaves lanceolate, glaucous beneath; usually exstipulate. --------------------------- 2. *S. amygdaloides.*
    2. Staminate aments thickish and densely flowered; flowers spirally arranged.
        4. Immature leaves bearing caducous ferruginous trichomes; stipules prominently glandular. ------------ 3. *S. lucida.*

4. Immature leaves glabrous; stipules minute or absent.
   5. Staminate aments 3–3.5 cm long; indigenous species. ______________________________________4. *S. serissima.*
   5. Staminate aments 2–6 cm long; introduced species. ______________________________________5. *S. pentandra.*

1. Stamens 2.
   6. Staminate aments precocious.
      7. Staminate aments and leaves opposite or subopposite; filaments and anthers coalescent. __________22. *S. purpurea.*
      7. Staminate aments and leaves alternate; filaments and anthers distinct.
         8. Leaves finely to densely sericeous beneath, margin entire or serrate; rare species in Wisconsin.
            9. Leaf margin serrulate; blade finely sericeous, at least beneath; filaments pubescent at base; indigenous species. ____________________________18. *S. sericea.*
            9. Leaf margin entire, revolute; blade densely sericeous beneath; filaments glabrous; introduced species. ______________________________________21. *S. viminalis.*
         8. Leaves pubescent when immature, but not sericeous; common species in Wisconsin.
            10. Staminate aments 0.7–1.5 cm long. __19. *S. humilis.*
            10. Staminate aments 2–3.5 cm long. ___20. *S. discolor.*
   6. Staminate aments coetaneous or some subprecocious.
      11. Filaments pubescent.
         12. Petiole glandular at distal end; introduced trees.
            13. Branchlets tenacious and flexible. ____8. *S. alba.*
            13. Branchlets brittle at base.
               14. Leaves sericeous, margin finely serrulate; branchlets pendulous; staminate aments 3–3.5 cm long. __________________6. *S. babylonica.*
               14. Leaves glabrous or glabrate, margin coarsely serrate; branchlets not pendulous; staminate aments 3–6 cm long. __________7. *S. fragilis.*
         12. Petiole not glandular at distal end; indigenous shrubs.
            15. Bracts black __________________17. *S. petiolaris.*
            15. Bracts yellow or yellow-green.
               16. Reproductive branchlets 0.8–8 cm long; staminate aments often branched; leaves linear; margin remotely denticulate. ______________________________________9. *S. interior.*
               16. Reproductive branchlets 0.3–0.6 cm long; staminate aments unbranched; leaves not linear, margin entire to crenate._15. *S. bebbiana.*

11. Filaments glabrous.
    17. Immature leaves and branchlets dull tomentose. ---- ------------------------------------14. *S. candida.*
    17. Immature leaves and branchlets pubescent or glabrous
        18. Immature leaves thin and translucent; plants with balsam-like fragrance. ----13. *S. pyrifolia.*
        18. Leaves or plants not as above.
            19. Staminate aments few flowered, 0.5–2 cm long; bracts yellowish; leaf margin entire, revolute. ----------------16. *S. pedicellaris.*
            19. Staminate aments many flowered, 1.2–4 cm long; bracts dark brown to black; leaf margin serrate.
                20. Inner bud scale persistent at base of aments and vegetative shoots.
                    21. Immature leaves glabrous, reddish. - ------------12. *S. glaucophylloides.*
                    21. Immature leaves pubescent, sometimes reddish.
                        22. Branchlets glabrate or velutious; immature leaves pubescent, reddish, margin serrate, not prominently glandular. --10. *S. rigida.*
                        22. Branchlets grayish tomentose; immature leaves densely sericeous, margin prominently glandular; on Lake Michigan dunes, rare. ----------11. *S. syrtcicola.*
                20. Inner bud scale not persistent. -------- ---------------------17. *S. petiolaris.*

B. KEY TO PISTILLATE SPECIMENS

1. Pistils and capsules pubescent.
    2. Pistillate aments precocious.
        3. Leaves and aments opposite or subopposite. ------------ --22. *S. purpurea.*
        3. Leaves and aments alternate.
            4. Capsules subsessile, pedicels less than 1 mm long; introduced tree. --------------------------21. *S. viminalis.*
            4. Capsules pedicellate, pedicels 1–2.5 mm long; indigenous species.

5. Pistils and capsules blunt; aments 1–2.5 cm long; reproductive branchlets 2–10 mm long; leaves silvery sericeous beneath; rare in Wisconsin. _18. *S. sericea.*
5. Pistils and capsules long beaked; aments 1.5–7 cm long; reproductive branchlets absent or very short; leaves not as above; common in Wisconsin.
    6. Pistillate aments 1.5–4 cm long in fruit; styles 0.2–0.4 mm long; capsules 4–7 mm long. ____19. *S. humilis.*
    6. Pistillate aments 4–7 cm long in fruit; styles 0.5–0.8 mm long; capsules 6–11 mm long. ____20. *S. discolor.*

2. Pistillate aments coetaneous or serotinous.
    7. Pistils and capsules dull white-tomatose. __14. *S. candida.*
    7. Pistils and capsules finely sericeous or glabrescent.
        8. Reproductive branchlets 3–6.5–12.5 cm long; bracts deciduous after flowering; capsules deciduous after dehiscence. ______________________________9. *S. interior.*
        8. Reproductive branchlets 0.3–1 cm long; bracts and capsules persistent.
            9. Bracts brown, oblong; pistillate aments 1.5–3.5 cm long in fruit; leaves linear-lanceolate, serrate to serrulate, sometimes with ferruginous pubescence. ____________________________________17. *S. petiolaris.*
            9. Bracts yellowish to tawny, lanceolate; pistillate aments 3.5–6 cm long in fruit; leaves elliptic, elliptic-ovate to oblanceolate, entire or crenate, lacking ferruginous pubescence. ______________15. *S. bebbiana.*

1. Pistils and capsules glabrous.
    10. Bracts deciduous after flowering, yellowish.
        11. Leaves green or pale beneath.
            12. Leaves linear to linear-lanceolate, remotely denticulate to serrulate; upper surface of blade dull.
                13. Leaves linear, remotely denticulate; stipules small or absent; pistillate aments often branched; capsules slender, 4.5–7 mm long. ____9. *S. interior.*
                13. Leaves linear-lanceolate, often falcate, serrulate; stipules large and prominent; pistillate aments unbranched; capsules 3–4 mm long. _1 *S. nigra*
            12. Leaves lanceolate or broader, serrulate; upper surface of blade glossy, often coriaceous or subcoriaceous.

14. Immature leaves bearing caducous ferruginous trichomes; stipules prominently glandular. ____ ________________________________3. *S. lucida.*
14. Immature leaves glabrous; stipules minute or absent.
    15. Pistillate aments stout, 2–4.5 cm long; capsules 7–10 mm long; indigenous species. ___ ___________________________4. *S. serissima.*
    15. Pistillate aments slender, 3.5–6 cm long; capsules 1–5 mm long; introduced species. _ ___________________________5. *S. pentandra.*

11. Leaves glaucous beneath.
    16. Pistillate aments short and stout, 2–4.5 cm long; capsules 7–10 mm long; seeds shed late in season.__ _________________________________4. *S. serissima.*
    16. Pistillate aments short or long, but slender, 2–3.5 or 4–8 cm long; capsules 1–5 mm long.
        17. Pistillate aments loosely flowered; pedicels long, 1.5–2.5 mm long; indigenous species; leaves lanceolate to ovate-lanceolate; stipules absent or minute. __________________2. *S. amygdaloides.*
        17. Pistillate aments not as loosely flowered; pedicels short to sessile, 0.0–0.5–0.75 mm long; introduced species; leaves linear-lanceolate to lanceolate; stipules usually small and caducous.
            18. Twigs slender and pendulous, not fragile. __ ________________________6. *S. babylonica.*
            18. Twigs stout, not pendulous, fragile.
                19. Leaves sericeous, margin serrulate. ___ ________________________8. *S. alba.*
                19. Leaves glabrous, margin coarsely serrate. ___________________7. *S. fragilis.*

10. Bracts persistent, yellow to brown.
    20. Leaf margin entire, revolute; bracts sparsely pubescent. ________________________________16. *S. pedicellaris.*
    20. Leaf margin serrate to crenate; bracts pubescent to densely villous.
        21. Immature leaves translucent, glabrous or glabrescent; plant with balsam-like fragrance; pistillate aments loosely flowered; pedicels 2.5–3.5 mm long. _ ________________________________13. *S. pyrifolia.*
        21. Immature leaves opaque, glabrous to pubescent; plants lack balsam-like fragrance; pistillate aments densely flowered; pedicels 0.5–2–(2.5) mm long.

22. Immature leaves white-pubescent or densely sericeous, green beneath or thinly glaucous in some plants.
    23. Leaves oblong-lanceolate, apex gradually acuminate or attenulate, margin serrulate; immature leaves reddish-purple; capsules 4–5 mm long. ---------------10. *S. rigida.*
    23. Leaves oblong-ovate, apex acute or acuminate, margin glandular serrate, teeth often prolonged; capsules 5–7 mm long. ---------------------------------11. *S. syrticola.*
22. Immature leaves glabrous, sometimes with caducous ferruginous trichomes, blade thickly glaucous beneath, often drying black. -----------------------------12. *S. glaucophylloides.*

C. KEY TO SPECIMENS WITH MATURE FOLIAGE

1. Leaves opposite or subopposite. ---------------22. *S. purpurea.*
1. Leaves alternate.
   2. Leaves glabrous or glabrate on both sides, midrib and petiole at times pubescent.
      3. Petiole glandular at distal end.
         4. Leaves glaucous or whitish beneath.
            5. Immature leaves thin and translucent, glabrate and green on both sides; mature leaves subcoriaceous, base cordate to rounded; plants with balsam-like fragrance. -------------------------13. *S. pyrifolia.*
            5. Leaves and plants not as above.
               6. Leaves coriaceous or subcoriaceous, margin serrulate, apex acuminate. ----------4. *S. serissima.*
               6. Leaves not coriaceous, margin finely to coarsely serrate.
                  7. Branchlets brittle at base; leaves often linear-lanceolate to oblong-lanceolate; introduced trees.
                     8. Leaves coarsely serrate; branchlets not pendulous; leaves lanceolate to oblong-lanceolate. ------------------7. *S. fragilis.*
                     8. Leaves serrulate; branchlets pendulous; leaves linear-lanceolate. ---6. *S. babylonica.*
                  7. Branchlets tenacious and flexible; leaves often ovate-lanceolate; indigenous trees or shrubs. --------------------------2. *S. amygdaloides.*

4. Leaves green beneath, sometimes pale but not glaucous.
   9. Leaves linear to linear-lanceolate, often falcate, not coriaceous, dull above; stipules prominent. ---1. *S. nigra.*
   9. Leaves lanceolate or elliptic-lanceolate, -ovate, or -oblong, coriaceous to subcoriaceous, glossy above; stipules prominent or absent.
      10. Stipules present, persistent, and prominently glandular on margin; immature leaves pubescent. ---------------------------------3. *S. lucida.*
      10. Stipules absent or minute and early deciduous; immature leaves glabrous.
          11. Indigenous species; aments broad; capsules 7–10 mm long. ------------4. *S. serissima.*
          11. Introduced species; aments slender; capsules 5–6 mm long. -------------5. *S. pentandra.*

3. Petiole not glandular at distal end.
   12. Leaves green beneath.
       13. Leaves linear to linear-lanceolate, margin remotely denticulate; immature leaves sericeous. ---9. *S. interior.*
       13. Leaves oblong-lanceolate, margin serrate to serrulate; immature leaves reddish-purple, densely pubescent. --------------------------10. *S. rigida.*
   12. Leaves glaucous beneath.
       14. Leaf margin entire or crenate, not serrate.
           15. Low bog shrubs, 20–70 cm tall; leaf margin entire, revolute; exstipulate. --16. *S. pedicellaris.*
           15. Tall shrubs or trees, 1.5–6 m tall; leaf margin commonly crenate; stipulate.
               16. Immature leaves with caducous ferruginous trichomes; mature leaves broadly elliptic, oblanceolate or lanceolate; stipules small, often persistent. ---20. *S. discolor.*
               16. Immature leaves pilose to sericeous-tomentose; mature leaves elliptic, elliptic-ovate or oblanceolate; stipules small, deciduous. ------------------------15. *S. bebbiana.*
       14. Leaf margin serrate, at least on immature leaves.
           17. Leaf base rounded to subcordate; stipules large and prominent, or sometimes absent.

18. Stipules small or absent; immature leaves thin and translucent; mature leaves lanceolate to narrowly ovate, L/W 1.6–2.5. ________________________13. *S. pyrifolia.*
18. Stipules prominent; immature leaves thick.
    19. Leaves narrow, 1.2–2 cm wide, L/W 3.7–5–6.2, apex acuminate to attenuate, thinly glaucous beneath. ________________________10. *S. rigida.*
    19. Leaves broader, 2.4–3.5–4.6 cm wide, L/W 1.9–3–4.4, apex acute to sometimes acuminate, thickly glaucous beneath. _____12. *S. glaucophylloides.*

17. Leaf base tapering; stipules usually small or absent.
    20. Leaves linear to lanceolate, if broader then with an attenuate apex and serrulate margin.
        21. Branchlets pendulous, brittle; introduced trees. ________6. *S. babylonica.*
        21. Branchlets erect, tenacious; indigenous trees or shrubs.
            22. Immature leaves mostly glabrous, reddish; leaf blades lanceolate to ovate-lanceolate, L/W 4.2–5.7, apex attenuate; petioles 10–16 mm long, glabrous. ___________________________2. *S. amygdaloides.*
            22. Immature leaves velutinous sericeous, green; leaf blades linear to lanceolate, L/W 5–7, apex acute; petioles 3–10 mm long, pubescent. ________________17. *S. petiolaris.*
    20. Leaves broader, elliptic to broadly lanceolate or oblanceolate, apex acute to subacuminate, margin entire to crenate or sometimes serrate.
        23. Immature leaves often bearing caducous ferruginous trichomes; mature leaves broadly elliptic, oblanceolate to lanceolate; stipules small, often persistent. ______________20. *S. discolor.*

23. Immature leaves pilose or sericeous-tomentose; mature leaves elliptic, elliptic-ovate to oblanceolate; stipules small, deciduous. ----15. *S. bebbiana.*

2. Leaves pubescent, at least beneath.
  24. Petioles glandular at distal end.
    25. Leaves glaucous beneath, not coriaceous; stipules small and deciduous; introduced trees. ----8. *S. alba.*
    25. Leaves green or pale beneath, coriaceous or subcoriaceous; stipules 1–6 mm long, persistent; indigenous shrubs. ----------------------3. *S. lucida,* variety.
  24. Petioles not glandular.
    26. Young branchlets and underside of leaves dull white tomentose, flocculent above, margin entire and undulate, revolute. -------------------14. *S. candida.*
    26. Young branchlets and underside of leaves not as above, margin entire, crenate or serrate.
      27. Leaves linear to linear-lanceolate, margin entire or remotely denticulate.
        28. Leaves densely sericeous beneath, margin entire, revolute; introduced species. -------------------------------------21. *S. viminalis.*
        28. Leaves mostly glabrescent, sericeous when immature or after insect damage.
          29. Leaves green beneath, linear, margin remotely denticulate. -------9. *S. interior.*
          29. Leaves glaucous beneath, sometimes drying black, linear-lanceolate, margin serrate to subentire. ------17. *S. petiolaris.*
      27. Leaves lanceolate or broader.
        30. Leaf margin entire, crenate or sometimes irregularly serrate.
          31. Leaves sometimes bearing ferruginous trichomes, L/W 3–5, apex acute to acuminate, bright green or gray green above; aments precocious.
            32. Margin revolute, leaves gray-green above, pubescence beneath persistent, often drying black. ---19. *S. humilis.*
            32. Margin not revolute, leaves bright green above, usually glabrate in age; immature leaves commonly bearing ferruginous trichomes. -------------------------------20. *S. discolor.*

31. Leaves lacking ferruginous trichomes, rugose beneath, L/W 2–3.8, apex abruptly acute, leaves dull green above; aments coetaneous. ____________15. *S. bebbiana.*

30. Leaf margin definitely and uniformly serrate.
    33. Leaves green on both sides; stipules prominent.
        34. Leaves oblong-lanceolate, apex acuminate to attenuate, base rounded to acute, becoming glabrescent, midrib often remaining velutinous. ____________________________10. *S. rigida.*
        34. Leaves oblong-ovate, apex acute or short acuminate, base cordate or rounded, densely sericeous. ___________________________11. *S. syrticola.*
    33. Leaves glaucous beneath; stipules small or lacking.
        35. Introduced trees; leaves sericeous, especially beneath. ______8. *S. alba.*
        35. Indigenous shrubs; leaves finely sericeous to glabrescent beneath.
            36. Leaves finely sericeous beneath. __________________18. *S. sericea.*
            36. Leaves usually glabrescent, if sericeous the trichomes are longer and less regularly distributed than in the above species. _____________________17. *S. petiolaris.*

TAXONOMIC TREATMENT

SALIX L. Sp. Pl. 1051. 1753.

Creeping alpine shrubs, erect shrubs or trees. Buds with a single outer bud scale fused into a cap or with overlapping margins. Leaves alternate, simple, and usually stipulate. Flowers unisexual, borne in spikelike aments, dioecious. The aments sessile on branches of the previous year or borne on short vegetative shoots (reproductive branchlets) on these branches. Each flower subtended by a bract (scale) and one to several glands (nectaries). The staminate flowers contain 1-several stamens, usually two. The pistillate flowers contain a single pedicellate (stipitate), bicarpellate, unilocular pistil, with 2 stigmas. The fruit a bivalved capsule releasing seeds surrounded by an arillate coma.

THE SPECIES OF SALIX IN WISCONSIN

1. S. nigra
2. S. amygdaloides
3. S. lucida
4. S. serissima
5. S. pentandra
6. S. babylonica
7. S. fragilis
8. S. alba
9. S. interior
10. S. rigida
11. S. syrticola
12. S. glaucophylloides
13. S. pyrifolia
14. S. candida
15. S. bebbiana
16. S. pedicellaris
17. S. petiolaris
18. S. sericea
19. S. humilis
20. S. discolor
21. S. viminalis
22. S. purpurea

Sect. NIGRAE Loudon

1. SALIX NIGRA Marsh. Arbust. Am. 139. 1785.
Black Willow Map 1, Fig. 2.

Shrubs or trees 3–20 m tall, often with several boles; branchlets brownish to sometimes yellowish, slender, often pubescent and becoming puberulent or glabrate, brittle at base. Leaf blade linear to linear-lanceolate, often falcate, 5–10.5 cm long, 0.8–1.5 cm wide, length/width 5.5–12, apex attenuate to a narrow tip, base acute to rounded, margin serrulate, immature leaves often densely pubescent, sometimes glabrous, mature leaves glabrescent or glabrous, dark green on both sides, puberulent on midrib beneath; petiole pubescent to puberulent, 3–8 mm long, glandular at distal end; stipules prominent, up to 10 mm long, glandular and subpersistent. Aments coetaneous, borne on reproductive branchlets. Staminate aments slender 3.5–10 cm long; reproductive branchlets 1–2 cm long; stamens 3–6, filaments pilose near base, distinct; bracts obovate, pale yellow, pubescent, not deciduous in staminate inflorescence; glands 2 to several surrounding filaments; flowers appear to be whorled along rachis. Pistillate aments loosely flowered, 4–6 cm long, slender; reproductive branchlets 1–3.5 cm long; capsules ovoid, glabrous, 3–4 mm long, often deciduous after dehiscence; styles and stigmas short; pedicel 0.5–0.75 mm long; bracts oblong, pale yellow, 2–3 mm long, pubescent, deciduous after anthesis; glands adaxial, about 0.25 mm long. Based on 14 staminate, 29 pistillate, and 48 vegetative specimens.

Salix nigra is a very important component of the southern lowland forests where it may occupy pioneer sites along sand bars, mud flats, and other areas of disturbance in association with *Populus deltoides* (Curtis, 1959). It has been collected in bottomland woods

FIGURE 2. Leaves of *S. nigra* and *S. amygdaloides*. Pistillate anent of *S. amygdaloides* in fruit.

associated with *Quercus bicolor, Fraxinus, Acer saccharinum,* and *Betula nigra,* in wet mixed savanna, sedge meadows, and in the northern hardwoods.

Sterile specimens of *Salix nigra* are often difficult to distinguish from *S. rigida.* Characteristics which are sometimes diagnostic include: leaves green on both sides in *S. nigra* vs. leaves mostly glaucous beneath in *S. rigida*; leaves narrower, more attenuate, and often falcate in *S. nigra* vs. broader and less attenuate in *S. rigida;* petiole glandular at the apex in *S. nigra* vs. petiole not glandular in *S. rigida*; and trees in *S. nigra* vs. shrubs in *S. rigida.* Some of these characteristics such as leaf glaucescence and shape are subject to wide variation and are not always definitive in themselves.

The floral morphology of *Salix nigra* is very similar to that in *S. amygdaloides*; see discussion under that species.

Sect. AMYGDALOIDES Kimura

2. SALIX AMYGDALOIDES Anderss. Öfvers. Vet-akad. Förh. 15:114. 1858.

Peach-leaved Willow — Map 2, Fig. 2.

Shrubs or trees 3–20 m tall, often with several boles; branchlets yellow or brownish, slender, glabrous, and tenacious. Leaf blade lanceolate to ovate-lanceolate, 8–11 cm long, 0.8–1.6 cm wide, length/width 4.2–5.7, apex attenuate, base acute or sometimes obtuse, margin serrulate, immature leaves mostly glabrous, sometimes puberulent and becoming glabrescent, reddish, mature leaves dark green and glabrous above, glaucous and glabrous beneath; petiole 10–16 mm long, yellow, glabrous, sometimes with small glands at distal end; stipules none or minute, rarely up to 1 cm long on vigorous shoots. Aments coetaneous, borne on reproductive branchets. Staminate aments slender, 3–6.5 cm long, sometimes pendulous; reproductive branchlets 1–3 cm long; stamens 3–5, filaments pilose at base, distinct; bracts pale yellow, glabrate abaxially, pubescent adaxially (inner side), not deciduous in staminate inflorescence; glands 2; flowers appear to be whorled along axis. Pistillate aments loosely flowered and often lax, 4.5–8 cm long; reproductive branchlets 1.5–3 cm long; pistils and capsules glabrous, ovoid, short beaked, 3–4 mm long; styles less than 0.5 mm long; stigmas short; pedicels 1.5–2.5 mm long, slender; bracts oblong, pale yellow, glabrescent at outer tip, pubescent at base and adaxially, deciduous after anthesis; glands adaxial, reddish. Based on 19 staminate, 26 pistillate, and 18 vegetative specimens.

Salix amygdaloides occurs along the edges of rivers, in alluvial woods, and margins of swamps, lakes, and streams. It is relatively important in wet southern lowland forests and is absent from the white pine-hemlock northern hardwoods.

This species is closely related to *Salix nigra* and, although *S. amygdaloides* does have longer more slender pedicels and generally longer aments, they are virtually identical in their floral morphology. Fortunately they are distinctive vegetatively (Fig. 2) and leaves are present even on early flowering specimens. The leaves of *S. amygdaloides* are broader, glaucous beneath, and rarely as pubescent, when young, as the narrowly lanceolate, non-glaucous leaves of *S. nigra*. Stipules, which are prominent in *S. nigra*, are very small or absent in *S. amygdaloides*. See *S. nigra*.

Sect. PENTANDRAE Dumortier

3. SALIX LUCIDA Muhl. Neue Schr. Ges. Naturf. Fr. Berlin 4:139. 1803.
Shining Willow Map 3, Figs. 3 and 4.

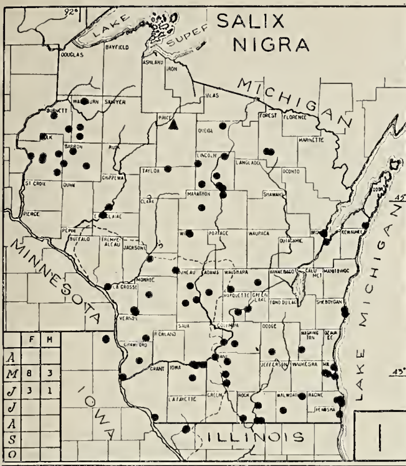
Shrubs or small trees 4–6 m tall; branchlets reddish brown or yellowish, glabrous and highly glossy, immature branchlets sometimes pubescent (remaining so in var. *intonsa*). Leaf blade lanceolate, broadly lanceolate to sometimes elliptic-ovate, 4–14 cm long (excluding apex), 1.4–3.3(–4.5) cm wide, length/width (excluding apex) (1.8–)2.2–3.5(–4.7), apex long-attenuate 2–4.9 cm long on later leaves, acute to acuminate on earlier leaves, base acute to rounded, margin serrate, teeth with large glands at the tip, immature leaves reddish, glabrous or with caducous, ferruginous and colorless trichomes (sometimes persistent in var. *intonsa*) mature leaves glabrous and dark green above (except in var. *intonsa*) and glabrous or pale beneath; petiole 5–13 mm long, glabrous or pubescent on adaxial side, glandular at distal end; stipules reniform to semicircular, 1–6 mm long, margin glandular. Aments coetaneous, borne on reproductive branchlets. Staminate aments 1.7–4 cm long; reproductive branchlets 1–2.5 cm long, often pubescent; stamens 3–6, filaments pilose near the base, distinct; bracts oblong 2–3 mm long, pale yellow, pubescent on both sides or becoming glabrate at abaxial side of apex, not deciduous in staminate inflorescence; glands 2, more or less cuplike. Pistillate aments 1.8–2.5–5 cm long; reproductive branchlets 1.3–2.5 cm long; pistils greenish or brown, glabrous, capsules light brown, 5–7 mm long, dehiscent between 7 June and 10 July, often deciduous after dehiscence; styles 0.5–0.75 mm long; stigmas short; pedicels 0.5–1–1.5 mm long; bracts oblong-oblanceolate, 1.5–3 mm long, pale yellow, pubescent both sides or glabrate toward abaxial side of apex, deciduous after anthesis; glands small, less than 0.25 mm long, somewhat cuplike, lobed adaxially and abaxially. $2n = 76$ (Darlington and Wylie, 1955). Based on 39 staminate, 38 pistillate, and 59 vegetative specimens.

Salix lucida commonly occurs in wet situations including swamps, low wet meadows, spruce bogs, mudflats along lake edges, lake dunes, and river banks. It may also occur along roadsides.

A group of closely related species in Wisconsin includes *Salix lucida,* an eastern American element, *S. serissima,* a western American element (Raup, 1959), and *S. pentandra,* an introduced European species. *Salix lucida* and *S. serissima,* although distinct species, have often been confused. The confusion seems to stem from the lack of a clear understanding of the characteristics ordinarily used to distinguish them, i.e. leaf glaucescence and leaf shape. In reference to leaf glaucescence *S. lucida* is usually considered to have leaves non-glaucous beneath, but sometimes pale, and *S. serissima* to have leaves glaucous beneath. It is difficult to apply this criterion to herbarium specimens for although the leaves of *S. serissima* are glaucous beneath in life, the glaucescence is very thin and is rapidly lost in drying. Only about 2% of the Wisconsin herbarium specimens examined retained this waxy bloom. For purposes of herbarium identification it is desirable to describe the leaves of *S. serissima* as whitish or subglaucous beneath and those of *S. lucida* as pale green beneath. With this refinement of the definition the characteristic becomes more useful.

The use of leaf shape places primary emphasis on the apex, for the shape of the body of the blade is only quantitatively different (Fig. 4) and for diagnostic purposes is essentially the same in both species (Fig. 3). *Salix lucida* has a long-attenuate apex in contrast to the acute or acuminate apex of *S. serissima.* However, there is not only intergradation in apex length between species but even in the same individual. On a single branchlet of *S. lucida* the lowermost (proximal) leaves have acute apices, the next higher acuminate, and only the distal leaves have the characteristic long-attenuate apex of the species (Fig. 3). This characteristic is useful as a diagnostic feature if intra-individual variation and intergradation are kept in mind.

Fernald (1950) reports hybridization between *Salix lucida* and *S. serissima* in northeastern United States and Canada. I have been unable to recognize this hybrid in the Wisconsin flora. The reason for this may be sought in the possible ecological or seasonal isolation of these species in Wisconsin. The taxa are at least partially isolated ecologically, with *S. lucida* occurring mainly on the margins of meadows, lakes, and streams, and *S. serissima* occurring in marshes and bogs. They may also be isolated seasonally but the available phenological data are still inconclusive. *Salix serissima*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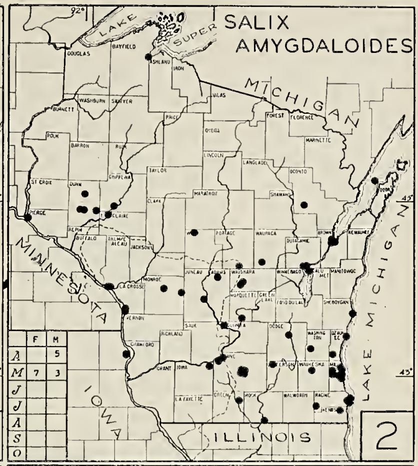
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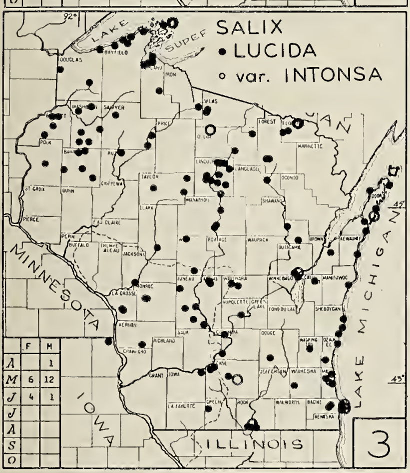
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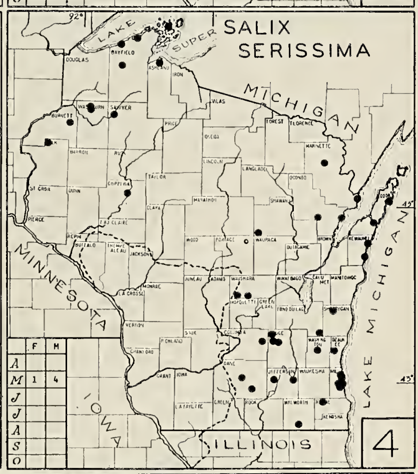
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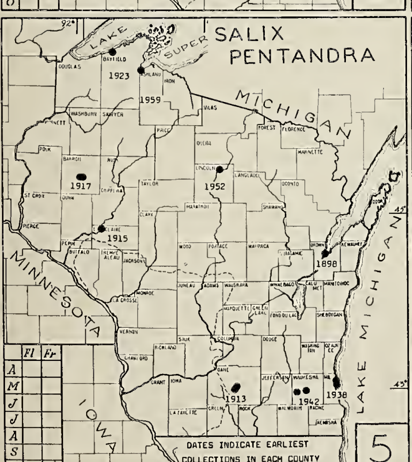
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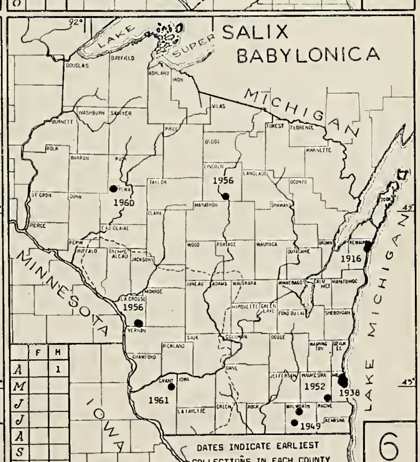
1942
1938
DATES INDICATE EARLIEST
COLLECTIONS IN EACH COUNTY
5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1916
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1961
1952
1938
1949
DATES INDICATE EARLIEST
COLLECTIONS IN EACH COUNTY
6

does shed its seeds later than *S. lucida* but they both seem to flower at about the same time.

The species in question are distinct and may be distinguished on the basis of the following characteristics (Figs. 3 and 4).

SALIX LUCIDA: Stipules 1–6 mm long, always with prominent glands on the margin. Immature leaves and branchlets usually bearing caducous ferruginous trichomes. Leaf apex usually long-attenuate. Pistillate aments narrow. Capsules 5–7 mm long and dehiscing between 7 June and 10 July.

SALIX SERISSIMA: Stipules minute, 1 mm long or less, or absent. Immature leaves and branchlets always glabrous. Leaf apex acute to attenuate. Pistillate aments broad. Capsules 7–10 mm long and dehiscing between 9 July and 23 August.

SALIX PENTANDRA combines some of the characteristics of each of the native species. It has narrow (but usually longer) pistillate aments and short capsules as in *S. lucida* and it is often exstipulate with the glabrous, acute to acuminate leaves characteristic of *S. serissima*. It rarely occurs as an escape in Wisconsin and is unlikely to be confused with either of the native species.

A variant of *Salix lucida* which has been recognized in this study is *S. lucida* var. *intonsa* Fern. (Rhodora 6:2. 1904). It is characterized by persistently hispid-pubescent branchlets and the persistence of pubescence on mature leaves. This variety is very common eastward, especially in northern New England and the Gulf of St. Lawrence region. Because of its possible geographic significance, I have recognized it in the Wisconsin flora.

4. SALIX SERISSIMA Fern. Rhodora 6:6. 1904.
Autumn Willow Map 4, Figs. 3 and 4.

Shrubs 1–4 m tall; branchlets yellowish to reddish brown, glabrous, highly glossy. Leaf blade broadly or narrowly lanceolate to elliptic-lanceolate, 5.4–9.5(–11.2) cm long (excluding apex), 0.9–2.5 cm wide, length/width (excluding apex) (2.7–3–)3.5–5(–6), apex acuminate on later leaves, base acute to obtuse, margin glandular serrulate, immature leaves glabrous, reddish, mature leaves dark green above, thinly glaucous beneath becoming whitish or subglaucous, subcoriaceous; petiole 4–10 mm long, glandular at distal end; stipules minute, often reduced to a single gland or absent. Aments coetaneous or subserotinous, borne on reproductive branchlets. Staminate aments 3–3.5 cm long; reproductive branchlets 1.5–3.5 cm long; stamens 4–7, filaments pilose below middle, distinct; bracts pale yellow, oblong, 2–3 mm long, pubescent, not deciduous in staminate inflorescence; glands 2. Pistillate aments 2–4.5 cm long; reproductive branchlets 1.7–5 cm long; ovaries reddish, glab-

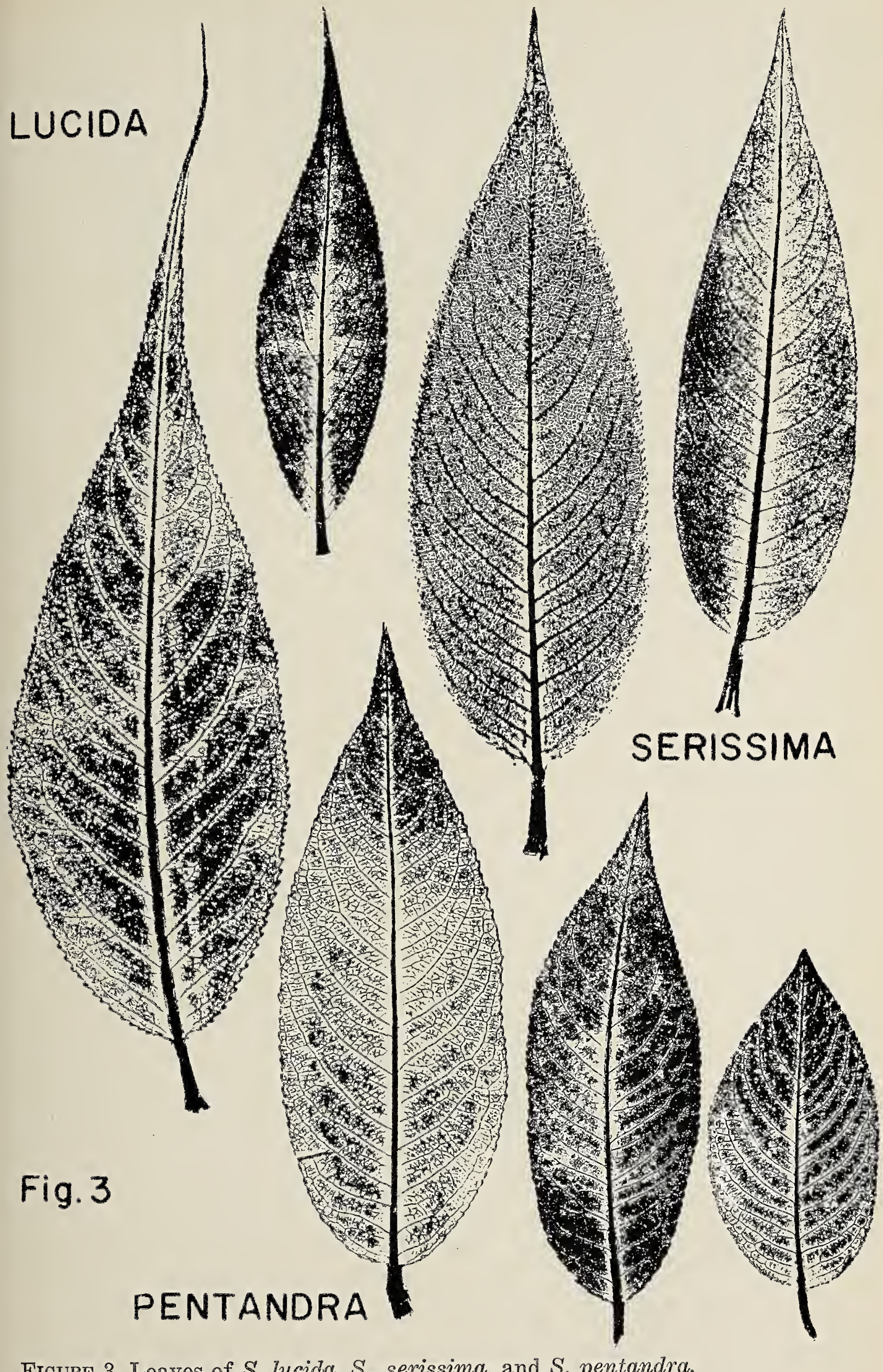


FIGURE 3. Leaves of *S. lucida*, *S.. serissima*, and *S. pentandra*.

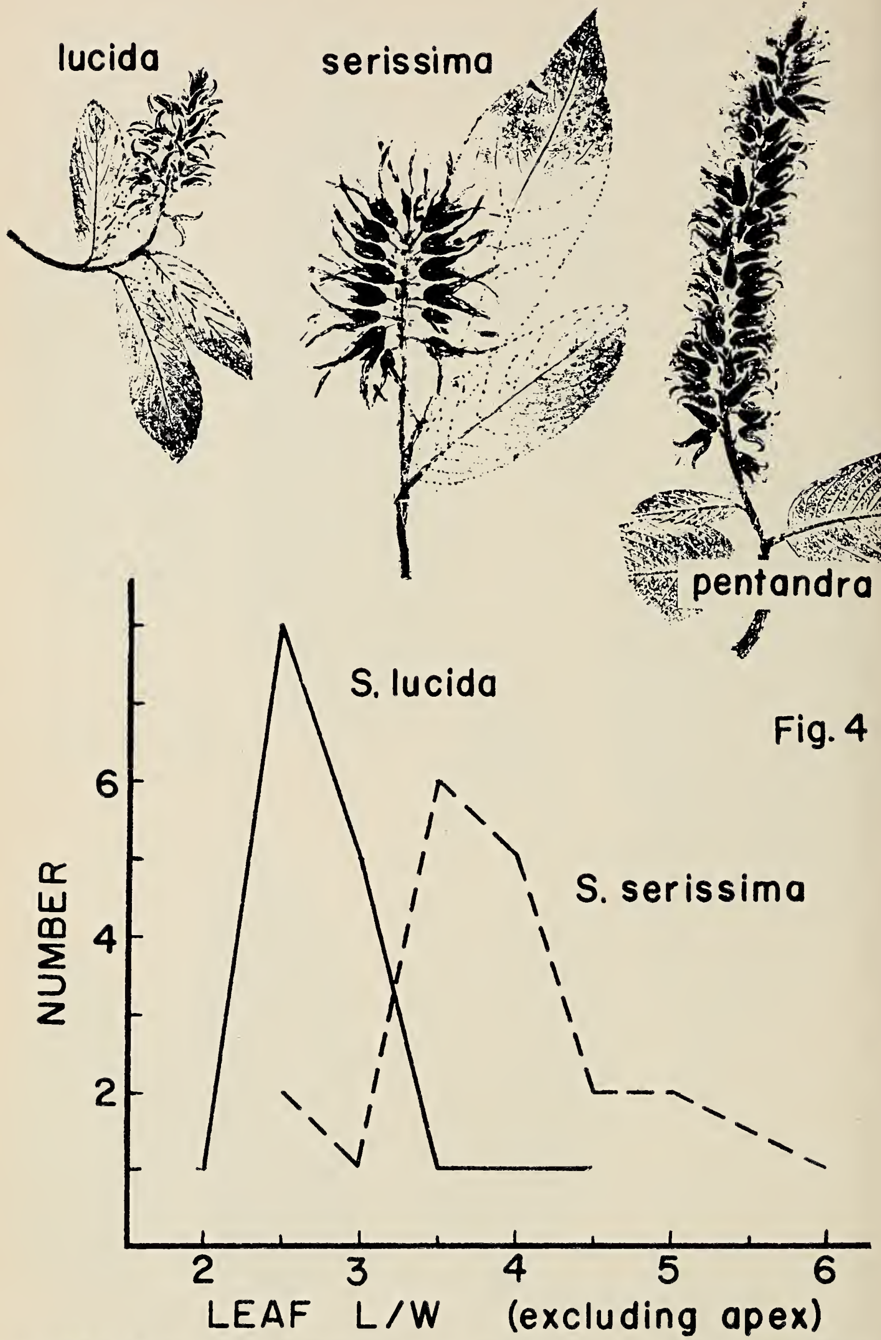


FIGURE 4. (Top) Pistillate eaments of *S. lucida, S. serissima* and *S. pentandra* in fruit. (Bottom) A comparison of the shape of the leaf blades (length-width ratio, excluding apex) of *S. lucida* and *S. serissima.*

rous, capsules light brown, 7–10 mm long, dehiscent between 9 July and 23 August, deciduous after dehiscence; styles up to 1 mm long; stigmas short; pedicels 0.75–2 mm long; bracts as in staminate but deciduous after anthesis; glands adaxial, about half as long as pedicel. Based on 7 staminate, 28 pistillate, and 13 vegetative specimens.

Salix serissima is a shrub of marshes and bogs. It has been collected from *Chamaedaphne calyculata-Sphagnum* bogs, *Larix* bogs, lake shores, and in willow scrub along creek margins and roadsides.

For discussion of *Salix serissima* and related species, see *S. lucida.*

5. SALIX PENTANDRA L. Sp. Pl. 1016. 1753.
Bay-leaved Willow — Map 5, Figs. 3 and 4.

Introduced shrubs or small trees up to 7 m tall; branchlets brown to reddish brown, glabrous and glossy, immature ones drying blackish. Leaf blade broadly lanceolate to elliptic-oblong, (3.5–) 7–8.5 (–11) cm long (excluding apex), (1.5–) 2.5–3 (–4.3) cm wide, length/width (excluding apex) 2.3–2.9, apex acuminate on later leaves, 7–12 mm long, base rounded, margin glandular-serrulate, immature leaves reddish, glabrous, mature leaves dark green above, green or pale beneath, coriaceous; petiole 4–10 mm long, glandular at distal end; stipules minute, up to 2–4 mm long in some specimens, deciduous. Aments coetaneous, borne on reproductive branchlets. Staminate aments 2–6 cm long; stamens 5, filaments pilose below middle, distinct. Pistillate aments 3. 5–6 cm long; reproductive branchlets 1.5–4 cm long; capsules 5–6 cm long, glabrous, dehiscent between 20 June and 6 Sept.; styles about 1 mm long; stigmas short; pedicels 0.5–1 mm long; bracts pale yellow, oblong, 2–3 mm long, glabrate adaxially and pubescent at base abaxially, deciduous after anthesis; glands cuplike with lobes adaxially and abaxially, sometimes laterally, about half as long as the pedicel. $2n = 76$ (Darlington and Wylie, 1955). Based on 15 pistillate specimens and the literature.

Salix pentandra is a species introduced from Europe and is cultivated in Wisconsin. It rarely occurs as an escape.

See *Salix lucida* for a discussion of related species.

Sect. FRAGILES W. D. J. Koch

6. SALIX BABYLONICA L. Sp. Pl. 1017. 1753.
Weeping Willow — Map 6, Fig. 5.

Introduced trees up to 12 m tall; branchlets slender, pendulous (in our area), yellowish to brown, glabrous. Leaf blade linear-lanceolate, 8–12 cm long, 0.5–1.5 cm wide, base acute, apex long-acuminate, margin serrulate, immature leaves sericeous, mature leaves glabrate, yellowish-green above, glaucous beneath; petiole with glands at distal end; stipules lanceolate, 2–7 mm long, or mostly wanting. Aments coetaneous, borne on reproductive branchlets. Staminate aments up to 4 cm long, slender; reproductive branchlets 0.5–1.5 cm long; stamens 2, occasionally 3–5 or more, filaments distinct, pubescent at base; bracts (in both sexes) pale yellow, pubescent, caducous. Pistillate aments 2–3.5 cm long, slender; reproductive branchlets present; capsules narrowly ovoid, 1–2 mm long, glabrous, nearly sessile; styles about 0.5 mm long; stigmas short; glands adaxial. $2n = 76$ (Darlington and Wylie, 1955). Based on 1 staminate, 3 pistillate, 6 vegetative specimens, and the literature.

Salix babylonica is a widely cultivated tree native to Asia and apparently introduced to North America from Europe. It escapes sparingly in Wisconsin and then may occur along roadsides and river banks.

7. SALIX FRAGILIS L. Sp. Pl. 1017. 1753.
Crack Willow — Map 7, Fig. 5.

Introduced trees up to 20–30 m tall; branchlets slender, yellowish to brown, glabrous to pubescent, very brittle at the base. Leaf blade lanceolate to oblong-lanceolate, 9–14(–16) cm long, 1.5–2.2(–3) cm wide, apex long-acuminate, base acute, margin coarsely serrate (4–5 serrations per 1 cm), glabrous above, glaucous or glaucescent and glabrous beneath; petiole 8–10(–18) mm long with prominent stalked glands at the distal end; stipules small, caducous. Aments coetaneous, borne on reproductive branchlets. Staminate aments 3–6 cm long, slender; stamens 2, occasionally 3–4, filaments pubescent at the base, distinct; bracts (in both sexes) pale yellow, sparsely pubescent, caducous; glands 2. Pistillate aments 5–7 cm long; reproductive branchlets 1.5–2.5 cm long; capsules narrowly conic, 4–5 mm long, glabrous; styles 0.5–1 mm long; stigmas short; pedicels about twice as long as the adaxial gland; glands 2, the abaxial small and inconspicuous. $2n = 76, 114$ (Darlington and Wylie, 1955). Based on 8 staminate, 29 pistillate, and 20 vegetative specimens.

Salix fragilis is a cultivated tree introduced to North America from Europe. It frequently escapes from cultivation and then may occur in low areas along the edges of rivers and lakes, and along roadsides.

In the keys I have used the characteristic pendulous branches of *Salix babylonica* to distinguish it from *S. fragilis*. However, this character is not invariable. I have seen collections of *S. fragilis*

FIGURE 5. Leaves of *S. babylonica*, *S. fragilis*, and *S. alba*.

cultivated in Illinois with pendulous branches. Furthermore, Otto von Seemen in his "Mitteleuropäische Wieden" (1911) describes the branches of *S. fragilis* as often long, thin, and pendent. The Illinois specimens of *S. fragilis* were collected by Professor G. N. Jones and I am grateful to him for calling them to my attention.

This species is sometimes difficult to distinguish from *Salix alba*, but its leaves are more coarsely serrate and glabrous, or only sparsely pubescent at maturity. The hybrid *S. alba* × *S. fragilis* is recognized in Wisconsin (see *S. alba*).

Sect. ALBAE Borrer

8. Salix alba L. Sp. Pl. 1021. 1753.
White Willow — Map 8, Fig. 5.

Introduced trees up to 20 m tall; branchlets greenish or yellowish brown, pubescent, not brittle. Leaf blade lanceolate to narrowly lanceolate, 4–8(–10) cm long, 1–2.5 cm wide, margin serrulate (about 9 serrations per 1 cm), immature leaves white-sericeous, mature leaves sericeous (especially beneath), glaucous beneath; petiole glandular at distal end; stipules small and deciduous. Aments coetaneous, borne or reproductive branchlets. Staminate aments 3–3.5 cm long; reproductive branchlets about 1 cm long; stamens 2, occasionally 3, filaments distinct, pubescent at base; bracts (in both sexes) pale yellow, sparsely pubescent and caducous. Pistillate aments 4–6 cm long; reproductive branchlets 1.5–2 cm long; capsules ovoid-conic, 3–4.5 mm long, glabrous, sessile or subsessile; styles small; stigmas minute; gland adaxial. $2n = 76$ (Darlington and Wylie, 1955). Based on 4 staminate, 12 pistillate, 5 vegetative specimens, and the literature.

Salix alba is an introduced tree which is occasionally found as an escape along rivers, especially in southeastern Wisconsin.

Hybrids between *Salix alba* and *S. fragilis* seem to be relatively common in Wisconsin and seven specimens representing this putative hybrid have been segregated out of the material studied. The difficulty encountered in distinguishing between *S. alba* and *S. fragilis* may be due in part to this hybridization; but our inadequate representation of these European taxa, and the frequent introduction of "unusual specimens" (sports, hybrids, etc.) contributes to the difficulties.

Specimens with sericeous, finely serrate leaves and sessile to subsessile capsules have been named *Salix alba*. Those with glabrous or sparsely pubescent, coarsely serrate leaves and capsules on distinct pedicels have been named *S. fragilis* (Fig. 5). There are numerous intermediate specimens in Wisconsin some of which have received varietal names. For our purposes it seems best not to attempt to distinguish any of these proposed varietal names but rather to consider *S. alba* in a broad sense.

Sect. LONGIFOLIAE Andersson

9. SALIX INTERIOR Rowlee, Bull. Torrey Bot. Club 27:253. 1900.
Sand Bar Willow Map 9, Fig. 6

S. longifolia Muhl.
S. interior var. *pedicellata* (Anderss.) Ball.
S. interior f. *wheeleri* (Rowlee) Rouleau.

Shrubs 1.5–2(–5) m tall, colonial, shoots originating from roots; branches numerous, grayish; branchlets brown to reddish-brown, sericeous or thinly so, becoming glabrescent. Leaf blade linear to linear-lanceolate, up to 6.5–10.5 cm long, 0.5–0.9 cm wide, length/width 9.4–15, sometimes broader on vigorous shoots, apex and base acuminate, margin distantly denticulate with glandular, often prolonged teeth 5–10 per 2 cm, immature leaves sericeous, sometimes glabrate, mature leaves glabrescent, sometimes sparsely pubescent or densely sericeous, green on both sides; petiole 2–7 mm long; stipules absent or minute, or up to 3 mm long, caducous. Aments coetaneous, borne on reproductive branchlets. Staminate aments 2–3 cm long, lateral secondary aments present in 60% of Wisconsin specimens; reproductive branchlets 0.8–8 cm long; stamens 2, filaments pubescent on lower half, distinct; bracts yellow or yellow-green, curly pubescent, becoming glabrescent. Pistillate aments loosely flowered, 2–5.5 cm long, lateral secondary aments present in 22% of Wisconsin specimens; reproductive branchlets 3–6.5 (–12.5) cm long; pistils glabrescent, glabrous or thinly sericeous, green or reddish, capsules glabrescent-glabrous, slender, 4.5–7 mm long, deciduous after dehiscence; styles obsolete; stigmas short; pedicels 0.5–1 mm long; bracts oblong to linear, 3 mm long, yellowish (green when young), pubescent adaxially, glabrescent abaxially, deciduous after anthesis (in pistillate inflorescence only), rachis pubescent; gland adaxial, half as long as the pedicel. Based on 72 staminate, 81 pistillate, and 61 vegetative specimens.

Salix interior is a pioneer woody plant in primary succession (Lindsey, *et al.*, 1961). It occurs widely in sandy habitats including sandy lake and river margins, sand and gravel bars, the foot of sandstone cliffs, sand dunes, edges of cultivated fields, railroad rights-of-way, and along roadsides. Although it has been collected in bottomland woods and bogs, it seems to be most abundant in moist, sandy situations.

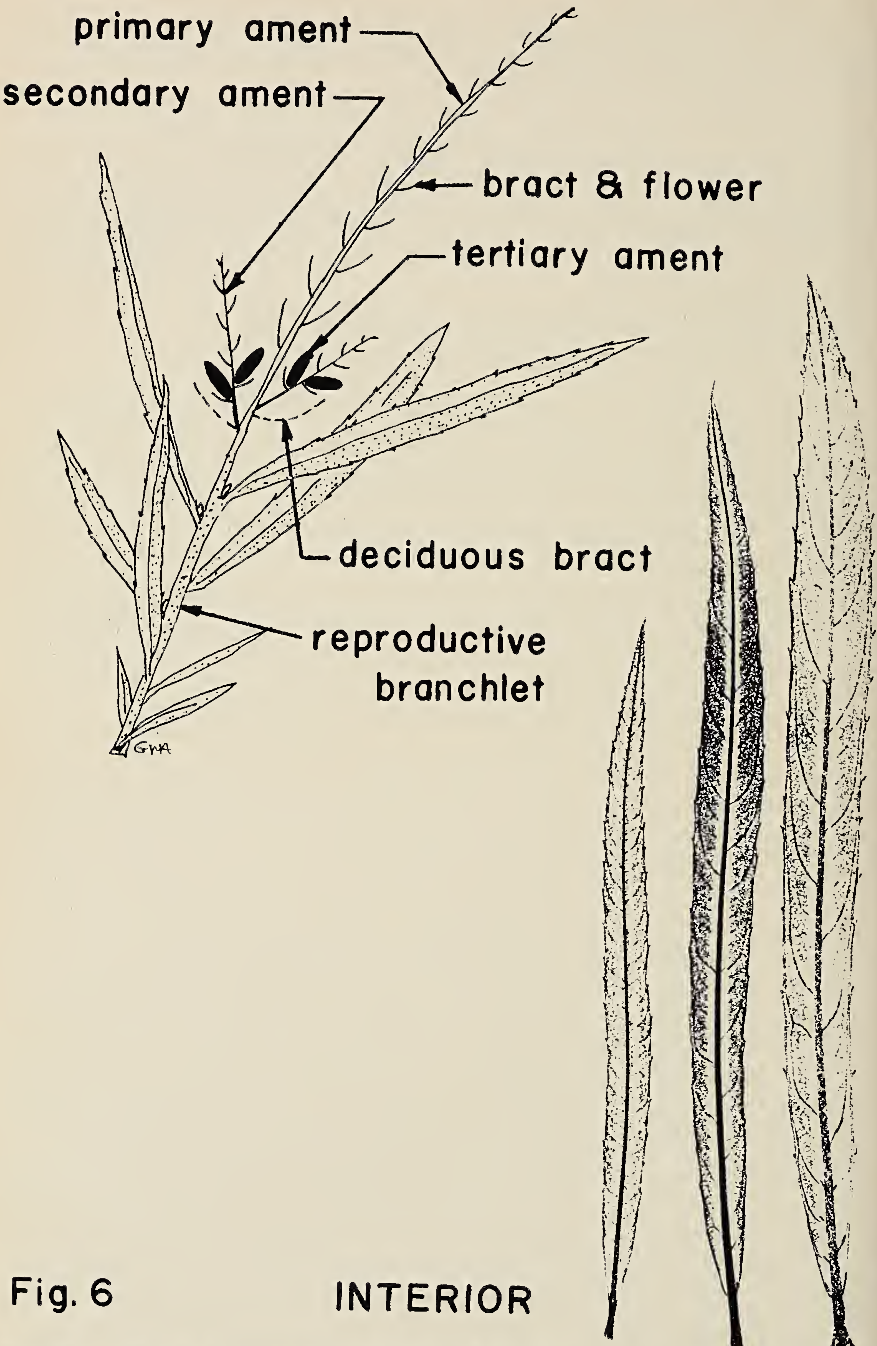
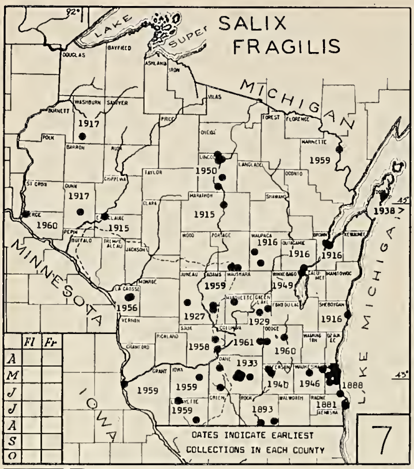


FIGURE 6. (Top) A generalized diagram of an ament (♂ or ♀) of *S. interior* illustrating the mode of branching (cf. text for discussion). (Bottom, right) Leaves of *S. interior.*

Vegetative propagation is highly developed in this species and large clones are commonly produced by vegetative shoots originating from roots and from prostrate branches. Although this mode of reproduction (vegetative buds originating on roots) has been suspected in other *Salix,* I have not seen it demonstrated for species outside of Section Longifoliae *(S. interior, S. exigua, et al.).* Propagation is not wholly vegetative. I have seen several collections of seedlings from Wisconsin *(N. C. Fassett 12914, 12915,* shores of the Mississippi, near Dubuque and Potosi, 8 Sept. 1930 (WIS)). The leaves of seedlings of *S. interior,* including those cited, have an unusual lobed blade. This lobed leaf form has been reported by Lindsey, *et al.* (1961) in seedlings which assumed a rosette-form during their first year of growth in open exposed habitats, and I have collected similar seedlings from a sand bar on the South Saskatchewan River *(Argus 91–62,* Batoche, Sask.). It is probable that the lobed leaf is the juvenile leaf shape, however, it may also be related to the rosette habit produced under certain environmental conditions. This problem requires further study.

Two variants, one based on leaf width and the other on leaf pubescence, have been recognized by authors in Wisconsin. The first (var. *pedicellaris)* is thought to be characterized by leaves shorter and narrower (6 mm wide) than "typical". This is a highly variable characteristic even on a single plant. In some cases short, narrow leaves can be related to second growth during the same year. The second variant (forma *wheeleri)* is distinguished by its densely and permanently sericeous leaves. As has been noted by Costello (1935) and others, sericeous leaves are often related to insect attack; and in virtually no instance have I seen densely sericeous specimens of *Salix interior* which did not show some sign of insect damage, or in which the sericeous leaved shoots were not initiated during the year of their development (see *Salix bebbiana* for discussion of a similar situation). It is very doubtful whether either of these taxa merit formal taxonomic recognition.

The inflorescences of *Salix interior* are often branched, having one or more lateral secondary and even tertiary aments borne at the base of the primary ament (Fig. 6). Branched inflorescences are common in staminate individuals (occurring in 66% of Wisconsin specimens), and somewhat less common in pistillate individuals (occurring in about 22%). A superficial examination of the branching shows that a lateral (secondary) inflorescence is sometimes located in the axil of the first, second, or rarely the third bract near the base of the primary inflorescence. The secondary inflorescence(s) may have a tertiary inflorescence located in the axil of one of its lower bracts. The bract subtending the secondary inflorescence is usually deciduous soon after the secondary inflorescence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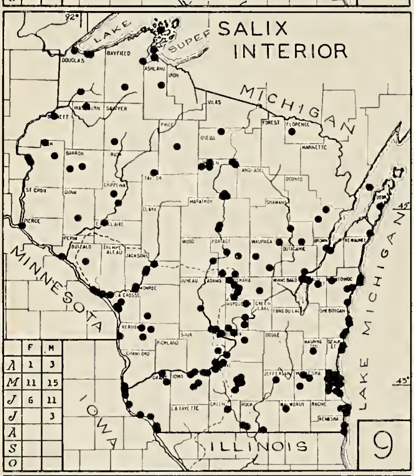
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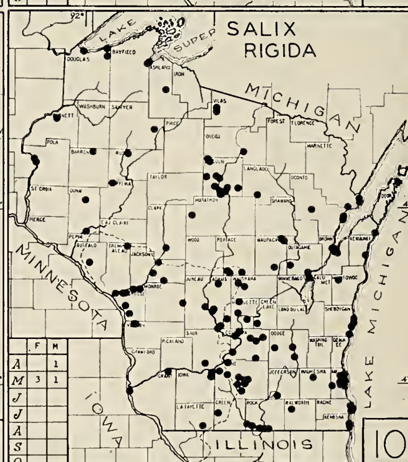
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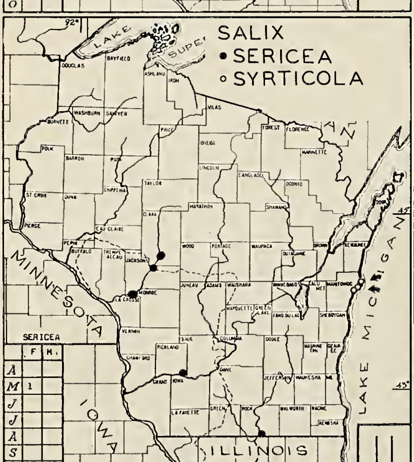
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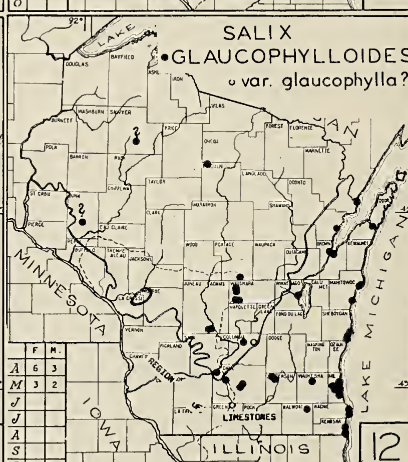
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∘ var. glaucophylla?
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12

begins to elongate. Not uncommonly, one or two secondary inflorescences may reach anthesis, however, tertiary inflorescences have not been observed to reach this stage of development. A detailed anatomical study of branched aments in *Salix interior* would contribute important information concerning the nature of the *Salix* inflorescence and the relationship between the ament and the reproductive branchlet.

A situation which may be confused with the development of lateral inflorescences occurs when the bud in the axil of the distal leaf on a reproductive branchlet develops during the same year in which it was initiated. If this happens, two or more aments may be produced on a single reproductive branchlet. The second ament in this case can be distinguished from the above by noting that it is borne on its own reproductive branchlet. However, if buds on the reproductive branchlet develop during the year of their initiation they are usually vegetative.

Sect. CORDATAE Barratt

10. SALIX RIGIDA Muhl. Neue Schr. Ges. Nat. Fr. Berlin 4:236. 1803.
S. cordata Muhl. Map 10, Fig. 7.

Shrubs 0.3–3 m tall, sometimes taller; branchlets reddish brown to yellow-green, glabrate, or often remaining velutinous for two years. Leaf blade oblong-lanceolate, 6–10.5 cm long, 1.2–2.1 cm wide, length/width 3.7–5–6.2, apex gradually acuminate or attenuate, base rounded to acute or rarely subcordate, margin serrulate, immature leaves reddish-purple, thin, densely white pubescent, mature leaves glabrate, midrib often remaining velutinous, green above and glabrate or finely pubescent, light green and becoming thinly glaucous beneath; petiole 8–17 mm long, velutinous on inner surface; stipules 5–9(–20) mm long, lanceolate to ovate semicordate, margin serrate; buds velutinous to glabrate, inner bud scale separating from the outer and often clinging to the base of the shoot. Aments coetaneous or subprecocious, borne on reproductive branchlets. Staminate aments 1.5–2.5 cm long; reproductive branchlets 2–5 mm long; stamens 2, filaments glabrous, coalescent at base; bracts tawny to dark brown, pilose, 1–1.5 mm long; gland adaxial. Pistillate aments 3–5 cm long; reproductive branchlets 3–13 mm long; ovaries slender, reddish or greenish and glabrous, capsules greenish becoming brown, 4–5 mm long; styles 0.5–0.75 mm long; stigmas small; pedicels 1–2 mm long, glabrous; bracts narrow, light brown to blackish, long pilose, about 2 mm long, apex reflexed in fruit; glands adaxial 0.2–0.5 mm long. Based on 14 staminate, 29 pistillate, and 48 vegetative specimens.

Salix rigida occurs in a variety of habitats from river banks, creek bottoms, and willow swamps to sedge flats, seepage bogs, *Acer rubrum* second growth woods, lake dunes, and waste places such as ditches and railroad rights-of-way.

The nomenclatural problems surrounding *Salix rigida* and the closely related *S. cordata* Michx. have been discussed by Fernald (1946). I am following his treatment in using the name *S. rigida* and in regarding *S. cordata* Muhl. as synonymous with it. The entire complex surrounding these species is confusing to me and is in need of a thorough study. However, *S. rigida* in Wisconsin seems to be a relatively homogeneous species and to represent a single taxon.

Species closely related to *Salix rigida* in Wisconsin include *S. syrticola* and *S. glaucophylloides*. *Salix rigida* can be distinguished from the very rare *S. syrticola* by immature leaves pubescent and reddish colored vs. densely sericeous and green, mature leaves oblong-lanceolate vs. oblong-ovate, leaf margins serrulate vs. glandular serrate, pistillate aments 3–5 cm long vs. 6–8 cm long, and capsules 4–5 mm long vs. 5–7 mm long. From *S. glaucophylloides* it may be distinguished as discussed under that species. Vegetatively *S. rigida* resembles *S. nigra;* see that species for distinguishing characteristics.

The pistillate aments of *Salix rigida* are very distinctive during flowering and early fruit. At this time the glabrous ovaries project beyond the bracts and contrast sharply with the long pilose bracts. The distinctive aspect is lost during the late fruiting stage as the apex of the bracts becomes reflexed and some of the bracts are abscissed.

11. SALIX SYRTICOLA Fern. Rhodora 9:225. 1907.
Sand Dune Willow — Map 11, Fig. 7.

Spreading shrubs 1–3 m tall; branchlets grayish tomentose, becoming glabrate. Leaf blade oblong-ovate, 3.5–9.5 cm long, 2–6 cm wide, apex acute or abruptly short acuminate, base cordate or broadly rounded, margin glandular serrate, teeth often prolonged, immature leaves densely sericeous, mature leaves pubescent or becoming glabrate, green on both sides; petiole 2–6(–10) mm long, pubescent; stipules prominent, 6–15 mm long, semicordate to subovate. Aments coetaneous, subsessile or borne on short reproductive branchlets. Staminate aments 2.5–4.5 cm long, subsessile and subtended by several bracts; stamens 2, filaments glabrous; bracts (in both sexes) oblong, pale brown, villous. Pistillate aments 6–8 cm long; reproductive branchlets about 10 mm long; capsules glabrous, 5–7 mm long; styles 0.7–1 mm long; stigmas small; pedicels

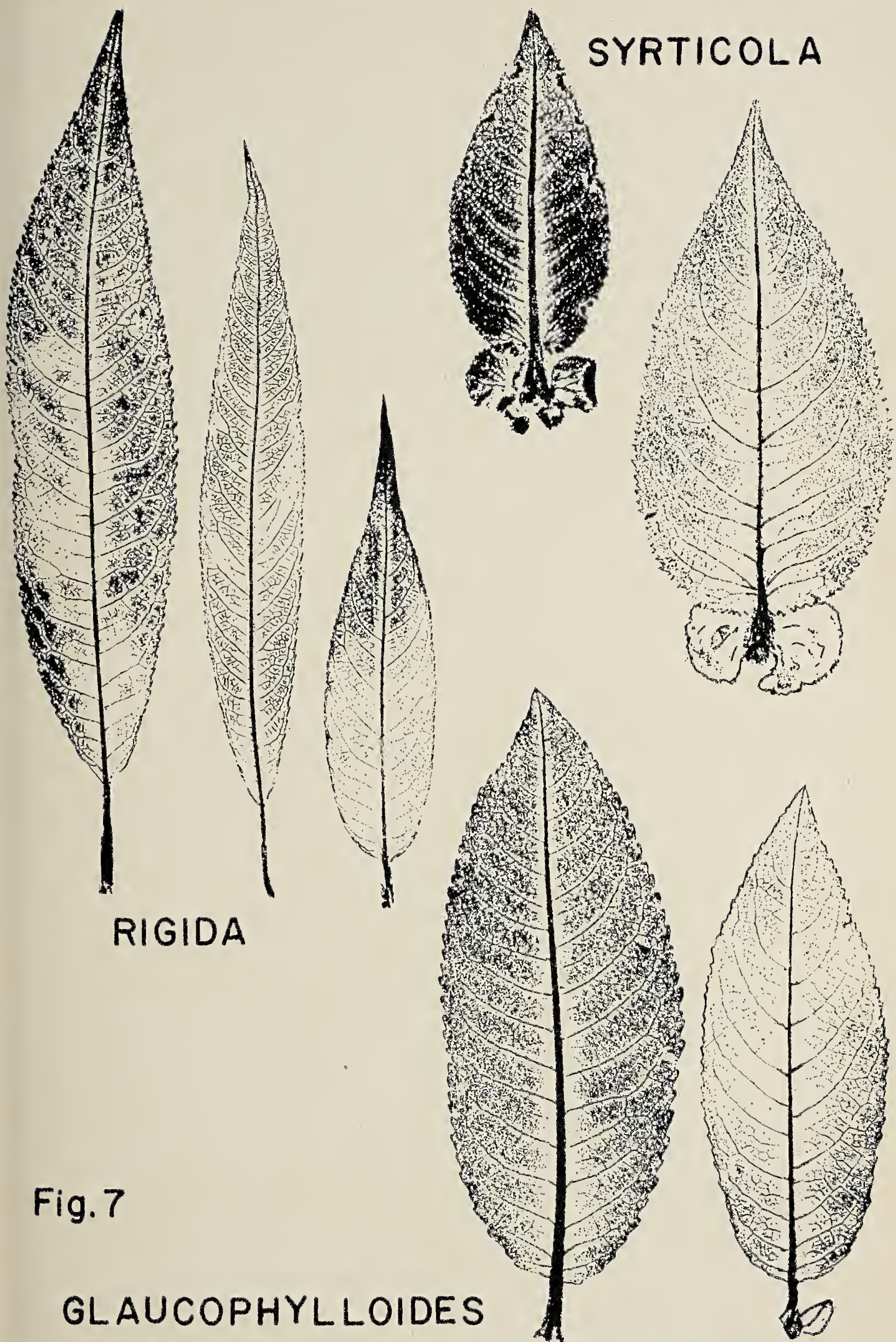


FIGURE 7. Leaves of *S. rigida*, *S. syrticola* (including stipules), *and S. glaucophylloides.*

0.5–1 mm long, glabrous; glands adaxial, small. Based on 1 staminate, 3 pistillate, 3 vegetative specimens, and the literature (especially Fernald, 1907, 1946, and 1950).

Salix syrticola apparently is a Great Lakes endemic occurring on sand dunes and beaches. It is known from only one locality in Wisconsin, namely Two Rivers, Manitowoc Co. I have also seen material from the southern end of Lake Michigan at Chicago, Illinois; the Indiana Dunes State Park and vicinity, Indiana; and New Buffalo, Michigan; and from Big Bay, Bruce Peninsula, Ontario.

In using this specific name I am following Fernald (1946) who regarded it as distinct from *Salix cordata* Michx. (*S. adenophylla*). Whether or not the populations occurring on sand dunes in the Great Lakes region represent a species different from the closely related and wider ranging *S. cordata* Michx. is open to question. However, this problem cannot be resolved without considering the entire complex surrounding *S. rigida* and *S. cordata*. The determination of the true nature and relationships of *S. syrticola* awaits a thorough study of this complex (see *S. rigida*).

12. Salix glaucophylloides Fern. Rhodora 16:173. 1914.
Blue-leaved Willow — Map 12. Fig. 7.

S. cordata var. *glaucophylla* Bebb.
S. glaucophylla (Bebb) Bebb.
S. glaucophylloides Fern. var. *glaucophylla* (Bebb) Schneider.

Shrubs 1–2.5 m tall; branchlets brown to yellowish, glabrous or gray pubescent, glossy. Leaf blade elliptic, broadly elliptic, oblong or obovate, 6.5–8.5–11.4 cm long, 2.4–3.5–4.6 cm wide, length/width 1.9–3 (–4.4), apex acute or abruptly short acuminate, base obtuse, rounded or rarely cordate, margin serrate or serrate-crenate, immature leaves often reddish, usually glabrous or with caducous ferruginous trichomes (the petiole and young branchlet may be white velutinous), mature leaves glabrate or with persistent pubescence on midrib, green above, strongly glaucous beneath with thick layer of wax, often drying black; petiole 4–10(–14) mm long, pubescent, dilated at base; stipules prominent, about 10 mm long, ovate, glandular toothed margin, glaucous beneath; buds glabrous or pubescent, inner bud scale sometimes clinging to the base of the branchlet. Aments coetaneous or subprecocious, subsessile or on short reproductive branchlets. Staminate aments 2–4 cm long, subsessile or reproductive branchlets 2–6 mm long; stamens 2, filaments glabrous, distinct or rarely coalescent at the base; bracts (in both sexes) dark brown to black, 1–2 mm long, densely villous. Pistillate aments loosely flowered in fruit, 3.5–6.5 cm long; reproductive branchlets 5–14 mm long; capsules glabrous 4.5–7 mm long;

styles 1–1.25 mm long; stigmas small; pedicels 1.5–2.5 mm long; glands adaxial. Based on 17 staminate, 40 pistillate, and 35 vegetative specimens.

Salix glaucophylloides occurs on sand dunes, sandy flats, and in thickets along Lake Michigan. It is also known from wet prairies, stream banks, and along railroad rights-of-way.

This species has been considered by Raup (1959) to be the eastern segregate of a continuous population whose western segregate is named *Salix padophylla* Rydb. The approximate area of overlap between these two taxa, which may have been isolated during the Pleistocene glaciation in "eastern" and "western" refugia, is in northern Ontario with Wisconsin probably lying within or near the southern edge of the zone of overlap. If this interpretation is correct it may account for the description of the species in Wisconsin under the variety *glaucophylla*, a taxon somewhat intermediate between *S. padophylla* and *S. glaucophylloides*. A critical study of these two taxa and their relatives is required for an understanding of the problem.

A closely related species in Wisconsin is *Salix rigida* Muhl. From this species *S. glaucophylloides* is distinguished vegetatively by broader leaves, less acuminate at the apex, the margin serrate to crenate, not serrulate, and immature leaves less pubescent and becoming glabrescent earlier. The undersides of the leaves are coated with a thick layer of wax and the blade often dries black. Reproductively *S. glaucophylloides* is distinguished by more villous bracts, especially in the staminate inflorescence, generally longer pistillate inflorescence, and longer capsules and styles.

A small leaved form of the species (var. *brevifolia* (Bebb) Ball, Ohio Jour. Sci. 50:187. 1950) has been collected along the shores of Lake Michigan at Two Rivers and Oostburg (*J. J. Davis*, Two Rivers, Manitowoc Co., 25 July 1917 (WIS); *W. Finger*, Two Rivers, 18 Aug. 1902 (MIL); and *T. F. Grittinger*, Oostburg, Sheboygan Co. 6 July 1961 (WIS)). Although the leaves on these specimens are small (3.8–5.8 cm long and 1.6–2 cm wide) this feature seems to be of doubtful taxonomic importance. It should be observed in the field and its possible ecological significance studied.

Sect. BALSAMIFERAE Schneider

13. SALIX PYRIFOLIA Anderss. Sv. Vet-akad. Handl. 6:162. 1867.
Balsam Willow Map. 13, Fig. 8.

S. balsamifera Barratt ex Anderss.

Shrubs 3 m tall; reported to have a strong balsam-like fragrance; branchlets glabrous, shiny, dark reddish-brown, rarely greenish, drying black. Leaf blade lanceolate, narrowly ovate, ovate or broadly so, to oblong-lanceolate, 4–6(–8.5) cm long, 2–3.5(–4) cm

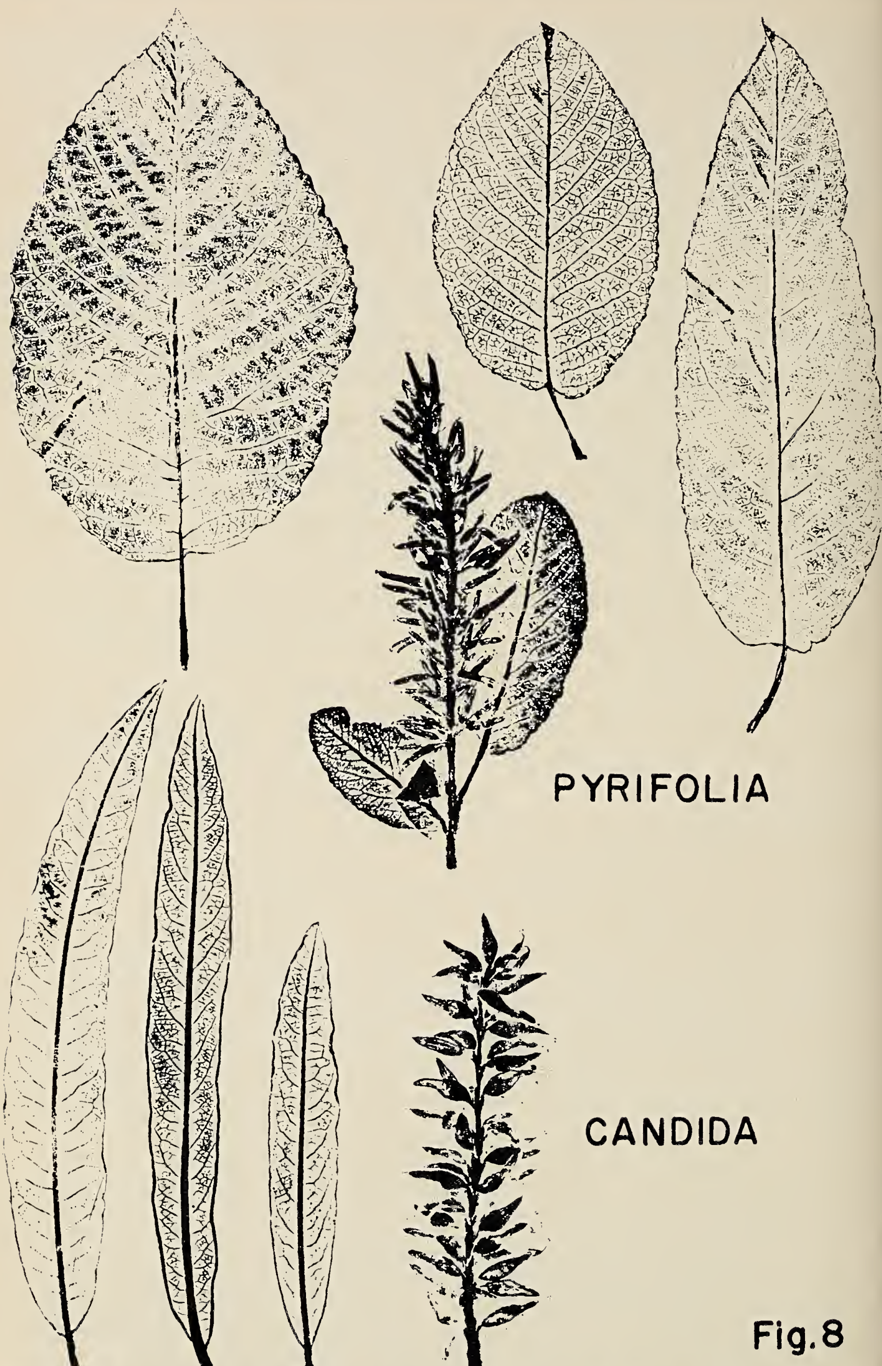


FIGURE 8. Leaves and pistillate aments (in early fruit) of *S. pyrifolia* and *S. candida.*

wide, length/width 1.6–2.5, apex acute, base cordate to rounded, margin glandular serrulate on immature leaves, becoming coarsely serrate or crenate in age, immature leaves thin and translucent, thinly pubescent or glabrescent, green on both sides or faintly glaucous beneath, mature leaves subcoriaceous, opaque, reticulate veined and glaucous beneath; petiole 7–15 mm long, pubescent, sometimes glandular at the distal end; stipules small, caducous. Aments coetaneous, borne on reproductive branchlets. Staminate aments 2.5–5 cm long; reproductive branchlets 5–7 mm long; stamens 2, filaments glabrous or pubescent at base; bracts (in both sexes) oblong, tawny, pilose. Pistillate aments loosely flowered, 2.5–6 cm long; reproductive branchlets 0.5–2 cm long, leaves of reproductive branchlets broad, apex obtuse to rounded; pistils and capsules glabrous, up to 5–6 mm long; styles 0.5–1 mm long; pedicels divergent, 2.5–3.5 mm long; glands adaxial. Based on 7 staminate, 26 pistillate, and 22 vegetative specimens.

Salix pyrifolia generally occurs in wet places and is most commonly encountered in *Chamaedaphne calyculata-Sphagnum* or *Larix-Picea bogs*. It has been collected along wet shores and marshes bordering lakes, in swamps, in the mixed northern hardwoods, and in waste places such as railroad rights-of-way and ditches.

Sect. CANDIDAE Schneider

14. Salix candida Flügge in Willd. Sp. Pl. 4:708. 1805.
Sage-leaved Willow — Map 14, Fig. 8.

Shrubs 0.5–3.5 m tall; branchlets yellowish to brownish, and tomentose to floccose when immature, becoming reddish-brown and glabrescent in age. Leaf blade linear to oblong, sometimes appearing to be narrowly lanceolate due to revolute margins near the base, 4.7–10.3 cm long, 0.5–2 cm wide, length/width (5–)7.8–12, apex acute, base attenuate, margin revolute, entire, undulate, often distantly glandular, dull white-tomentose beneath persistent in age, floccose to pubescent above becoming glabrate, drying dark green to brown above, midrib prominent and yellowish beneath, veins impressed above; petiole 3–5–10 mm long; stipules lanceolate, tomentose. Aments coetaneous, borne on short reproductive branchlets. Staminate aments 1–1.5 cm long, subsessile, stamens 2, filaments glabrous, bracts (in both sexes) pale to dark brown, bearded. Pistillate aments 2.2–5.2 cm long, cylindrical or narrowly so, densely to loosely flowered; reproductive branchlets 0–15 mm long; pistils dull white-tomentose, 4–6 mm long, styles about 1 mm long, red when fresh; pedicels 1 mm long or less; glands adaxial, red when fresh. Based on 5 staminate, 40 pistillate, and 37 vegetative specimens.

Salix candida is a shrub of alkaline *Carex-Eriophorum* meadows, sloughs, limestone shores, *Larix* bogs, and floating *Carex-Typha* mats. It commonly occurs in wet calcareous habitats, but it is not restricted to them.

The distribution of *Salix candida* in Wisconsin (Map 14) is similar to that of other calciphilous species including *Solidago patula* and *S. ridellii* (Salamun, 1963), *Lysimachia quadriflora* (Iltis and Shaughnessy, 1960), and *Gentiana procera* (Iltis, pers. comm.). *Salix candida* principally occurs in eastern Wisconsin, with rare extensions into northwestern Wisconsin. Its occurrence in Trempealeau Co., well within the "Driftless Area", parallels that of *Lysimachia quadriflora* (cf. Iltis and Shaughnessy, 1960).

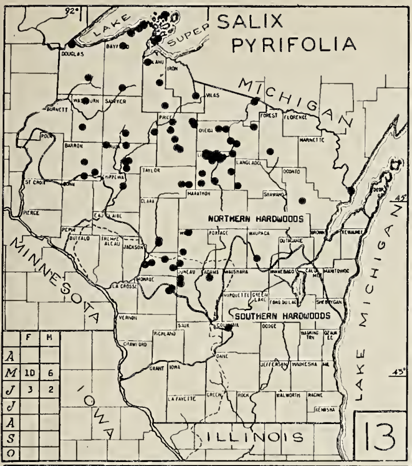
A glabrate variant of this characteristically tomentose species has been named *Salix candida* f. *denudata* (Anderss.) Rouleau (Nat. Canada. 71:266. 1944). Two specimens of this variant from Wisconsin have been seen (*A. M. Fuller 2371*, Cedarburg swamp, Ozaukee Co., Wis., 9 June 1928 (MIL); *H. Iltis 17532*,½ mi. North of Maplewood, edge of old *Larix* bog, Door Co., Wis., 9 June 1961 (WIS)). Its glabrous or glabrescent leaves, branchlets and capsules are in marked contrast with the typically tomentose species. Specimens of typical *S. candida* as well as the putative hybrid *S. candida* X *S. petiolaris* have also been collected at the Cedarburg swamp (bog), and it is possible that forma *denudata* is of hybrid origin. Other habitats in which *S. candida* and *S. petiolaris* occur together should be searched for glabrescent hybrids which resemble f. *denudata*.

Sect. FULVAE Barratt

15. SALIX BEBBIANA Sarg., Gard. and For. 8:463. 1895.
Long-beaked Willow, Bebb's Willow Map 15, Fig. 9.

S. rostrata Richards.
S. perrostrata Rydb.
S. bebbiana var. *perrostrata* (Rydb.) Schneid.

Shrubs or small trees 1.5–6 m tall; branchlets divaricate, reddish brown, becoming darker in age, gray pubescent, sometimes glabrescent, pubescence commonly persistent for several years. Leaf blade elliptic, elliptic-obovate, oblanceolate or rarely broadly elliptic, 3–7.5 cm long, 1.3–3.3 cm wide, length/width 2–3.8, apex abruptly acute, rarely obtuse or sometimes tapering, base acute to obtuse, margin entire to crenate or irregularly glandular toothed, immature leaves pilose and ciliate or sericeous-tomentose, mature leaves pubescent, sericeous-tomentose or glabrate, dull green above, glaucous and often rugose-veiny beneath; petiole (3–)5–7(–10) mm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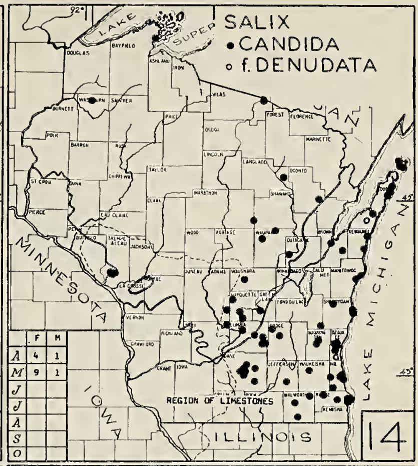
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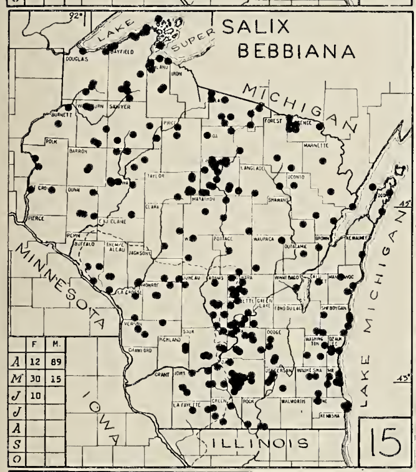
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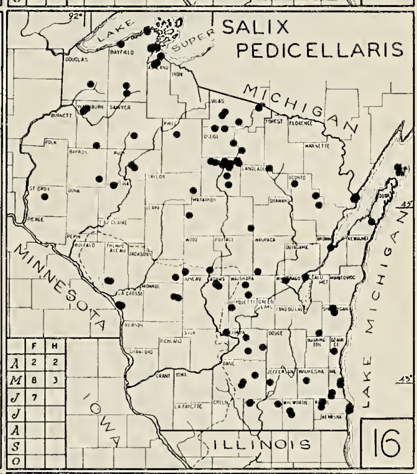
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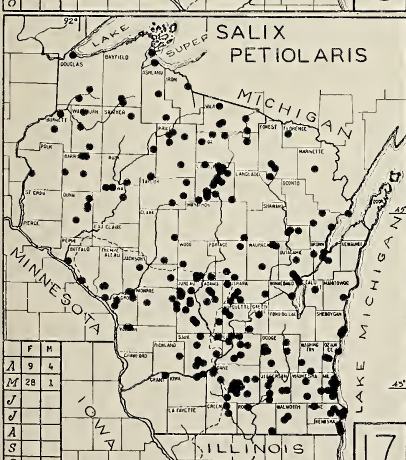
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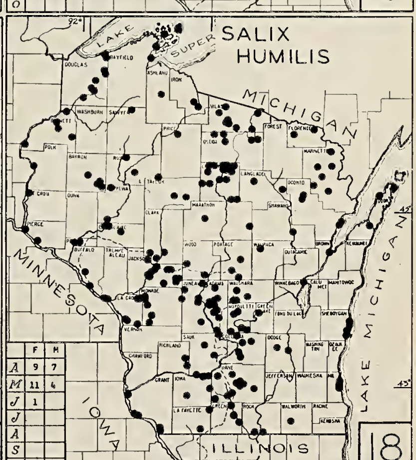
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long, pubescent; stipules small, usually less than 2 mm long, deciduous. Aments coetaneous or subprecocious, borne on reproductive branchlets. Staminate aments 1.5–2.5 cm long; reproductive branchlets 3–6 mm long; stamens 2, filaments pilose at base, distinct or partly coalescent; bracts (in both sexes) lanceolate, yellowish to tawny, thinly pilose to long pubescent, 2 mm long. Pistillate aments loosely flowered, often lax, 3.5–6 cm long, reproductive branchlets 3–10 mm long; pistils lanceolate, long beaked, gray sericeous, capsules pubescent, 3–7 mm long; styles obsolete; stigmas short; pedicels 2–3.5 mm long; glands adaxial, half as long as the bract. Based on 44 staminate, 141 pistillate, and 112 vegetative specimens.

Salix bebbiana is a very common shrub in Wisconsin and occurs in a wide variety of habitats. In northern Wisconsin it is known from *Larix-Picea mariana* forests on the edge of open bogs, thickets of *Abies balsamea, Thuja occidentalis,* and *Picea glauca;* in the central portion from rich deciduous woods, *Quercus* scrub, swamps, alkaline sedge meadows, and *Larix* bogs; and in the south from bogs, willow swamps, and virgin prairie where it may be associated with *Andropogon gerardi, Carex, Cornus racemosa, Corylus americana* and scattered *Quercus macrocarpa.* Throughout the state it is commonly encountered in old fields and along roadsides.

The variation in *Salix bebbiana* is highly complex. Its extremes of variation in leaf pubescence and rugosity have been typified by var. *bebbiana* which has pubescent and rugose leaves, and var. *perrostrata* which has glabrescent and plane leaves. These characteristics seem to be influenced by the time of initiation and development of the leaves, the stage of leaf development, and the external environment. Leaves which develop later in the season, especially on vigorous or sprout shoots, are more rugose and pubescent than those which developed earlier. Presumably these leaves were initiated and developed during the same season. Many of the specimens identified as var. *perrostrata* are immature and may become more rugose in age. Individual shrubs, or even branches, growing under shade conditions often produce leaves which are less pubescent, thinner, and more plane than usual, and this may account for some of the leaves of the *perrostrata* type in *S. bebbiana.* Insect attack may stimulate the host to produce densely pubescent shoots and leaves (see: *Cheney 7473,* LaChapelle to mouth of Brule R., Wis., 17 July 1897, (WIS, MIL)). This condition is also known to occur in *S. interior.* Most Wisconsin material represents some stage of intermediacy between the extremes of leaf pubescence and rugosity and the recognition of intraspecific taxa on the basis of this variation is of doubtful validity. I agree with Raup (1959) and others in placing *S. bebbiana* var. *perrostrata* in synonymy.

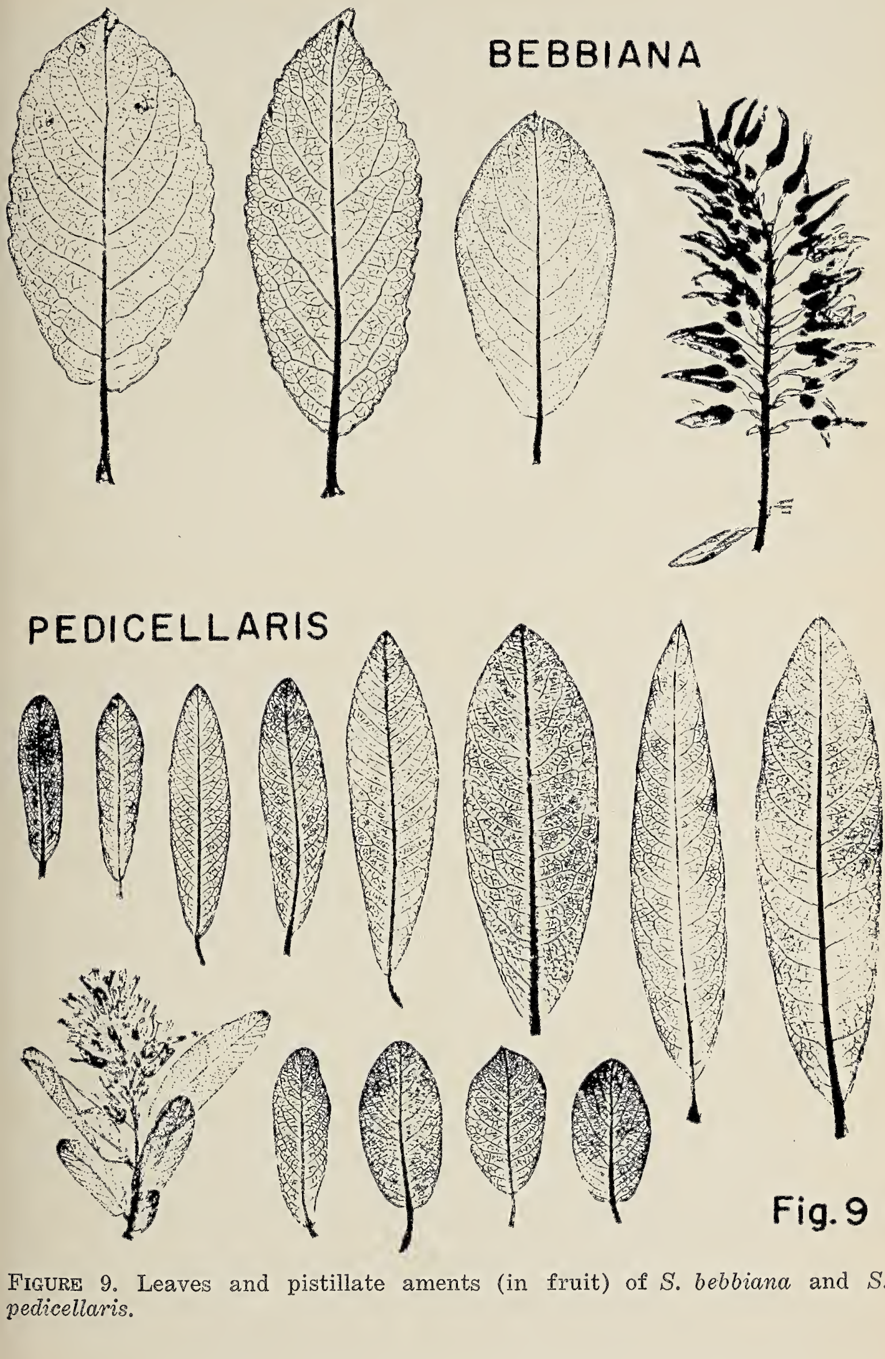


FIGURE 9. Leaves and pistillate aments (in fruit) of *S. bebbiana* and *S. pedicellaris*.

The leaf margins vary from entire to crenate or irregularly toothed. This variation, similar to that discussed above, seems to be correlated with the time of leaf development, or perhaps initiation. The proximal (lowermost) leaves on almost all shoots have entire margins, and the distal leaves have margins crenate to toothed. It is possible that the distal, toothed leaves are not only developed later in the season but initiated during the season of their development. Evidence supporting this hypothesis is found in the observation that all the leaves are often toothed on sprout shoots and shoots located in the axil of the same year's leaf. For example see *F. C. Seymour 14389*, Lincoln Co., Wis., Tomahawk, 10 July 1952, (WIS); and *12184*, Lincoln Co., Wis., Pine R., 27 Aug. 1950, (WIS). This possible correlation of variation with seasonal development and/or initiation emphasizes the need for thorough developmental and autecological studies of *Salix bebbiana.*

Sect. ROSEAE Andersson

16. SALIX PEDICELLARIS Pursh Fl. Am. Sept. 2:611. 1814.
Bog Willow Map 16, Fig. 9.

S. pedicellaris var. *hypoglauca* Fern.

Low shrubs 20–70 cm tall, rarely to 2.5 m, loosely branched or simple, often partly decumbent and rooting along the branches; branchlets glabrous, yellowish, becoming reddish brown and grayish in age. Leaf blade oblong, elliptic-oblong, narrowly oblanceolate, obovate, or oblanceolate, (1.9–)2.5–4.7(–6.9) cm long, 0.6–1.3 (–2.2) cm wide, length/width (1.9–)2.5–4(–4.9), apex obtuse to rounded or acute, base narrowed, obtuse to acute, margin entire, revolute, mature leaves subcoriaceous, dark green, glabrous, and with fine but prominent veination above, glaucous and with prominent midrib beneath; petiole (2–)3–5(–6) mm long; exstipulate. Aments coetaneous, borne on reproductive branchlets. Staminate aments 0.5–2 cm long; reproductive branchlets 0.5–1 cm long; stamens 2, filaments glabrous, distinct or partly coalescent, bracts (in both sexes) tawny, sparsely pubescent on adaxial surface, glabrous abaxially. Pistillate aments loosely flowered, broad, 1.5–3 cm long; reproductive branchlets 1–1.5 or up to 5 cm long; pistils glabrous, dark red or yellow, capsules becoming yellow to brown, 4–6 (–8) mm long; styles very short or obsolete; pedicels 2–3 mm long. Based on 7 staminate, 58 pistillate, and 31 vegetative specimens.

Salix pedicellaris is a bog species found in open *Sphagnum-Chamaedaphne* bogs, *Larix-Sphagnum* bogs, *Larix, Picea, Pinus strobus* and *P. resinosa* bogs, and floating bogs. It also occurs along lake shores and in moist to wet *Acer rubrum-Pinus strobus* northern hardwoods.

In 1909 Fernald proposed names for three variations of *Salix pedicellaris*. The commonest variant (var. *hypoglauca)* had leaves obovate-oblong and glaucous beneath. The second variant (var. *pedicellaris)* was uncommon and although similar to the first had leaves which were green on both sides. The third variant (var. *tenuescens)* was narrow leaved and similar in other respects to var. *hypoglauca*. The two names which are most important in Wisconsin are var. *hypoglauca* and var. *pedicellaris*. Evidence obtained from Wisconsin specimens suggests that the grounds for distinguishing between these names, i.e. the absence of leaf glaucescence, in one variety is simply an artifact and not of taxonomic importance. It is well known that leaf glaucescence may be driven off in drying specimens over excessive heat. I have seen 4 Wisconsin specimens of *S. pedicellaris* with leaves green on both sides. In one of these *(H. Iltis 13688,* Oconto Co., Wis., Island Lake, 11 July 1959, WIS) a duplicate specimen (in Argus collection) had leaves which were partly and irregularly glaucous beneath giving every indication that it had been dried over excessive heat which drove off some of the waxy bloom. The other three specimens may have been similarly affected.

The material that Fernald cites in his description of var. *hypoglauca* has been noted by Schneider (1920) to have leaves ". . . with at least a partly more or less glaucescent undersurface." In the light of the knowledge that leaf glaucescence is, at best, a fickle characteristic I am not recognizing the name *Salix pedicellaris* var. *hypoglauca* in Wisconsin. A complete study of this species should be undertaken to finally settle the status of the proposed intraspecific taxa.

Sect. GRISEAE Borrer

17. SALIX PETIOLARIS J. E. Smith, Trans. Linn. Soc. 6:122. 1802.
Slender Willow Map 17, Fig. 10.

S. gracilis Anderss.

Shrubs 1–3 m tall; branches slender, dark brown, drying blackish and glabrate, rarely pruinose; branchlets yellow-green to brown, pubescent. Leaf blade linear to lanceolate, 3.8–11 cm long, 0.6–1.9 cm wide on flowering specimens, 3.8–6.8 cm long, 0.8–1 cm wide on fruiting specimens, length/width 5–7(–9), apex acuminate, base acute, margin serrate with sharp sometimes prolonged teeth, to irregularly and distantly serrate or subentire, immature leaves velutinous-sericeous, often with ferruginous trichomes, mature leaves glabrate or remaining more or less sericeous, green and glabrate above, midrib pubescent, glaucous and glabrate to thinly sericeous beneath, often drying black; petiole 3–10 mm long, yellow and pubescent; stipules absent or minute and caducous. Aments coetaneous, sessile or on reproductive branchlets. Staminate aments 1.2–2 cm long, sessile or reproductive branchlets 1–2 mm long; anthers 2, filaments glabrous or pubescent at base, distinct; bracts (in both sexes) oblong, 1–2 mm long, brown, pubescent. Pistillate aments broad and sometimes lax in fruit, 1.5–3–3.5 cm long; reproductive branchlets 3–7 mm long; pistils densely sericeous, capsules finely sericeous, lanceolate, slender beaked, 5–8 mm long; styles obsolete; stigmas short; pedicels sericeous, 1.5–4 mm long; glands adaxial, small. Based on 20 staminate, 98 pistillate, and 102 vegetative specimens.

Salix petiolaris is a common shrub occurring in a variety of habitats from sandy or peaty low prairie (with *Sorghastrum, Castilleja coccinea, Viola sagittata,* and *V. lanceolata),* sand prairies (with *Artemisia caudata, Viola adunca,* and *Antennaria),* sandy lakeshores and thickets (including dunes); to damp, low, rich deciduous woods (with *Ulmus, Tilia, Acer, Betula,* and *Quercus macrocarpa),* and northern hardwoods (with *Acer rubrum* and *Pinus strobus,* or *Abies, Picea, Tsuga,* and *Acer);* to lake edge communities including *Juncus-Carex* meadows; and peat bogs (with *Picea, Larix,* and *Sphagnum*). It also occurs in waste places along roadsides and railroad rights-of-way.

There has been considerable discussion in the literature concerning the correct name for this species (see: Schneider, 1920:16–19; Fernald, 1946:46–48; Ball, 1948; and Raup, 1959:84–85). One view is that *Salix petiolaris* is an English "tree" and has nothing to do with the North American taxon whose correct name is *S. gracilis* (Fernald, 1946); the other view is that the type of *S. petiolaris* was a specimen introduced from eastern North America into an English garden and described in a more or less atypical form (Ball, 1948). Although there is a large measure of subjectivity in both arguments, Ball's argument is the most convincing, and it seems most likely that *S. petiolaris* was based on material of American origin. For the time being I will continue to recognize *S. petiolaris* as the name applicable to the North American taxon.

This nomenclatural dispute has brought to light the east-west geographic variation which occurs in this species. A species concept based on *S. petiolaris,* whose type is presumably of eastern American origin, has large leaves (4–10 cm long, 2 cm wide) with prominently serrate margins. A concept based on *S. gracilis,* described from material from Cumberland House, Saskatchewan, has leaves somewhat smaller (2.5–7 cm long, 3–11 mm wide) and margins often subentire. Most of the material from Wisconsin is of the east-

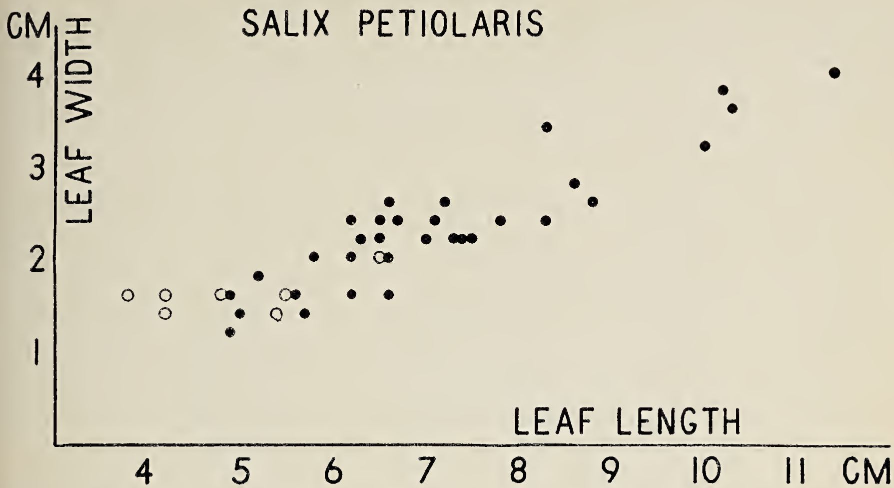


FIGURE 12. Leaf length and width of *Salix petiolaris* in Wisconsin. The scatter diagram compares leaf length and leaf width of fruiting (open circles) and vegetative (closed circles) specimens. See text for discussion.

ern type (Fig. 12) although there is considerable variation in leaf size. This variation seems to be correlated with either the stage of ontogenetic development or a difference in leaf size on vegetative and reproductive branches. Specimens with subentire leaves are rare in Wisconsin. A study of population and geographic variation in this taxon would contribute to an understanding of the intraspecific variation which may be related to postglacial plant migrations.

A close relationship seems to exist between *Salix petiolaris* and *S. sericea*. However, on the basis of the available material of *S. sericea* the relationship cannot be fully explained. These species can be distinguished by the narrow beaked ovaries, coetaneous aments, longer reproductive branchlets, and generally glabrate mature leaves of *S. petiolaris* contrasted with the blunt ovaries, apparently precocious aments, very short or absent reproductive branchlets, and finely sericeous undersurface of leaves in *S. sericea*.

Specimens of *Salix petiolaris* with permanently sericeous leaves do occur in Wisconsin, and they have generally been named *S. sericea*, although they are clearly of the *S. petiolaris* type. These specimens may fit the concept of *S.* × *subsericea* (Anderss.) Schneid. Ill. Handb. Laubholzk. 1:65, 1904, a hybridogenous taxon supposedly representing *S. petiolaris* × *S. sericea*. I am reluctant to regard those specimens with coarsely sericeous leaves as *S. sericea* or as the above hybrid. The reasons are two, (1) a more or less continuous variation in leaf pubescence can be observed in *Salix petiolaris,* and (2) typical *S. sericea* is extremely rare in the state and unknown from the localities in which the sericeous form of *S. petiolaris* occurs.

Specimens which represent the sericeous form of *Salix petiolaris* in Wisconsin include: *Heyns, Laferriere, Meyer,* and *Nichols,* Columbia Co., 29 Apr., 14 May, and 31 May 1960 (a successive collection) ; *M. Johnson 29,* Wood Co., 20 May 1960; *F. Seymour 15743,* Lincoln Co., Pine R., 8 July 1954; *H. Gale,* et al., Oconto Co., Lena, 25 June 1958; *H. Iltis 15132,* Waushara Co., Wautoma, 1 Sept. 1959; *15237,* Portage Co., Rosholt, 2 Sept. 1959; *K. White 708,* Columbia Co., Portage, 30 Aug. 1960; *293,* Dane Co., Stoughton, 15 June 1960; *415,* Dodge Co., Horicon, 7 July 1960 (WIS).

18. SALIX SERICEA Marsh. Arbust. Am. 140. 1785.

Map 11, Fig. 10.

Shrubs 1–3 m tall; branchlets glabrate, light brown to dark brown. Leaf blade narrowly lanceolate, 4–10 cm long, 1–2.5 cm wide, apex acuminate, base acute, margin serrulate, immature leaves sericeous on both surfaces, mature leaves puberulent to glabrescent above, silvery sericeous beneath, blackening in drying; petiole 5–10 mm long; stipules on sprout shoots lanceolate, deciduous. Aments apparently precocious, sessile or borne on short reproductive branchlets. Staminate aments (unknown from Wisconsin) 1–2.5 cm long; stamens 2, filaments distinct, pubescent at base; bracts (in both sexes) dark brown to blackish. Pistillate aments 1–2.5 cm long; reproductive branchlets 2–10 mm long; capsules blunt, sericeous, 3–5 mm long; styles obsolete; stigmas short; pedicels 1–2 mm long. Based on 3 pistillate, 4 vegetative specimens, and the literature.

Salix sericea occurs in Wisconsin in wet, boggy soils and sand terraces along rivers and on ledges above rivers.

This species is rare in Wisconsin and unequivocal specimens are known from only the following: Clark Co.: Neillsville, 1915, *Goessl s.n.* (WIS) ; Jackson Co.: Ledges along Black River, near Hatfield, *Fassett & Schmidt 15495* (WIS) ; shrub, moist acid meadow near the Black River, sect. 36, Melrose Township, *Hartley & Hartley 3136a* (WIS) ; Richland Co.: sand terraces of the Wisconsin River, 1 mi. south of Gotham, *Hartley 5234* (IU). A fourth specimen may have been collected at Beloit, but it is on a sheet with specimens from New York and the locality is in doubt. *Salix sericea* is closely related to *S. petiolaris* (see that species). Pistillate Wisconsin specimens have a very low level of seed formation suggesting that they may be hybrids.

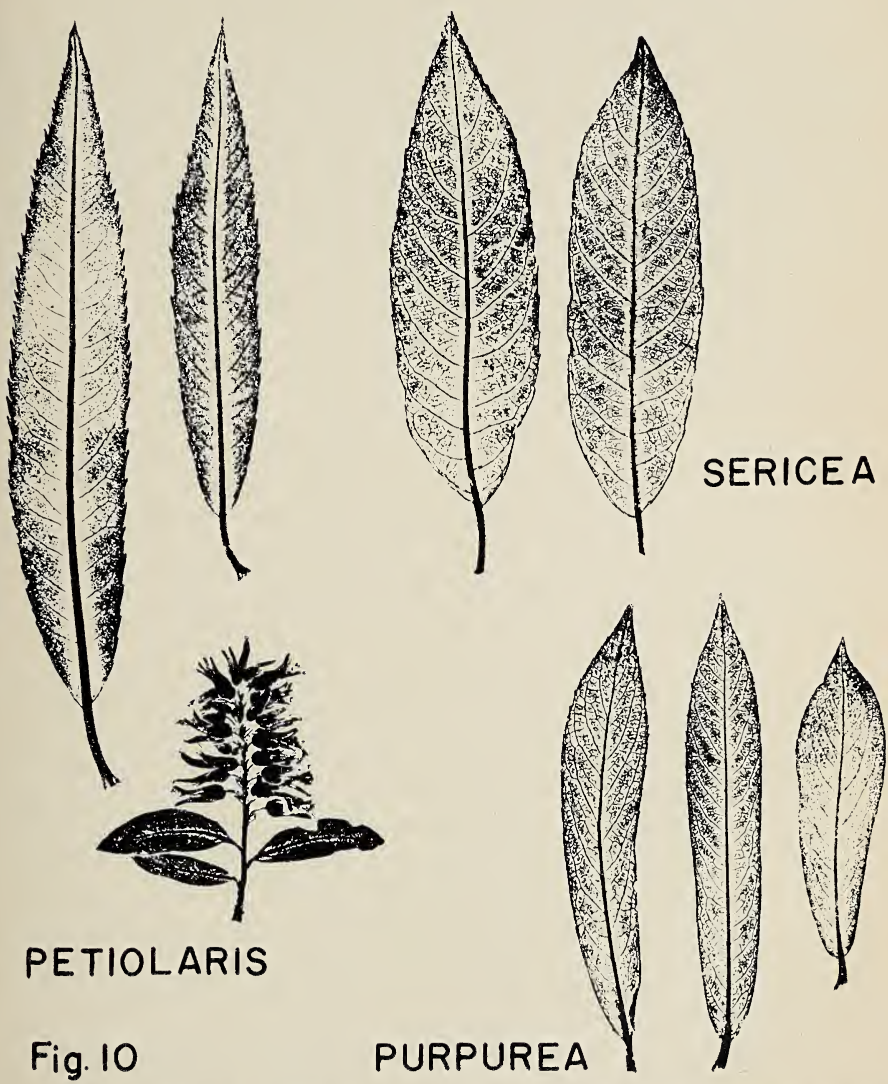


FIGURE 10. Leaves of *S. petiolaris*, *S. sericea*, and *S. purpurea*. Pistillate ament of *S. petiolaris* in fruit.

Sect. CAPREAE Bluff and Fingerhuth

19. SALIX HUMILIS Marsh. Arbust. Am. 140. 1785.
Upland Willow, Prairie Willow Map 18, Fig. 11.

S. tristis Ait.
S. humilis var. *microphylla* (Anderss.) Fern.

Shrubs 1–3 m tall; branchlets yellow to brown, densely pubescent to glabrate, dull, drying dark. Leaf blade narrowly to broadly oblanceolate, sometimes obovate, 4–10 cm long, 0.8–1.9(–2.7) cm wide, length/width 3.2–5(–6.3), apex acute to short acuminate, base acute, margin subentire, undulate or crenate, revolute, immature leaves tomentose, sometimes with ferruginous trichomes, mature leaves pubescent to glabrate, gray-green above, rugose, pubescent-tomentose to glabrate and glaucous beneath; petiole (2–) 5–10 (–15) mm long, yellow, pubescent; stipules narrow, deciduous, 3–11 mm long. Aments precocious, sessile. Staminate aments 7–15 mm long, sessile, usually subtended by several light colored, sterile bracts; stamens 2, anthers often reddish (drying purple), filaments glabrous, distinct; bracts (in both sexes) 1.5–2 mm long, brown to black, or often bicolored, long villous. Pistillate aments (0.6–1–) 1.3–4(–5) cm long, subsessile often on short reproductive branchlets with several sterile, light colored or greenish bracts; pistils gray sericeous, capsules long beaked, 4–7 mm long, thinly pubescent; styles short; stigmas short; pedicels 1–2.5 mm long; gland adaxial. Based on 25 staminate, 76 pistillate, and 131 vegetative specimens.

Salix humilis commonly occurs in wet or wet-mesic prairie where it has been collected in association with *Andropogon gerardi, Carex, Cornus racemosa* and *Corylus americana.* It also occurs on sandy uplands in pine barrens with *Pinus banksiana* and *Quercus,* in oak barrens associated with *Quercus velutina* and *Q. alba,* and around the base of sandstone bluffs. It has also been collected in willow thickets grading into *Carex-Typha* "swinging" mats, and *Sphagnum* bogs.

Salix humilis and the related *S. discolor* are the earliest flowering species in Wisconsin and, as a result, they are the most conspicuous willows in the early spring. These species have precocious aments and flower in April and early May.

Salix humilis is a variable species which intergrades in one direction with *S. discolor* and in another with *S. scouleriana* Barratt. The glabrate leaved form (var. *hyporhysa* Fern. Rhodora 48:45. 1946) probably represents intergradation with *S. discolor* (see discussion under that species), and the tomentose leaved form (var. *keweenawensis* Farwell, Rep. Mich. Acad. Sci. 6:206. 1904) repre-

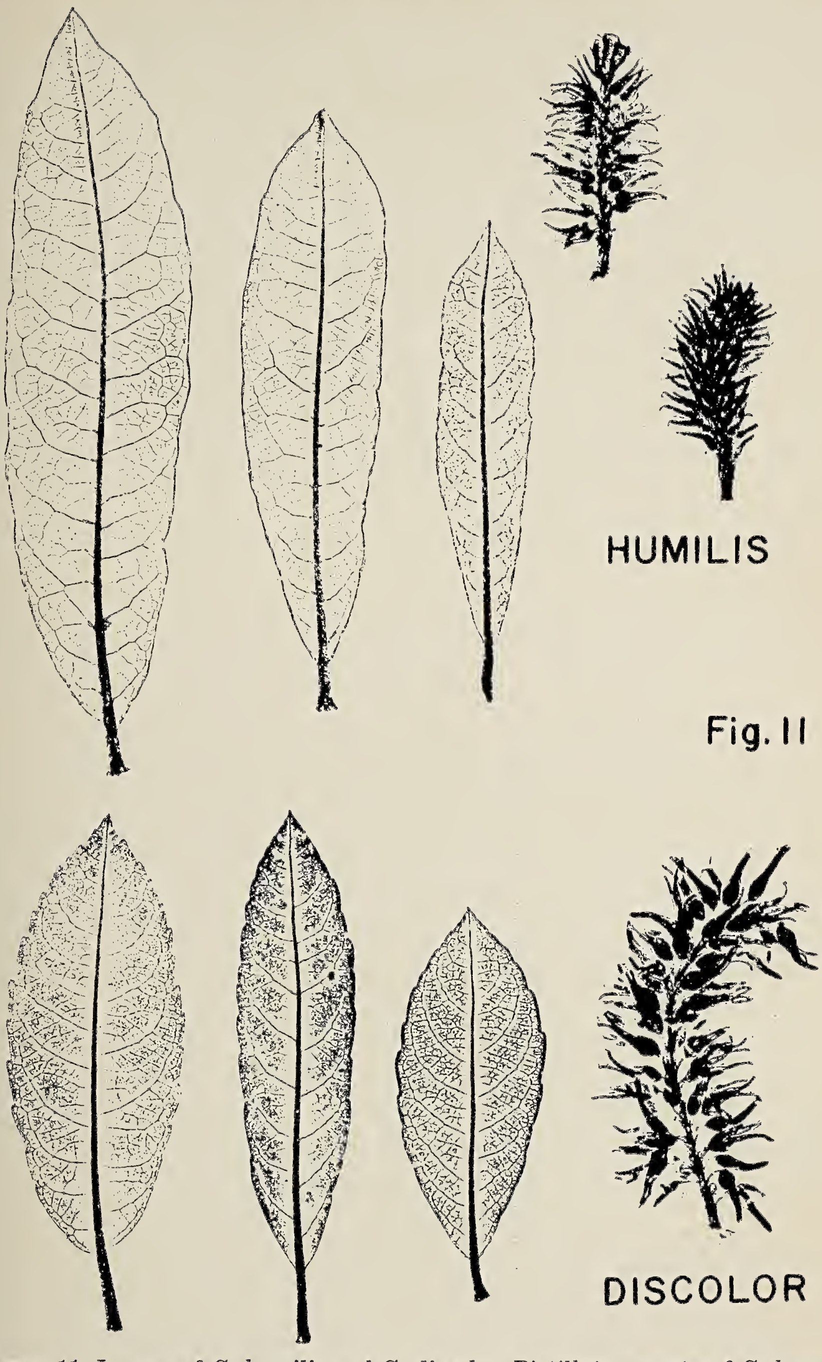


FIGURE 11. Leaves of *S. humilis* and *S. discolor*. Pistillate aments of *S. humilis* (upper in fruit, lower in flower) and *S. discolor* (in fruit).

sents intergradation with *S. scouleriana*. The problems in identification which are posed by this variation are of considerable importance, especially to ecologists who may be identifying sterile specimens. The intergradation with *S. scouleriana* is not of particular importance in Wisconsin but it becomes an acute problem in southern Ontario and Manitoba. It may be that this intergradation is due to hybridization, but this is speculation in the absence of experimental evidence. The total variation based on population studies is not yet available for these three species (*S. discolor, S. humilis,* and *S. scouleriana*) and this poses an obstacle to the understanding of any of these taxa.

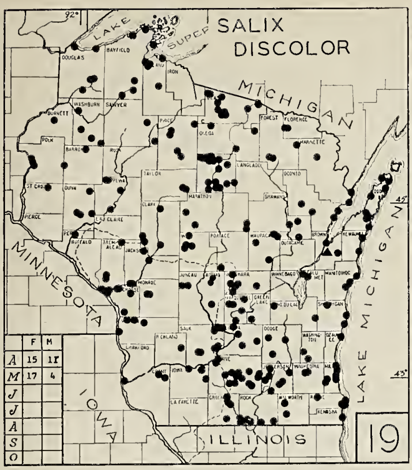
A diminutive form of *Salix humilis* which occurs in Wisconsin has been named *S. tristis* Ait., or *S. humilis* var. *microphylla* Fern. It is distinguished from the species on the basis of the small size of all its organs and may represent a prairie ecotoype or perhaps an ecophene (a reversible ecological modification). Whether or not this is so remains to be studied.

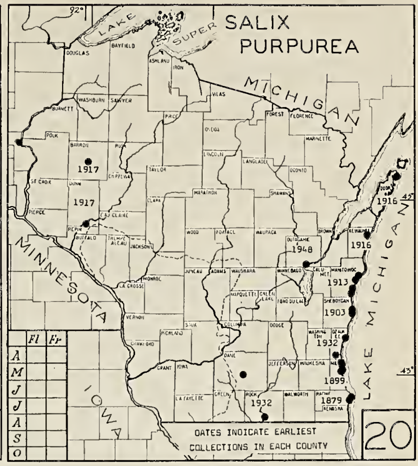
None of the forementioned varieties have been distinguished in this study.

20. SALIX DISCOLOR Muhl. Neue Schr. Ges. Nat. Fr. Berlin 4:234. 1803.

Pussy Willow — Map 19, Fig. 11.

Shrubs or small trees 2–3(–6) m tall; branchlets reddish to dark brown, pubescent, usually becoming glabrate the same year but sometimes remaining pubescent; branches glabrous and sometimes pruinose. Leaf blade narrowly to broadly elliptic, oblanceolate or lanceolate, 3.7–8(–11) cm long, 1.2–3 cm wide, length/width (2.3–)3–3.5(–4.5), apex acute to subacuminate, base obtuse to acute, margin crenate to serrate, immature leaves mostly thinly pubescent composed in part of caducous ferruginous trichomes, sometimes densely pubescent, blade usually thin and commonly reddish, mature leaves glabrate and dark green above, glabrate to puberulent, and glaucous beneath; petiole 7–17 mm long, often pubescent; stipules present, prominent on sprout shoots. Aments precocious, sessile or subsessile. Staminate aments sessile usually with several sterile, yellowish or greenish bracts at the base, 2–3.5 cm long; stamens 2, filaments glabrous or puberulent at the base, distinct; bracts black, brown or bicolored, 1.5–2.5 mm long, acute to rounded at apex, long villous. Pistillate aments densely flowered, sometimes becoming loosely flowered in fruit (2.5–3.5–) 4–7 cm long, up to 9.5 cm in fruit; sessile or subsessile with several sterile, light colored bracts at the base, rarely borne on a reproductive branchlet (see discussion); pistils densely sericeous, capsules





long beaked, pubescent to puberulent, 6–11 mm long; styles 0.5–0.8 mm long; stigmas as long or longer than the styles, up to 1 mm long; pedicels 2–2.5 mm long, bracts black to brown, broad, 1.5–2 mm long, sometimes oblong and up to 3 mm long, long villous to pubescent; glands adaxial, 0.5–0.8 mm long. Based on 24 staminate, 97 pistillate, and 127 vegetative specimens.

Salix discolor commonly occurs in willow thickets along rivers, wet margins of lakes (in *Juncus-Carex* or *Carex*-grass meadows), and in *Chamaedaphne-Sphagnum* bogs. It also occurs in *Acer rubrum-Betula* northern hardwoods, *Quercus bicolor-Fraxinus-Acer saccharinum-Betula nigra* bottomland woods, pine barrens, dry sandy beaches, and prairies. It is a component of the shrub carr in association with other willows including *S. bebbiana, S. interior* and *S. petiolaris.*

This species is highly variable; however, the factors which influence the variation are poorly understood. Two of the many varieties and forms of *Salix discolor* which have been described are often found in modern literature. The typical variety of *S. discolor* is characterized by glabrous branchlets, or, if pilose, soon becoming glabrate, and leaves early glabrate. The var. *latifolia* Anderss. (Sv. Vet-akad. Handl. 6:84. 1867) is characterized by pubescent branchlets which remain puberulent in the second year, and leaves puberulent beneath and often retaining ferruginous trichomes. This variation in pubescence is not extraordinary in *Salix* and has been described in *S. bebbiana, S. humilis, S. interior,* et al. The pubescent form of *S. discolor* (var. *latifolia*) intergrades with *S. humilis* (see that species) and raises the problem of identification of some vegetative specimens and the question of hybridization between *S. dis-*

color and *S. humilis*. Hybridization may be more common than is suggested by the present circumscription of these taxa and it may be that specimens referrable to var. *latifolia* are of hybrid origin. A parallel situation may exist in relation to the glabrate form of *S. humilis* (var. *hyporhysa*) which is discussed under that species. The possibility of hybridization between these two common species deserves careful field study and experimental hybridization. I have not attempted to formally recognize *S. discolor* var. *latifolia* in my annotations of Wisconsin specimens.

The aments of *Salix discolor* are usually sessile or subsessile. However, there are several specimens which have aments borne on reproductive branchlets 8–25 mm long, and represent exceptions to this statement. The specimens are: *W. Finger,* Milwaukee Co., 21 May 1908 (MIL), 20–25 mm long; *W. Derr, K. Rabideau, B. Smith 27,* Iowa Co., Lone Rock, 14 May 1961 (WIS), 8–10 mm long; and *P. Wise,* Sauk Co., Leland, 19 May 1961 (WIS), 8–10 mm long.

The formulation of a clear concept of *Salix discolor* has been handicapped by its precocious nature and the manner in which collections are made. This species flowers early and the aments are deciduous before the leaves mature. Therefore, most herbarium collections represent either fertile or vegetative material, but rarely both. This problem can be largely eliminated by applying the technique of successive collection. Such collections would enable the student to relate fertile and vegetative material and permit a more meaningful evaluation of putative hybrids or ecological modifications.

I have examined several vegetative specimens which have been determined as *Salix planifolia* Pursh. Their leaves are smaller than usual for *S. discolor,* but they are similar to that species in all other respects. In the absence of flowering or fruiting specimens of *S. planifolia* I cannot recognize that species in Wisconsin and I have referred material so identified to *S. discolor.*

Sect. VIMINALIS Bluff and Fingerhuth

21. SALIX VIMINALIS L. Sp. Pl. 1021. 1753. Osier

Introduced shrubs or small trees; branchlets yellowish to reddish brown, puberulent and becoming glabrous. Leaf blade linear to linear-lanceolate, 12–17 (–25) cm long, 0.5–1 cm wide, apex long acuminate, base acute, margin entire, revolute, mature leaves dull green and puberulent above, densely sericeous beneath, midrib yellow; petiole slender, up to 1 cm long; stipules narrow, caducous. Aments precocious, sessile. Staminate aments 2–3 cm long, sessile;

stamens 2, filaments slender, glabrous, distinct; bracts (in both sexes) acutish, black, long villous. Pistillate aments up to 4–6 cm long, sessile; capsules 4–6 mm long, subsessile, densely sericeous; styles 0.7–1.2 mm long; stigmas short. $2n = 38$ (Darlington and Wylie, 1955). Based on 2 staminate, 2 vegative specimens (all possible hybrids), and the literature.

Salix viminalis is a species introduced from Europe. It is not known to occur as an escape in Wisconsin.

All of the specimens I have seen from Wisconsin are possible hybrids. The typical form of the species is unknown in Wisconsin.

SALIX INCANA Schrank, Baier. Fl. I: 230. 1789

A specimen which may represent this species was seen in the W. P. Fraser Herbarium (*L. H. Shinners,* Milwaukee, 10 Aug. 1940 (SASK). It is an introduced, cultivated species very similar to *Salix viminalis.* From that species it differs in being a lower shrub with shorter acute leaves, pistillate aments shorter in fruit (1–2 cm vs. 4–6 cm long) and pedicellate capsules (Fernald, 1950). This species is of doubtful occurrence in Wisconsin and is not included in the keys.

Sect. HELIX Dumortier

22. SALIX PURPUREA L. Sp. Pl. 1017. 1753.
Purple Osier Map 20, Fig. 10.

Introduced shrubs 1–2.5 m tall; branchlets slender, glabrous, yellow, green to brown, sometimes purplish on immature branchlets. Leaf blade spatulate to linear, 3.4–6.8 cm long, 0.8–1 cm wide, apex acute to acuminate, base obtuse, margin entire on basal portion, irregularly serrulate above, glabrous, glaucous beneath, subopposite; petiole 2–6 mm long; exstipulate. Aments precocious, sessile or subsessile. Staminate aments 2–3 cm long, narrow, sessile or subsessile, subtended by several yellowish or green bracts, aments usually in subopposite pairs; stamens 2, filaments pubescent on lower half, filaments and anthers often coalescent; bracts (in both sexes) obovate, bicolor or black, pubescent, often reflexed in anthesis. Pistillate aments 2–3 cm long, narrow, subsessile and bracteate; pistils densely pubescent, capsules pubescent, ovoid, 3 mm long, sessile; styles and stigmas minute. $2n = 38$ (Darlington and Wylie, 1955). Based on 10 staminate, 2 pistillate, 14 vegetative specimens, and the literature.

Salix purpurea was introduced into North America from Europe during colonial times. It is found widely as an apparent escape and may occur along river banks, lake shores (especially Lake Michigan), wooded ravines, sandy beaches, or along roadsides and in waste places.

This species is characterized by its subopposite leaves and aments, its coalescent filaments and anthers, and its prominently bicolored bracts.

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PRELIMINARY REPORTS ON THE FLORA OF WISCONSIN. NO. 52. GENTIANA HYBRIDS IN WISCONSIN[1]

James S. Pringle
Royal Botanical Gardens, Hamilton, Ontario

The species of *Gentiana (sensu stricto)* native to Wisconsin appear to exhibit a remarkable degree of interfertility even among species morphologically very diverse. The isolation of the species is probably largely due to such factors as past geographic separation, phenology (seasonal isolation), and small population size rather than to genetic barriers. All of the four species indigenous to Wisconsin appear occasionally to hybridize within the state. Descriptions and illustrations of the hybrids known from Wisconsin are presented here, which, with Dr. Mason's (1965) descriptions of the species, will much facilitate the identification of any specimen of *Gentiana* likely to be collected in the state.

The Herbarium of the University of Wisconsin contains an exceptionally excellent collection of *Gentiana* which has been most useful in this study. The private collection and notes of the late Dr. J. T. Curtis of the University of Wisconsin, who was especially interested in gentian hybridization, were made available through the kindness of Mrs. Curtis and have been very valuable. The illustrations in this paper (Figs. 1–12) are photographs of these remarkable collections as they are mounted and labelled in Curtis' notebook. The collection of S. C. Wadmond, late of Delavan, Wisconsin, in the Herbarium of the University of Minnesota, has also been useful. The photographs of Dr. Curtis's specimens are by Mr. Max A. Gratzl, photographer of the University of Wisconsin Botany Department.

KEY TO THE GENTIANA HYBRIDS OF WISCONSIN

A. Leaves glaucous; involucral leaves ascending, enveloping the lower portions of the calyces; calyx tubes hyaline ---4. *G.* x *grandilacustris*.

AA. Leaves not glaucous; involucral leaves spreading, not enveloping calyces; calyx tubes not hyaline.

B. Appendages of corollas 1.5 mm high or more; corolla lobes as high as broad, conspicuously exceeding the appendages; stems puberulent or glabrous.

[1] Contribution No. 3 from the Royal Botanical Gardens, Hamilton, Ontario, Canada.

C. Appendages obliquely triangular; corollas pale to medium blue; calyx lobes slightly keeled ______________ _________________________________2. *G.* x *curtisii.*

CC. Appendages nearly symmetrical, bifid; corollas deep blue; calyx lobes not keeled ________1. *G.* x *billingtonii.*

BB. Appendages lower, erose; corolla lobes broader than high, scarcely exceeding the appendages; stem glabrous _______ ______________________________3. *G.* x *pallidocyanea.*

The above key should generally be adequate for F_1 hybrids and most components of hybrid swarms. However, since segregation following hybridization sometimes results in the production of too wide a range of variation for satisfactory coverage in such a key, Table 1 has been included as an aid in the identification of problematic segregates. The characteristics listed are distinctive for the respective species and thus may serve as indicators of probable parentage when encountered in hybrids.

TABLE 1. SPECIFIC TRAITS OF GENTIANA USEFUL IN DETERMINING PROBABLE PARENTAGE OF HYBRIDS

Trait	Species
Stems puberulent	*G. puberula*
Upper internodes long	*G. rubricaulis*
Leaves glaucous, pale bluish- or grayish-green	*G. rubricaulis*
Leaves yellowish-green, relatively large	*G. alba*
Involucral leaves ascending, folded, enveloping calyces	*G. rubricaulis*
Lower leaves linear-oblong	*G. rubricaulis*
Calyx tubes hyaline	*G. rubricaulis*
Calyx lobes keeled, pushed to one side in pressing	*G. alba*
Corollas pale, whitish or yellowish	*G. alba* (and albinos)
Corollas banded or suffused externally with green	*G. puberula*
Corolla lobes large, ovate, spreading (open)	*G. puberula*
Corolla lobes very small, connivent (closed)	*G. andrewsii*
Corolla appendages (plaits) bifid	*G. puberula* and *G. andrewsii*
Corolla appendages with attenuate divisions	*G. puberula*
Corolla appendages symmetrical, broad, truncate	*G. andrewsii*
Corolla appendages low, asymmetrically triangular	*G. alba* and *G. rubricaulis*
Anthers separate	*G. puberula* (and sometimes *G. alba*)

1. GENTIANA X BILLINGTONII Farw. pro sp. (*G. puberula* Michx. x *G. andrewsii* Griseb.)

Gentiana andrewsii and *G. puberula* are both species of the North American prairies. In Wisconsin, *G. andrewsii* is usually found in moister sites than in *G. puberula*. The incidence of hybridization of these species may also be limited by the differences in the forms of their corollas, since different pollinators may be attracted. The small size and wide separation of the populations in which all of the Wisconsin species of *Gentiana* usually occur may function as a barrier to genetic exchange among all of these species.

As shown in Figures 1 to 6, representing the remarkable hybrid populations from the low prairies north of Swan Lake in Columbia County, hybrids between *G. andrewsii* and *G. puberula* are intermediate between the parental species in several respects. The stems of the putative and experimental F_1 hybrids are usually sparsely puberulent. The leaves are oblong-lanceolate, not acuminate, and are widest near the base. The corolla lobes are intermediate in size and position, rounded-triangular, and usually 2 to 7 mm long. The calyx lobes are often longer and more foliaceous than those of either of the parent species. Both *G. andrewsii* and *G. puberula* have well-developed, subequally bifid corolla appendages (corolla plaits). Those of the hybrids are likewise bifid, with the divisions less attenuate than those of *G. puberula*. The corollas of both the parent species and their hybrids are characteristically deep blue. In some localities, a wide range of intermediates between these two species has been encountered.

The type specimen of *G.* x *billingtonii* is *Farwell 5678* (BLH; a numerical duplicate is in GH but this was never identified as "*G. billingtonii*" by Farwell). The type specimen, from Squirrel Island, Lambton County, Ontario, appears likely to be an F_1.

In some areas, mostly west of the Mississippi River from Saskatchewan to Missouri, populations of *G. andrewsii* occur in which the corolla lobes are not so much reduced as is usual in eastern populations. This variant, *G. andrewsii* var. *dakotica* A. Nels., may have arisen through the introgression of genetic material from *G. puberula* into *G. andrewsii*. Although occasional specimens from hybrid swarms in Wisconsin resemble this variety, e.g., that shown in Fig. 3 (Curtis No. 25 "? 9/15/52 not opening, plicae not visible on exterior. Backcross to Andrewsii?"), no uniform populations of this variety appear to have formed in this state. In comparison to the specimen illustrated in Fig. 3, characteristic var. *dakotica* from the Dakotas or Iowa would be expected to have more rounded corolla lobes.

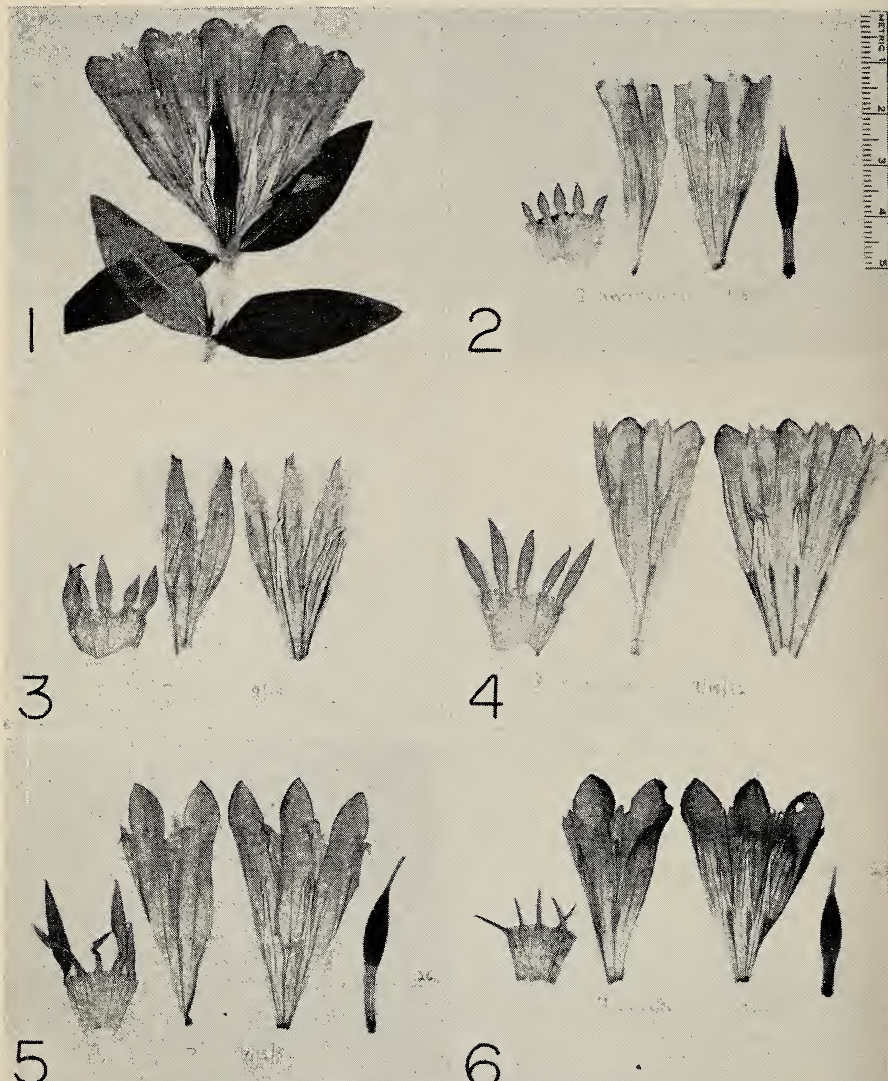
Wisconsin: Columbia Co.: prairie at Hwys SS and P, Town of Springvale, *Curtis s.n.*, 13 Sept. 1953 (WIS).

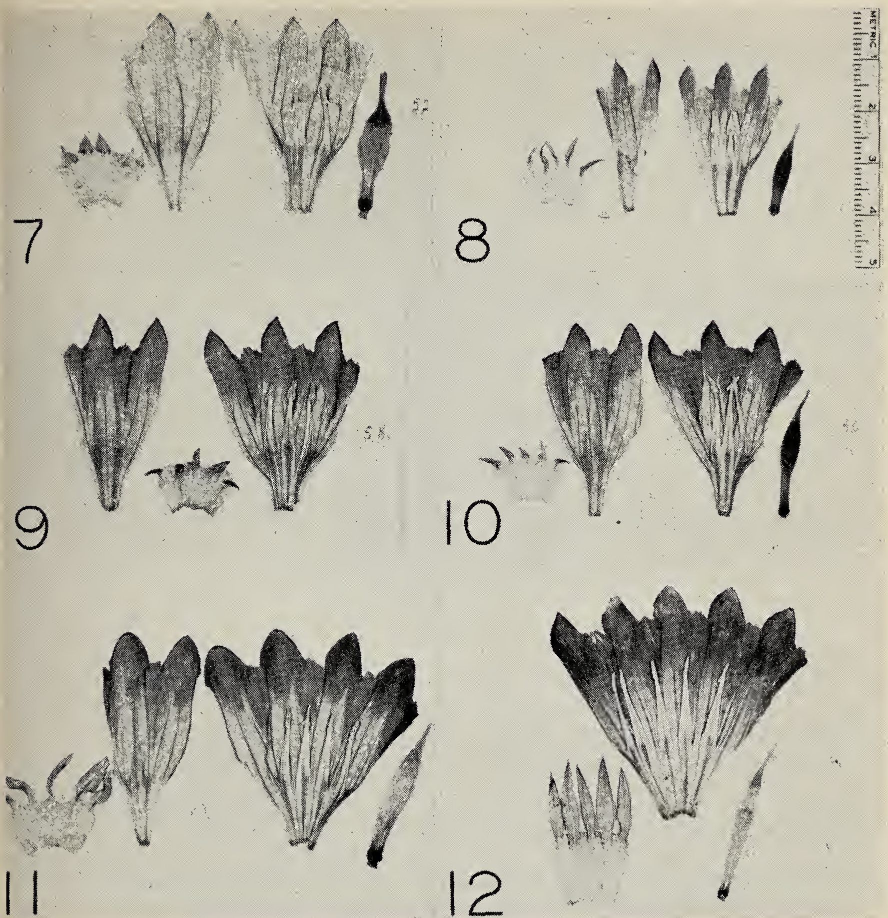
Green Co.: "Milwaukee" RR w of Brodhead at Park Road, *Fell 58–825*, 3 Sept. 1958 (WIS); *ibid.*, *Fell 58–889, 58–891*, 27 Sept. 1958 (WIS); s of Belleville between County Road CC and rr track, *Mason 1387*, 17 Sept. 1950 (WIS); along rr track, Exeter, S 32, R8E, T4N, *Mason 1393*, 17 Sept. 1950 (WIS); Belleville, 1 mi s of village, *Gale s.n.*, 2 Sept. 1949 (NHA).

Sauk Co.: Aldo Leopold shack north of Baraboo, *McCabe s.n.*, 8 Sept. 1945 (WIS); shack, Sec. 34, T13N, R7E, *Leopold s.n.*, 8 Sept. 1945 (WIS).

Walworth Co.: in prairie habitat, along rt-of-way of CMStP & Pac RR just w of Delavan city limits, *Wadmond s.n.*, 29 Sept. 1935 (WIS).

Curtis collection: 21, Exeter; *24, 25, 26,* Swan Lake; *29,* Pardeeville; *30, 31,* s of Belleville; *35* through *42,* experimental; *32, 34,*





FIGURES 1–12. Calyces and corollas (cut longitudinally and flattened) of specimens of *Gentiana* in the collection of J. T. Curtis, × ⅔. FIGURE 1. An experimental F_1, *G. puberula* × *G. andrewsii*. FIGURES 2–6. Components of a hybrid swarm involving *G. puberula* and *G. andrewsii* from the low prairies north of Swan Lake, Columbia County, Wisconsin. FIGURES 7–12. Components of a hybrid swarm involving *G. puberula* and *G. alba*, also from Swan Lake. Legends on photographs are in the hand of Dr. Curtis.

Exeter; *33*, presumably experimental (Mason's # *S 52–30) 43, 44, 45*, experimental; unnumbered leaves.

2. GENTIANA X CURTISII Pringle[2] (*G. puberula* Michx. x *G. alba* Muhl.)

[2] **Gentiana x curtisii** Pringle, **hyb. nov.**, inter *Gentiana puberula* Michx. et *G. alba* Muhl. Caules aegre puberulentes. Foliae lanceolatae. Corollae pallido-cyaneae. Lobae corollarum suberectae, triangulae, conspicue reticulatae, 5–10 mm longae. Appendicies corollarum oblique triangulae, parviores quam lobae.

Typus: along Chicago & Northwestern Railroad, S 34, T2N, R13E, Rock County, Wisconsin, 20 Sept 1951, *Mason 1470* (WIS).

The hybridization of *Gentiana puberula* Michx. and *G. alba* Muhl. (*G. flavida* Gray) is also relatively frequent in southern Wisconsin. This hybridization is of special interest, since *G. puberula* is one of a group of species with large, bifid corolla appendages, open corollas, and ciliate leaves, while *G. alba* is one of a group with low, triangular appendages, closed corollas and nearly entire leaves. Both *G. puberula* and *G. alba* are prairie species, and their ranges are nearly coincident except that *G. puberula* extends further north; however, in Wisconsin *G. puberula* is usually found in drier situations (e.g. sand prairies, xeric hill prairies) than is *G. alba,* though in moist calcareous prairies, such as south of Kenosha, both may occur together. Reproductive isolation may be effected by the differences in color and closure of the corollas of these species, since different pollinators may be attracted, and by the somewhat earlier blooming of *G. alba.* The infrequent occurrence of *G. alba* in Wisconsin, where it approaches the northern limit of its range, is doubtless also partly responsible for the rarity of its hybrids in this state.

The leaves of these hybrids are usually lanceolate, widest near the base, and intermediate in size and shape between those of the parent species. Some trace of the carinate condition of the calyx lobes characteristic of *G. alba* is usually present. The corolla lobes are pale blue, somewhat erect, usually 5–10 mm long, triangular, conspicuously veined like those of *G. alba.* The corolla appendages are usually longer than those of *G. alba,* but obliquely triangular, scarcely bifid, and smaller than the lobes. There is often a minute deflexed projection at the juncture of each lobe with the appendage clockwise from it, as in *G. alba.* The difference in the shape of the corolla appendages is most useful in distinguishing hybrids involving these species from those involving *G. puberula* and *G. andrewsii.*

Hybrid swarms, in which a wide range of intermediates between these two species are present, have occasionally been encountered in Wisconsin and elsewhere. Specimens from one such swarm collected by Curtis on the low prairies north of Swan Lake are shown in Figures 7 to 12. A wide range of colors may be found among the corollas of plants in such hybrid swarms. Most of the corollas are pale blue, or white suffused with blue on the exterior of the upper parts of the petals; however, occasional segregates have pink or rose-violet corollas.

The name *G.* x *curtisii* recognizes the contributions of the late Dr. J. T. Curtis of the University of Wisconsin to our knowledge of hybridization in *Gentiana,* a genus for which he had a lifelong affection. His studies of the hybridization of *G. puberula* with *G. alba* are especially excellent.

Wisconsin: Rock Co.: along Chicago & Northwestern Railroad, Sec. 34, T2N, R13E, *Mason 1470,* 20 Sept. 1951 (WIS).

Curtis collection: 48, Swan Lake; *49* Brodhead (Green Co.); *50;* Swan Lake; *51, 52, 53, 55, 56, 57, 58, 62* through *69,* Swan Lake. *(54, 59,* and *60* were interpreted as being of same origin, but I suspect that *G. andrewsii* is involved.)

3. GENTIANA X PALLIDOCYANEA Pringle[3] (*G. andrewsii* Griseb. x *G. alba* Muhl.)

Hybrids between *Gentiana andrewsii* and *G. alba* have been colected less frequently than those previously mentioned. As noted by Mason (1965), *G. alba* generally blooms somewhat earlier than *G. andrewsii* in Wisconsin. These species also differ in corolla color and closure.

The crossing of *G. andrewsii,* which has short corolla lobes and rather long appendages, with *G. alba,* which has rather long lobes and short appendages, results in plants with corollas relatively even across the summit, appearing as though broken off. The lobes and appendages are about equal, neither often exceeding 2 mm. The lobes are triangular, the appendages shallowly erose. The corollas are pale blue , often with white appendages. The calyx lobes are usually slightly keeled. Both the parental species and their hybrids have glabrous stems and ovate-acuminate leaves.

Wisconsin: Sauk Co.: vicinity of Kilbourn (Dells of Wisconsin River) on the Wisconsin River, *Steele 19,* 25 Aug. 1909 (US).

Sheboygan Co.: Plymouth, *Goessl s.n.,* 29 Aug. 1930 (MIN.)

Waukesha Co.: between Hartland and Pewaukee, along RR, *Cull s.n.,* 23 Sept. 1945 (WIS).

4. GENTIANA X GRANDILACUSTRIS Pringle[4] (*G. andrewsii* Griseb. X *G. rubricaulis* Schwein.)

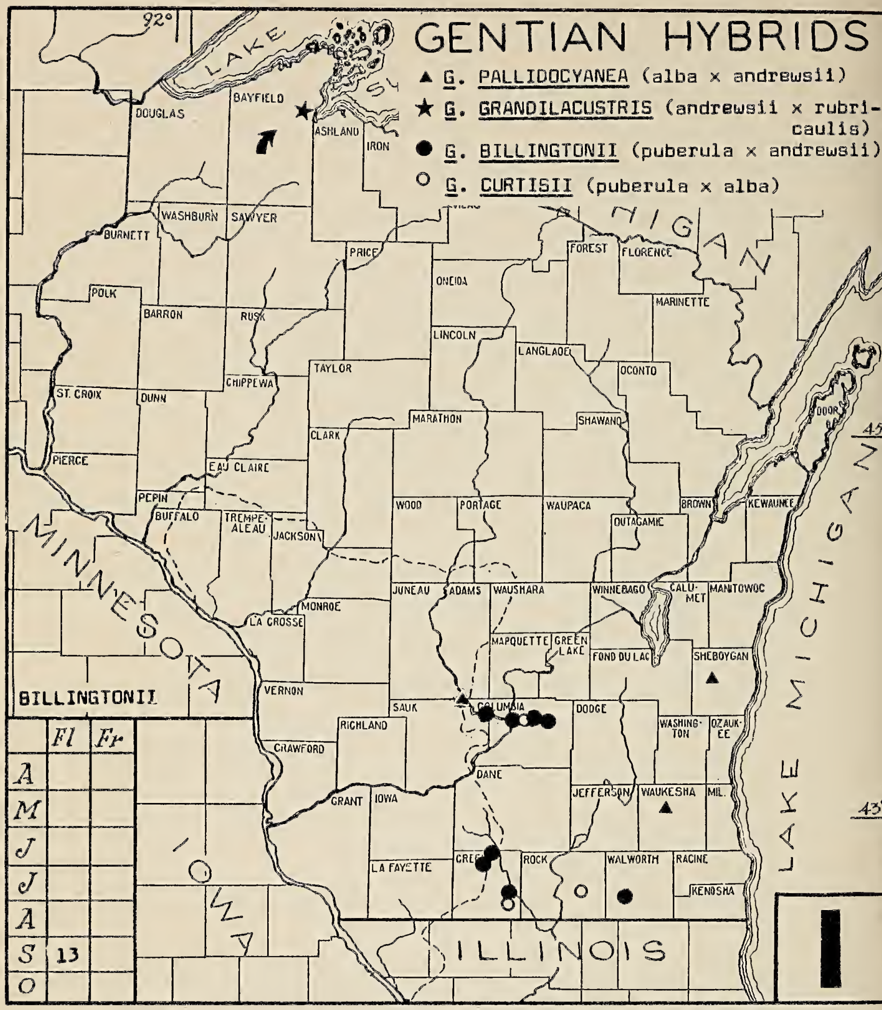
Hybrids between *Gentiana andrewsii* and *G. rubricaulis* are rare. The range of *G. andrewsii* is largely south of that of *G. rubricaulis;* in addition, as indicated by Mason (1965), *G. rubricaulis* usually blooms considerably earlier than *G. andrewsii* in Wisconsin.

[3] **Gentiana** x **pallidocyanea** Pringle, **hyb. nov.,** inter *G. andrewsii Griseb.* et *G. alba* Muhl. Caules glabri. Foliae ovatae acuminatae. Lobae calycium ovatae, plus minusve carinatae. Corollae pallido-cyaneae appendicibus saepe albis. Lobae corollarum triangulae parvae, appendicies aegre superantes. Appendicies corollarum paulae, irregulare erosae.

Typus: Between Hartland and Pewaukee, along R.R., SE 1/4, Sec. 1, T7N, R18E, Waukesha County, Wisconsin, 23 Sept. 1945, *Irene Cull s.n.* (WIS).

[4] **Gentiana** x **grandilacustris** Pringle, **hyb. nov.,** inter *Gentiana andrewsii* Griseb. et *G. rubricaulis* Schwein. Caules glabri purpurascentes, internodis superioribus elongatis. Foliae glaucae, inferiores anguste oblongae, superiores ovatae. Foliae involucri adscendentes et conduplicatae. Calyces tubis hyalinis, lobis oblongis. Corollae paene clausae lobis circa 2.5 mm longis, appendicibus laceratis.

Typus: Squaw Lake, Sec. SE–NW 5, Twp. 143, R 36, Clearwater County, Minnesota, 3 Sept. 1935, *Grant 6747* (MIN).



No specimens from Wisconsin are very clearly intermediate between these two species. However, a few specimens of *G. andrewsii* from the northern part of the state, which have rounded rather than mucronate corolla lobes, have foliage which suggests introgression of genetic material from *G. rubricaulis* into *G. andrewsii.*

One specimen from Minnesota (see footnote 4) and one from Wisconsin cited below appear almost certainly to be hybrids between these two species. Their vegetative organs and calyces resemble those of *G. rubricaulis.* Their corolla lobes, smaller than those of *G. rubricaulis,* are about 2.5 mm long. Their appendages are longer than those of *G. rubricaulis* and more lacerate. The corollas appear to have been nearly closed. Their color, which is well preserved, is a deep violet, the petals themselves darker and bluer than their appendages.

Wisconsin: Bayfield Co.: popple—white cedar and sandy beach of L. Superior along Boyd Creek, e of road 13, s of Barksdale, *Zimmerman, Ugent & Weber s.n.,* 3 Sept 1959 (WIS).

The name *Gentiana saponaria* has occasionally been applied to various *Gentiana* hybrids of the United States (Mason, C. T., in Brittonia 10:40–43, 1959). True *G. saponaria* L. is a southeastern species, readily distinguished from any of these hybrids by its dark green leaves, which are widest near the middle, by its oblanceolate to spatulate calyx lobes, and by its bright blue, ventricose corolla. It has not been collected in Wisconsin, but approaches the state line rather closely in northeastern Illinois.

Literature Cited

Mason, C. T. 1965. Preliminary Report on the Flora of Wisconsin No. 53. Gentianaceae-Gentian Family and Menyanthaceae-Buckbean Family. Transact. Wisc. Acad. Sci., Arts. and Letters (in manuscript).

Postscript

The following collections of *G.* × *billingtonii* were inadvertently left out of text and map: *Dane Co.:* Madison, *T. O. Hale s. n.* ca. 1860 (WIS). *Pierce Co.:* River Falls, *Weinzirl s.n.* Sept. 23, 1892 (WIS).

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THE NATURAL RESOURCES OF NORTHERN WISCONSIN

A Wisconsin Academy Profile

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GOODWIN F. BERQUIST, JR.
Editor

This publication was made possible through the generous financial assistance of Dr. Harry Steenbock, Patron of the Wisconsin Academy of Sciences, Arts and Letters, Emeritus Professor of Biochemistry at the University of Wisconsin, and Founder of the Wisconsin Alumni Research Foundation.

THE NATURAL RESOURCES OF NORTHERN WISCONSIN

A Wisconsin Academy Profile

A special monograph based upon a series of addresses on natural resources presented at the 94th Annual Meeting of the Wisconsin Academy of Sciences, Arts and Letters,

Wausau, Wisconsin

May 1–3, 1964

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Copies of THE WISCONSIN ACADEMY LOOKS AT URBANISM, the Academy's 1963 special monograph, are available at $2.00 per copy through: The University Bookstore, University of Wisconsin–Milwaukee, Milwaukee, Wisconsin, 53211.

Preface

The Wisconsin Academy of Sciences, Arts, and Letters is a ninety-four year old society dedicated jointly to original research and to the dissemination of new knowledge. The *Transactions* of the Academy is an inter-disciplinary research annual designed to publicize the original investigations of Academy members. New knowledge is disseminated from time to time by means of special monographs like this one.

Mr. Walter Scott, current president of the Academy, suggested the conference theme of the 1964 Annual Meeting: "The Natural Resources of Northern Wisconsin." The significance of this theme was stressed in memorable fashion by United States Senator Gaylord Nelson. Among his impromptu remarks to Academy members at the Annual Meeting, Nelson spoke as follows:

. . . I think the subject matter that you're talking about really is the most important issue that confronts the country. As long ago as 1906, when Teddy Roosevelt called the Conference of Governors in Washington, D. C., one of the lines in his remarks to the governors at that time, more than 50 years ago, was that the most significant domestic issue in America is the conservation of our natural resources. He had the foresight to see it then. More than a half century has gone by and a vast majority of the people in this country don't recognize it yet. . . . Time is running out on us. I think that unless we move with some massive programs in the next decade or decade and a half, we will have lost our opportunity. I think this calls for leadership at all levels and all walks of life, and the one I'm concerned most about in this field is the question of political leadership.

The late President Kennedy saw the significance of the problem and last fall took a conservation tour of the country. I had discussed the idea with him several times. I told him I thought nothing short of a federal appropriation of at least a billion dollars a year over and above all the expenditures we are now making—nothing less than that—would make a significant dent in the problem of acquisition of park areas, seashore, wilderness areas, and all the other things we're concerned about. I think that he was interested and concerned about it. I told him that I thought probably you'd have trouble with the Congress on a billion dollars right off the bat, but I thought you could really get through a 500 million dollar a year bill with 250 million of it for matching funds to go back to our various conservation departments in the 50 states for development of their own programs.

I think it's going to require this kind of a massive investment and we'll only get it if the public is aroused enough and people like you who are concerned are able to make the Congress feel the need for this kind of an investment. It does seem to me quite a tragedy when we see that it is so easy to pass other kinds of legislation on the floor of the Senate. I remember last fall, the day we left on the conservation tour from the White House, to Pennsylvania, then here to Wisconsin. That day the defense budget came to the floor of the Senate. That specific budget had 46 billion dollars in it for national defense. I would have to go back to check the *Congressional Record* to be exactly accurate, but my memory is that we spent about 200 minutes on a 46 billion dollar bill. This is an important investment for the country. But, even though we passed through the Senate an air pollution bill, a water pollution bill, a land and water conservation bill, a wilderness bill, all of them have gone to the House of Representatives where they still sit in a committee without action. No one of these bills really cost very much money and yet you don't see the public aroused about it. In fact, I got very little mail if any—oh, a couple dozen letters—on the wilderness bill. I was on the subcommittee on water and air pollution—half a dozen letters on that—none on the bill that would raise additional funds.

I think that's a failure on the part of all of us to develop the concern and understanding at the local level which would cause legislative bodies to support the kind of appropriations that are necessary . . . .

It is hoped that this publication will prove useful in the on-going campaign to conserve America's great and natural resources.

Each of the twenty-one papers which follow was presented during the course of the Academy's Annual Meeting in May. Each was the work of a specialist intent upon explaining his area of specialization to the intelligent layman. Together the twenty-one form, in the opinion of this writer, an impressive profile of our natural resources.

Goodwin F. Berquist, Jr. Milwaukee, Wisconsin

THE BRANDYWINE: A WATERSHED AT WORK

Clayton M. Hoff, Executive Vice-President
Forward Lands, Inc.

This is the story of a valley, the Brandywine Valley, and of how people worked together to make their Valley a better place in which to live, work, and play.

The Brandywine Valley is not large, only 330 square miles. It is not heavily populated, only about 200,000 inhabitants. But this Valley has been important in the political and industrial history of our country and it continues to be important because of its remarkable program for the conservation of natural resources.

It all began back in March, 1945, when thirty-five interested citizens representing the many varied interests of the Valley met at the Mansion House Hotel in West Chester, Pennsylvania. The purpose of the meeting was to discuss the depletion of natural resources in the region. After seeing, through the medium of Kodachrome slides, the polluting effect of industrial and sewerage waste, the decrease in the yields of crops and the lower fertility of the farmland due to soil erosion, the damage done to forests through improper lumbering, pasturing of woodlots, and forest fires, the diminishing game and wildlife due to loss of food and shelter, the sacrificing of fishing and other forms of recreation due to polluted and flooded streams—after seeing all these things and how they affected the health and welfare of Valley residents, the group decided to act. A committee was formed to study each of these problems in depth. Shortly thereafter, the Commonwealth of Pennsylvania incorporated the Brandywine Valley Association, a private, non-profit educational organization concerned with the restoration and preservation of natural resources in the Brandywine watershed.

There was nothing unusual or novel in the procedure thus far unless it was the effective use of visual education at the group's first meeting. What became unique were the principles followed in the later program of the Association. Association members believed that a watershed represented a more logical unit to work with than a political division. They further felt that it was the responsibility of the local people of the watershed to initiate and prosecute their own program of conservation. In addition to self-help, every step was taken to secure the assistance of available local, state, and federal agencies, especially with respect to technical assistance. The Association diligently avoided competing with any existing agency, but if a needed agency did not exist, one was created. Another basic principle followed was that work should be done simultaneously on all problems and all resources. The financial assistance of every interest in the Valley was solicited and obtained. Successful watershed associations elsewhere adhered closely to these same principles.

As mentioned earlier, the work of the Association is primarily educational. Broadly interpreted, this includes fact-finding research, the dissemination of public information, area promotion, and the encouragement of cooperation among the various agencies working in the watershed. Here are some typical Association projects: measuring the rainfall, discharge, and silt content of the Brandywine (by means of a cooperative agreement with the United States Geological Survey); determining the cumulative effects of pollution through a limnological survey of the Brandywine waters (by means of an agreement with the Philadelphia Academy of Natural Sciences); measuring the amount of topsoil to determine the degree of soil erosion (with the help of the Agricultural Extension Service and the Soil Conservation Service of the United States Department of Agriculture); and securing a comprehensive water and land use survey of the entire Valley (through the help of the Soil Conservation Service, United States Department of Agriculture).

In the educational field the Association relied heavily on visual education. Illustrated talks employing Kodachrome slides were presented to audiences of over 700,000. These talks were a very important part of the educational program because they provided speaker flexibility and could be easily kept up-to-date. To meet the demand for more illustrated talks than the staff was capable of presenting, a twenty-seven-minute, 16mm. sound-color film, entitled "The Brandywine—A Watershed At Work", was prepared with the assistance of the Department of Forests and Waters, the Department of Agriculture of the Commonwealth of Pennsylvania, and the motion picture laboratory of the Pennsylvania State University. Thirteen prints of this film, distributed both by the Brandywine Valley Association and the Department of Forests and Waters of the Commonwealth of Pennsylvania, have enabled hundreds of organizations and thousands of people in and out of this watershed to study the program. The Association for almost all of its lifetime has participated in one conservation workshop for teachers and has instigated the formation of two more; one at the University of Delaware and one at West Chester State Teachers College. These workshops have provided the opportunity for over 100 teachers each year to study the conservation of natural resources in the field and to equip themselves for teaching the subject in their schools.

Hundreds of conservation tours have been conducted by Association staff members, (usually by bus) for teachers, schools, society clubs, service clubs, civic organizations, educational and other groups.

Among other important educational projects was the Gregory Farm Demonstration, which was planned in cooperation with the Agricultural Extension Service and the local Soil Conservation District. This was a project in which a rather comprehensive face-lifting program on a farm was witnessed by over 10,000 people. Similarly, a sanitary landfill demonstration was arranged in cooperation with four townships. Hundreds of people could see and study the various new methods of rubbish and garbage disposal.

The "Watershed News", a quarterly publication of the Association, is regularly sent to all of the 2,000 members. Other Association publications are distributed from time to time. The staff has presented weekly and monthly radio broadcasts, and telecasts are arranged to cover interesting events or activities of the Association. In fact, the Association has maintained a continuous educational or public information program, using all available media ever since its founding.

Once the need for a non-existent organization was determined, the Association took steps to help the local people secure one. Thus was formed the Soil Conservation District for Chester County. Its staff has cooperated with both the New Castle County, Delaware, Soil Conservation District and the Chester County Soil Conservation District in a broad program to combat erosion and improve farm practices and yields.

Likewise, sensing that little progress could be made on reduction of pollution in Delaware unless that state had some pure stream laws, steps were taken to prepare a Pure Stream Bill for Delaware, and the Association assisted in its passage by the Legislature and since has cooperated with the Water Pollution Commission of Delaware and the Sanitary Water Board of Pennsylvania in the reduction of pollution from industrial and sewage waste.

In order to improve the harvesting of forest products from farm woodlots in the Brandywine Valley, the Association promoted the organization of Woodland Products, Inc., and Forestry Services, Inc. A cooperative sawmill was soon in operation.

For a more thorough study of the present and future needs of water supplies in the Valley, the Association organized the Brandywine Water Resources Committee, membership of which consists of the major water users of the entire Valley. This committee directed the survey of the present and future needs for water in the Valley, the water now available, and the means for reconciling the two.

The Association has worked very closely with all the schools and colleges in this area and has participated in many local, state, interstate, and national meetings and activities with mutually profitable benefits. It has cooperated directly and indirectly with most community, township, county, state, and federal agencies. It has fostered the interest and support of other organizations in conservation activities, such as interesting the Chester County Bankers Association and the Delaware Bankers Association in sponsoring and financing the Future Farmers of America Annual Conservation Contest.

A rather comprehensive evaluation of the results of the activities of the Association was made after the first ten-year period of its existence. As of October 1955, over 55% of the farms were under conservation plans with Soil Conservation Districts and 70% of the farms were following good conservation practices. Over 20,000 acres were in contour strips and some 18,000 acres had been converted to grassland farming. The conservation activities included over thirteen miles of diversion terraces and 145 new farm ponds, with the result that the runoff has been reduced by about 30%, as measured by our series of rain gage, flow-gage and silt-sampling stations. There has been over a 60% reduction in silt discharge. As a result of conservation practices and better farming methods, there has been a 37% increase in farm income in the Valley during this period.

Insofar as forestry is concerned, over 2,200 acres of woodlots were harvested under the supervision of a farm forester and over one and one half million new trees, planted in reforestation projects. While the woodlot owner has been the greatest beneficiary, Forestry Services, Inc. and Woodland Products, Inc. both have prospered and are continually expanding and rendering greater service to the community.

Due to a decrease in the pasturing of forests, the burning of woodlots, and the burning of grass, and also due to the fact that over twenty-one miles of multiflora rose living fences have been planted, game and wildlife have increased.

With the creation of the Delaware Water Pollution Commission, progress has been rapid in the reduction of pollution. The City of Wilmington has spent $18,000,000 on a new sewage treatment plant and other communities in the Valley have spent $4,000,000 on expanding or improving their plant facilities. Valley industries have spent over $1,100,000 on waste disposal equipment. The net result of this is that there is now installed in the Valley equipment for handling about 95% of the sewage and industrial waste. Of course, this means that fishing is rapidly getting better in the Brandywine, not to mention the additional fishing in the farm ponds. Facilities for recreation are rapidly improving. The water of the Brandywine is now classified as a satisfactory source of domestic water supply by the Water Pollution Commission of Delaware in their report dated June 24, 1954.

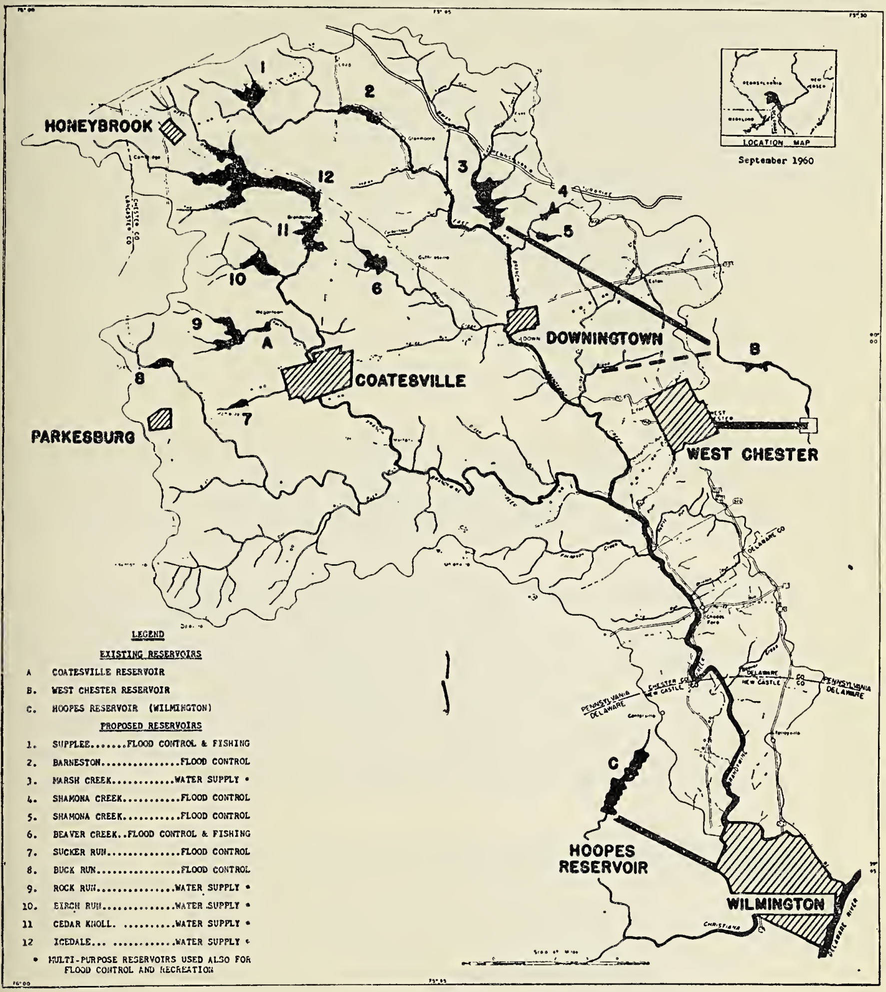
Water Supply and Flood Control Project

There was a definite reason for reporting the progress for the first ten years ending with 1955, for about this time there occurred a considerable change in the Association's major activities. This was precipitated by two years of severe drought periods and by a period of two years in which extensive drought and flood damages were experienced. Industries were forced to curtail production, citizens of communities where the municipal water supply was low were requested to refrain from washing cars, sprinkling lawns, etc., and many farmers, in order to salvage their withering crops, resorted to supplemental irrigation thus decreasing the level of water in the wells and the flow of water in the streams. Following these periods of drought there were usually torrential rains resulting in terrific flood damage again to industry, community and to agricultural land, not to mention highways, utilities and water supplies.

The extremes of these conditions can be best illustrated by referring to the flow measurements at the dam of the Wilmington water supply intake. For several days the flow of the Brandywine was below 38,000,000 gallons per day, of which industry consumed 5,000,000 (normal consumption 15,000,000 gallons per day) and the City of Wilmington 33,000,000 gallons per day, leaving not a trickle flowing over the Water Works dam. In fact, children were using it for a playground. Then—the cloudburst—and approximately 10 billion gallons of water went over this same dam in two and a half days, enough to supply the City of Wilmington for almost one whole year. It was obvious that we were not managing our water as well as we should. The simple answer was to save some of this water during flood periods and use it during periods of drought. This led to a comprehensive Water Supply and Flood Control Project for the Brandywine Valley.

Preliminary surveys, made by staff members, soon indicated that this job was one far beyond the facilities of the Association. Assistance on flood damage

BRANDYWINE WATER SUPPLY AND FLOOD CONTROL PROJECT



surveys was requested from the Soil Conservation Service under the provisions of Public Law 566, and help was asked from the Department of Forests and Waters of the Commonwealth of Pennsylvania for determining the present and future requirements for water supplies for all users in the Brandywine Valley. The surveys were soon extended to determine the structures necessary and the cost thereof to establish a satisfactory degree of flood control and to provide for storage of water and downstream releases to meet the needs of community, industry, agricultural irrigation, and recreation for fifty years in the future.

Engineering-wise, this project resolved itself into twelve structures quite well-distributed throughout the upper part of the Brandywine Valley. Seven of these structures were primarily for flood control, with supplemental recreational facilities, and five were primarily for water supply, but including recreation and flood control facilities and to be operated as multipurpose reservoirs.

The gratifying part about this project was the assurance by the Soil Conservation Service of the U.S. Department of Agriculture that it would build the flood control reservoirs, and by the Department of Forests and Waters of the Commonwealth of Pennsylvania that it would build and operate the water supply reservoirs, if the local people of the Valley would purchase the necessary land, acquire the easements, and stand the cost of the necessary relocation of utilities, such as highways, railroads, pipelines, telephone, and power lines.

The total cost of this comprehensive Water Supply and Flood Control Project for the Brandywine Valley is estimated at $11,445,600 and the suggested distribution of this cost is as follows:

Local People of the Valley	$3,824,800
State of Pennsylvania	6,122,600
Federal Government (S.C.S., U.S.D.A.)	1,498,200

At first glance the cost to the local people (almost $4,000,000) seems like a large amount but, on the basis of a twenty-year amortization, it is believed that this project would cost the local people $1.00 per year, per person, over a period of twenty years, which is pretty low cost water supply and flood protection.

This project would provide two things—flood protection and water supply—flood protection to the extent of a reduction of 77% of the existing flood damages in the Valley, and water supply in the amount of fifty-five million additional gallons per day. Now there would be enough water even for a 90-day period of drought in the vicinity of Coatesville, Downingtown and West Chester and almost this amount at Wilmington. In other words, water supplies would now be ample to meet the needs of industry, community, agriculture, and recreation for fifty years in the future. Currently progress is being made on this project on all fronts.

Financing. Bonding Houses have been consulted and they speak very optimistically about the financing of this project by issuing bonds at moderate rates of interest. In fact, they have stated that the multipurpose features of this project are somewhat novel in the financing field and strongly appeal to them.

Legal. The commissioners of one of the counties involved indicate that they are agreeable to creating an authority for implementing this project if they are assured of the cooperation of all principal interests in the watershed, or more correctly stated, the principal beneficiaries. Conferences between the Attorneys General of the two States and other state officials representing departments or commissions involved have indicated the desirability of an interstate compact between the States of Delaware and Pennsylvania for managing the water supplies on the interstate streams. The participation of the various communities in this project does not seem to involve any unsolvable legal problems.

Legislative. The proposed interstate compact, once prepared, must be passed by the legislatures of both states and sent to Washington for approval by Congress before it becomes effective. Furthermore, it seems essential that a Water Resources Commission be established for the State of Delaware in order that the State may have one official body responsible for the water resources, who would also have the responsibility of cooperating with similar official commissions in other states. Delaware at present lacks the counterpart of the Department of Forests and Waters of Pennsylvania. However, Senate Bill #81, providing for a Delaware Water Resources Commission has been prepared as a result of almost three years' study and will soon be introduced into the legislature for action. While this matter is not as urgent in Pennsylvania, there is need for additional water rights legislation in the Commonwealth and steps are being taken to remedy this situation.

Allocation of costs. Carrying out one of the basic philosophies of the Association—that the cost of such a beneficial project should be shared by those benefiting and in proportion to the benefits—studies are now being directed to determine more accurately the relative benefits of flood control and water supply to each of the beneficiaries, and to apportion the costs of the respective projects.

Engineering. When the allocation of costs has been accepted, authorities created, and the method of financing approved, a start will be made on the detailed design engineering. Then contractor bids will be made, subject to legislative approval, authorizations and appropriations. Only after all these steps will construction work be started.

While of economic necessity, most of the land involved must be purchased or optioned now, the period of completion of all stages of this project may be extended over a period of ten, fifteen or even twenty years, depending upon rate of demand due to increased populations, expanded industries, etc.

When completed, this project will provide urgently needed water supplies, flood control and recreational facilities for the people of the Brandywine Valley. This project is but one more example of the power of people working together and the benefits of constructive community action on a watershed basis.

The Brandywine has been important in the nation's political and industrial history. The people of the Brandywine Valley are now building the future history of the Valley.

THE WOLF RIVER

Arthur A. Oehmcke, Fish Management Area Supervisor
Wayne C. Truax, Game Management Area Supervisor
Wisconsin Conservation Department

INTRODUCTION

The early picture of northern Wisconsin, so aptly portrayed by our state historians, largely reflects the beginning of the development of the entire Wolf River Basin. This river system was an integral part of the mass resource exploitation (otherwise categorized as "progress") for which men labored in the pineries of Forest, Langlade and Shawano Counties, and then in the fields and factories after the wood was gone.

As a major tributary to the Fox-Winnebago waterway, the Wolf River Basin was first traversed by French explorers, fur traders and missionaries, all compatriots of Jean Nicolet who came to the Green Bay area in 1634. After the French (1763) and then the English (1815) relinquished control of the region, the first Wisconsin settlers moved into the upper Wolf River Basin.

The first permanent white settlement appeared at the outlet of Shawano Lake in 1843. Here, Charles D. Wescott contructed a sawmill for Samuel Farnsworth. The sawmill was adjacent to the site of "Shawanaw", then an Indian village on the Wolf River. This point in upper Wolf River history was important to the economic expansion of the Fox-Winnebago area which is importantly linked to the lower Wolf.

Steamboats and other river navigation on the lower Wolf during 1849 to 1854 were instrumental in spearheading settlement and, subsequently, the fabulous logging operations on the central and upper Wolf River Basin.

Wolf River log drives reached their destination at Lake Poygan where timber companies made up rafts of logs which were floated to Oshkosh. In 1873, at the peak of logging, 217,000,000 board feet of lumber were sawed in mills in Oshkosh, which was properly named the "Sawdust City".

The entire length of the Wolf River was utilized for the transportation of saw logs. Remnants of small impounding structures and rafting dams, constructed in the mid-19th century at fifteen different sites on the main stream to flush logs over shallow stretches, are witness to the extent to the early log drives.

Not all saw timber was driven downstream to Lake Poygan. Railroad and wagon road penetration into the upper watershed by 1870 and 1880 aided in the development of local mills at Hiles, Lily, White Lake, Red River, Langlade, Pearson and many other sites on the main stream and tributaries.

The reputation of the upper Wolf River system as prime trout water is well established. Before the turn of the century this region was the destination for anglers from many midwestern states. Trout fishing on the West Branch of the Wolf River is described in an article in the magazine *Forest and Stream,* by Dr. Alfred Hinde of Chicago, in 1894. Dr. Hinde reported his railroad trip to Matoon, via Oshkosh and Aniwa, where he

> Drove by team to Phlox (a distance of four miles). Went half way toward W. Branch of Wolf. Two miles through virgin woods to an

> Indian sugar camp on the Menominee Indian Reservation . . . Found fishing rough, fighting brush, mosquitoes, etc. Stream had to be waded, too deep at some places. Had to use worms, fly fishing impractical. First day 95 trout . . . 334 trout in 3½ days (3 men)—largest 1½ pounds. Found the trout small, the river difficult to fish and too inaccessible for comfort.

Thus, even virgin fishing had its critics. But its supporters frequented the inns, fishing camps and small hotels in nearby sawmill towns and the city of Antigo.

Although initially dependent on the upper watershed, the later economy of the Lower Wolf-Fox-Winnebago area experienced a different trend in growth resulting, in the main, from its geographic position. The proximity to the fertile bottom lands of Wisconsin's Central Plain, to low cost transportation and, consequently, necessary raw materials, were among more important factors of opportunity which were eagerly seized by the early citizens of this locality. Their initiative is well documented and presently in evidence by the great complex of paper mills in the adjacent Fox River Valley and the prospering urban areas between Oshkosh and Green Bay.

The economy of the upper Wolf River Basin transformed directly from pioneer land clearing and lumbering to dairying. There was no intermediate wheat growing era prior to implementation of dairying as in the more southern counties of the state. The watershed of the upper Wolf has not prospered at the same rate and to the same extent as the larger area of its lower basin. But, the lack of natural resource "development" in the upper watershed might possibly be considered a blessing to the state as a whole. Many of the original natural endowments on the upper Wolf have not been obliterated or despoiled although some have been considerably altered. Thus, many features and resources remain for our wise use and/or enjoyment; some by chance, others by deliberation.

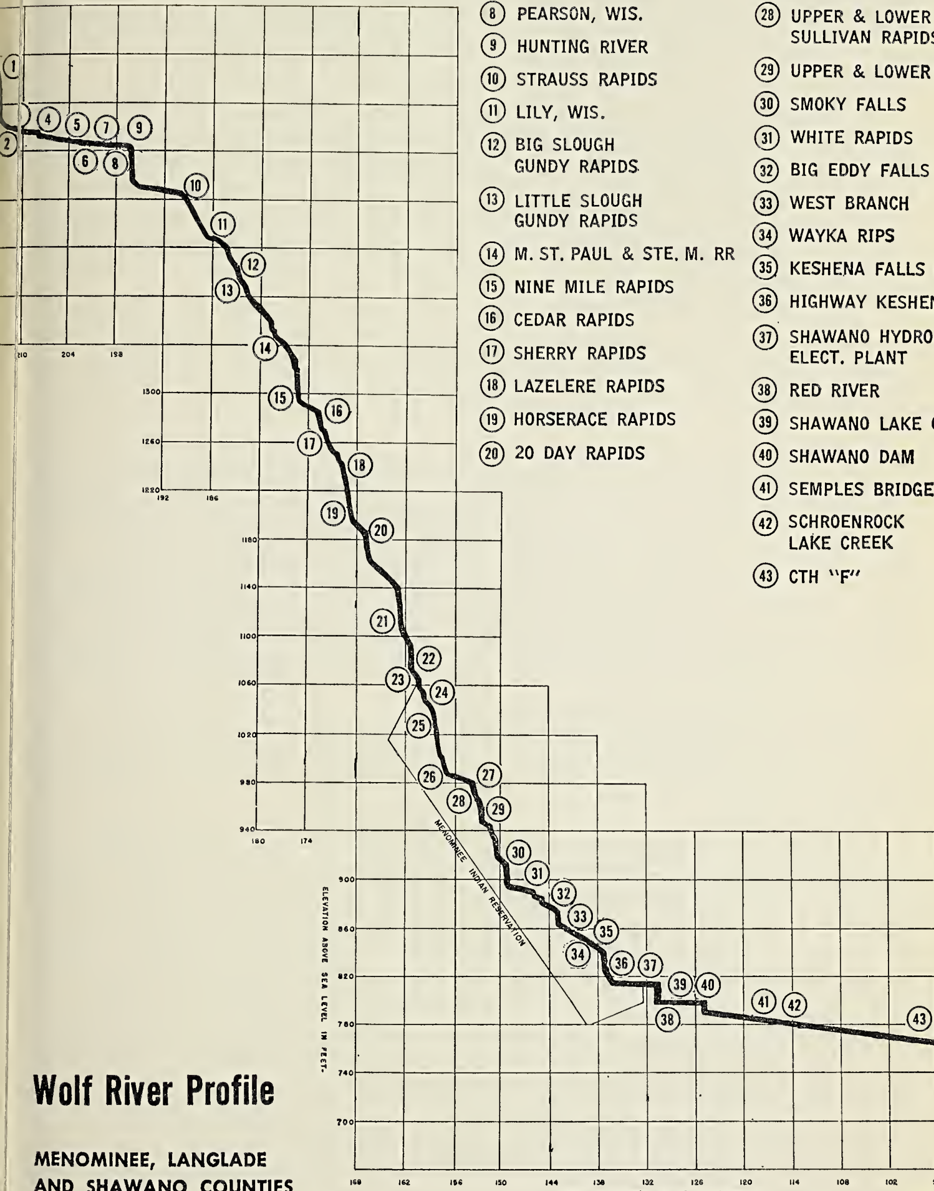
The River

Several characteristics of the Wolf River are common to other classic Wisconsin streams. The precipitous drop of the central Wolf is duplicated on the Menominee, Popple, Pine and Peshtigo Rivers. The Wolf River has a total vertical drop from source to mouth of 903 feet, contrasted with the 1,018 foot fall of the Peshtigo River.

The Northern Highland ground moraine gives birth to the Chippewa-Flambeau, Brule-Menominee and the Wolf River systems. From this gravel-covered granite perch, all four streams flow down to lowland areas of the Mississippi River and Lake Michigan.

The Wolf tumbles, riffles and meanders through 220 miles of terrain of eight counties from its source in Little Pine Creek north of Hiles, less than twenty-five miles from the Wisconsin-Michigan boundary, to Lake Poygan. The forested headwaters of the Wolf are distinctly slow moving. Not until the Wolf has coursed through about twelve miles of northern Langlade County does it begin its spectacular lurch to Keshena Falls. In this stretch alone the Wolf descends nearly 700 feet.

After leaving the granitic-crystalline upland, the pace of the Wolf slows down considerably, falling only about fifty feet in its 100-mile course from Shawano to Lake Winneconne.



1. C&NW RR
2. CTH "B"
3. POLACK CREEK
4. UPPER POST LAKE DAM
5. SWAMP CREEK
6. SPIDER CREEK
7. PICKERAL CREEK
8. PEARSON, WIS.
9. HUNTING RIVER
10. STRAUSS RAPIDS
11. LILY, WIS.
12. BIG SLOUGH GUNDY RAPIDS
13. LITTLE SLOUGH GUNDY RAPIDS
14. M. ST. PAUL & STE. M. RR
15. NINE MILE RAPIDS
16. CEDAR RAPIDS
17. SHERRY RAPIDS
18. LAZELERE RAPIDS
19. HORSERACE RAPIDS
20. 20 DAY RAPIDS
21. GARFIELD RAPIDS
22. HANSON RIPS
23. GILMORE'S MISTAKE
24. BURNT SHANTY RIPS
25. SHOTGUN RAPIDS
26. PISSMIRE FALLS
27. EVERGREEN RIVER
28. UPPER & LOWER SULLIVAN RAPIDS
29. UPPER & LOWER DALLES
30. SMOKY FALLS
31. WHITE RAPIDS
32. BIG EDDY FALLS
33. WEST BRANCH
34. WAYKA RIPS
35. KESHENA FALLS DAM
36. HIGHWAY KESHENA, WIS.
37. SHAWANO HYDRO-ELECT. PLANT
38. RED RIVER
39. SHAWANO LAKE OUTLET
40. SHAWANO DAM
41. SEMPLES BRIDGE
42. SCHROENROCK LAKE CREEK
43. CTH "F"

Wolf River Profile

MENOMINEE, LANGLADE AND SHAWANO COUNTIES

HOR. SCALE: EACH SQUARE = 6 MILES

VER. SCALE: EACH SQUARE = 40 FEET

Gauging stations on the Wolf River operated by the United States Geological Survey for nearly fifty years indicate an erratic flow from seasonal high water levels caused by prolonged periods of precipitation and heavy runoff. During drought years (viz. 1961–1964), the level of the lower Wolf drops to such an extent that walleye and northern pike are prevented from reaching their natural spawning marshes. The average volume of flow in the Wolf River is 1,734 cubic feet per second. Annual precipitation in the watershed varies from an annual high average of 43 inches to a low of 23 inches.

Fish populations in the lower warm water sections include game fish, panfish and rough fish. The more important species of these groups are lake sturgeon, walleye, largemouth bass, northern pike, white bass, catfish, perch, bullheads, crappies, bluegill, carp, sucker, sheepshead, eelpout, and garfish.

The fishing in the Wolf above Keshena Falls for a distance of sixty miles consists predominantly of brown trout, but rainbow and brook trout are taken early and late in the season.

Another warm water fishery exists at the headwaters and is made up of species similar to those found in the lower Wolf with the exception of the sturgeon, white bass, catfish, sheepshead and carp. While muskellunge are present in the lower Wolf, they are much more abundant in the headwaters, particularly in the Post Lake area.

The flat, expansive flood plain of the Wolf River below Shawano and the characteristics heterogeneous habitats in the sub-watersheds provides a variety of wildlife species for hunting and observation. Deer and grouse are abundant while farm game occupies the habitat along the forest edges. About 27% of the 1,169,720 acres in the lower basin is forested, amounting to 316,650 acres. The remainder is made up of extensive open wetlands, largely incapable of being drained, and farmland. Thousands of acres are in fur farms for the production and harvest of muskrats, mink and otter. The degrees of management vary greatly, depending on the resources of the private owner, the natural attributes of the land and the fur market.

Waterfowl traditionally use the lower Wolf in their spring and fall migrations. Summer residents are largely teal and mallards, and other species occasionally nest along the sloughs, in the muskrat ditches, and on the shores of the adjacent lakes.

A discussion of the scenic and aesthetic values of the Wolf River generates another encore to that splendid central portion with its white water, foaming cascades and the beautiful gorges in Menominee County called the Dalles. Hardly any other Wisconsin canoe route offers a trip on one of the more important trout streams which, in Langlade and Menominee Counties, is considered to be one of the state's most scenic, exciting, rugged and dangerous. The precaution that it is not recommended for inexperienced canoemen is sufficient commendation for this stream. To comfort present day "voyageurs", numerous unimproved campsites are found on the river along with adequate put-in and take-out spots. Since no rapids or dams are found in the lower stretch of the Wolf, a trip in this section is ideal for novice canoeists.

One must indulge in fishing, canoeing, boating or hiking to appreciate to its fullest extent the beauty of the Wolf River. The northern hardwood stands and age-old conifers lining its banks, have already disappeared from most Wisconsin streams.

An erroneous reputation of being the least "dammed" stream in the state has been awarded the Wolf. Actually, there are five dams upstream from the City of Shawano. The Shawano, Upper Shawano, and Keshena dams are used for electric power generation and have a capacity of 1,590 kilowatts. The Post Lake and Little Rice Flowage dams in Langlade and Forest Counties are primarily recreational and water storage reservoirs.

The Feeders

Six major tributaries drain the 3,750 square miles of the Wolf River Basin. The post-glacial drainage pattern displayed by the Evergreen, Red, West Branch, Little Wolf, and Embarrass Rivers on the west and northwest portions of the basin account for most of the runoff from this large area. Only the small subwatershed of the Shioc River is of any consequence east of the main stream. The contribution of the Lily River and Nine Mile Creek in the upper Wolf River of Langlade County is significant to the trout management program of the upper river system.

All of the Wolf's feeder streams have their origin in springs, spring seeps and natural exposed aquifers in the glacial sands and gravels. The fact that nearly every stream in the feeder system sustains a trout population confirms the quality of the water.

With several exceptions, almost all branches of the Wolf have moderate to high gradients. However, spruce-cedar shelves on the Nine Mile, Evergreen and Lily have provided excellent locations for beaver to impound water.

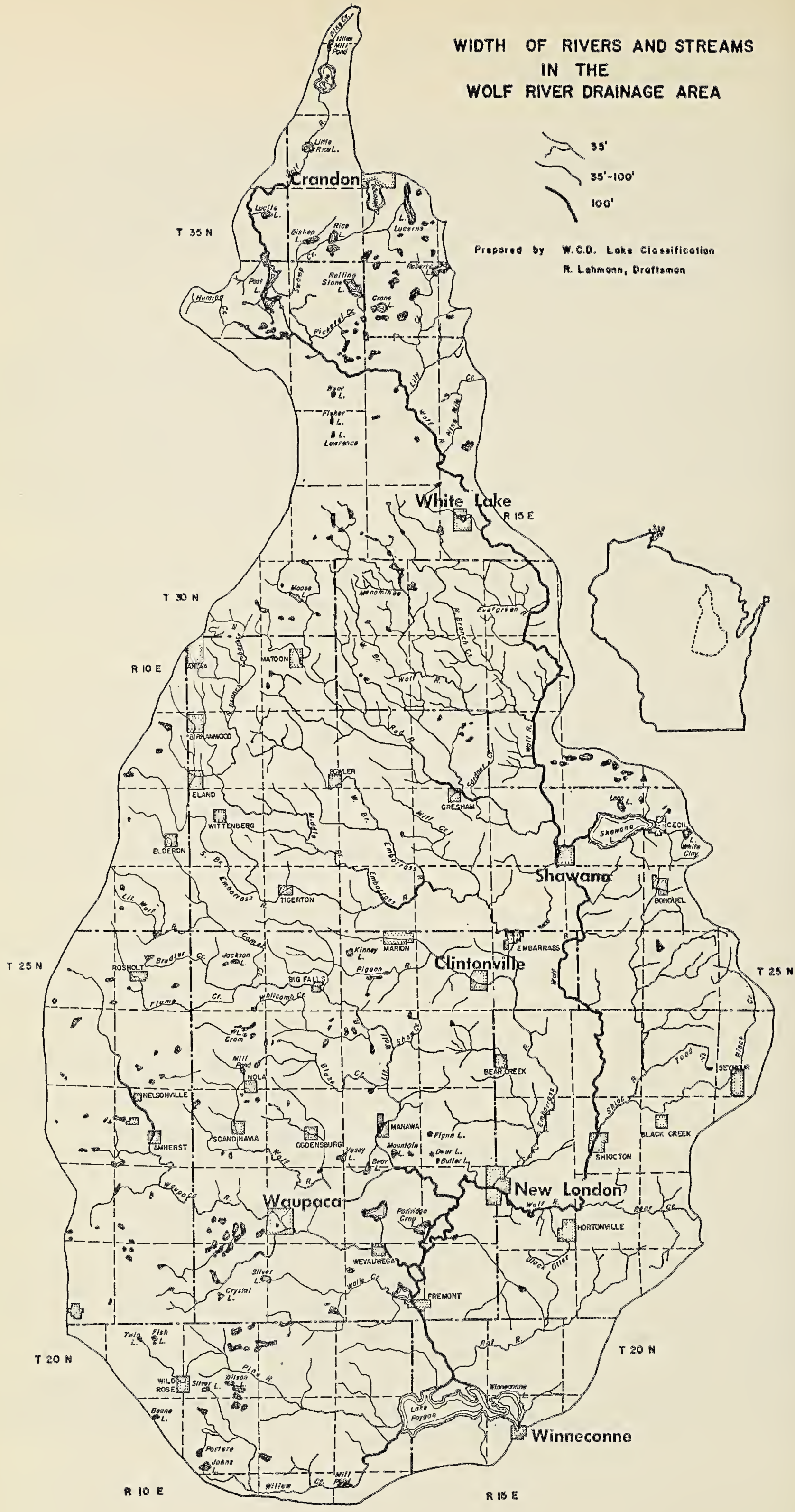
Thus, problems in management programs develop since the feeder streams, with very few exceptions, are high grade trout waters. An increasing trend in beaver populations is occurring on the headwaters of the sand country streams of Waupaca and Shawano Counties. Beaver numbers in the forested portions of the upper watershed are gradually being controlled through special regulatory management.

Among the best producers of trout, the Wolf's tentacles in Waupaca and Waushara Counties are heavily fished for trout and are noted for their high capacity for natural reproduction. The reputation of the Tomorrow, Little Wolf, White and Waupaca Rivers for their ability to maintain themselves without stocking are a few examples.

Northern feeder streams of some repute include the Evergreen River, Nine Mile Creek, Spring Creek, and the Hunting River. Because of past extensive beaver damage, these streams are not as productive as they were in previous years. They are nonetheless meeting present fishermen demands by a heavy "put and take" trout stocking and stream habitat improvement program.

Many miles of scenic tributary waterways can still be found on the Wolf watershed but farming, logging and general habitat changes have transferred the present feeder stream scene from one of continuous stream cover to a broken pattern of farm-woods-field. Exceptions, of course, appear on the main stem and branches of the West Branch of the Wolf, the Red and Evergreen Rivers in Menominee County. Here, the preservation of wilderness and attendant values to a stream are demonstrated in Wisconsin's last big timber stand.

Even though the main Wolf can boast of fewer dams than other state streams of similar size and importance, not as much can be said of its feeders.



WIDTH OF RIVERS AND STREAMS
IN THE
WOLF RIVER DRAINAGE AREA
35'
35'-100'
100'
Prepared by W.C.D. Lake Classification
R. Lehmann, Draftsman
Crandon
White Lake
Shawano
Clintonville
New London
Waupaca
Winneconne
T 35 N
T 30 N
T 25 N
T 20 N
R 10 E
R 15 E
ANIWA
MATOON
BIRNAMWOOD
BOWLER
ELAND
GRESHAM
WITTENBERG
ELDERON
CECIL
TIGERTON
BONDUEL
MARION
EMBARRASS
ROSHOLT
BIG FALLS
BEAR CREEK
SEYMOUR
IOLA
NELSONVILLE
MANAWA
AMHERST
SCANDINAVIA
OGDENSBURG
BLACK CREEK
SHIOCTON
HORTONVILLE
WEYAUWEGA
FREMONT
WILD ROSE
Wolf R.
Embarrass R.
Lake Poygan

This fact is particularly true of the Embarrass River where five dams have been built and still operate. Ponds in back of these barriers support, for the most part, warm water fish populations. Constructed originally for sawing lumber and grinding feed, they no longer serve such purposes. Most sites have been used as hydro-electric plants but several have been abandoned in the past fifteen years.

In their entirety, the 1,352 miles of feeder streams, making up the sub-watersheds of the upper Wolf River, drain 790,041 acres, or 32.3 per cent of the 2,438,900 acres in the watershed as a whole and offer varying characteristics. Those in the upper portion of the watershed originate in forested sub-watersheds which provides habitat for typical forest game species including deer, ruffed grouse and snowshoe hares.

Watersheds which the feeders drain, and which are west of the main stem of the Wolf River below Menominee County also have typical forest game species. Marginal farming and other factors produce a bio-ecological complex conducive to forming habitats occupied by a greater variety of game species including farm game along with forest species.

East of the main stem the sub-watersheds are fewer and larger, draining better soils. Forest cover is lacking and farming is more predominating than elsewhere in the Wolf River Basin. This gives rise to farm game habitats with forest species in the more or less isolated forest coverts. Wildlife is less abundant in this region than elsewhere in the basin, but the area has considerable potential as will be discussed later.

The Lakes

Three significant inland lake areas appear in the Langlade, Menominee, Shawano and Waupaca County portions of the Wolf River Basin. There are over 400 lakes of glacial origin which vary in size from several acres to over 10,000 acres, but most contain less than 100 acres of surface area. Lakes Poygan and Shawano are the largest and the most prominent natural lakes in the Wolf watershed. They are also classified among the twenty largest lakes in the state.

The nature of the substrate from the northern to the southern extremes of the basin influences the fertility of the lakes. Those lakes formed in or adjacent to glacial drift containing limestone and dolomite, or near sedimentary rocks of a calcareous nature, have a high proportion of nutrients. The crystalline-granite sands and gravel of the northern section of the watershed contribute hardly any material of a soluble nature and as a result the lakes in this region are not very fertile and consequently less productive. Generally speaking, the clarity and lower temperatures of the water in the northern lakes make them highly desirable for water recreation activities whereas the lower watershed lakes warm up considerably and, due to their higher fertility, lack the clarity desired for general water-centered activity except fishing.

All fish species listed for the north and south sections of the main Wolf River are also common to lakes of these sectors of the river basin.

Thus, the factor of fertility points up the productivity of the lakes in the basin, and, although there is danger in any generalization, one can safely say that good fish producing areas are generally found in the better farming areas.

Forests and Lands

Almost all of the original forest is gone from the Wolf watershed but a remarkable recovery has taken place in the present woodland area which covers about 46% of the entire Wolf River Basin. Agriculture, urban areas, water and highways absorb the remaining surface area.

Our foresters tell us that this region contains over 1,000,000 acres of commercial forest land, 61% of which is privately owned by small landowners.

The only remaining choice pine is found in Menominee County, but these species have been replaced in other counties predominantly by dense hardwoods and aspens. Mixed hardwoods and lowland hardwoods in the lower portion of the basin and oak in the sandy, well-drained soils of the western section is typical. Farming is the major land use in the southern half of the watershed with livestock and livestock products the more important source of farm cash income.

The use of lake and stream frontage for rest and recreation has grown considerably. Much river frontage on the main Wolf north and south of Shawano has been platted and is being sold and developed. Many small land parcels have been acquired by trout fishermen and hunters on this extensive water system. Riparian lands in public ownership on this river show a much healthier ratio to private holdings in Forest, Oneida and northern Langlade Counties. South of the village of Hollister, however, the picture changes drastically and private ownership of downstream river frontage runs higher progressively.

Highways to all portions of the river basin are not only adequate but of excellent quality. General public access facilities to the Wolf ranges from fair to good except for Menominee Enterprises, Inc. lands in Menominee County. Access to major lakes is fair but is poor to non-existent on many lakes under 100 acres.

The People

Census figures from 1960 show that the human population of the Wolf watershed has decreased by nearly 3,000 people since 1950. This decrease appears to parallel similar rural area population trends in Wisconsin and the United States.

The various sectors of the river basin have very low population densities. Only 2,600 people, mostly Menominee Indians, inhabit Menominee County, one of the less populated vicinities in this river system.

Problems and Potential

During periods of abnormal rainfall, high water has created an incessant problem in the lower Wolf River and damaging floods, particularly in the New London area. The Corps of Engineers of the United States Army contend that most lower Wolf River lands will flood because of the nearly flat slopes of the river's natural cross section and that the high flow during flood stages cannot help but spread out over the lowlands below Leeman. While this may be considered a problem, it perhaps is not greater in scope than any other lowland river area. The frequency of flooding leaves one to speculate that possibly changes in land use and land use patterns and less emphasis on river channel improvement would be effective and economical. It is noted that only 39,000 acres of the total watershed area are subject to floods. It would appear that local planning could devise some system of eliminating areas of this type without creating additional problems throughout the watershed.

Paradoxically, drought influence on trout habitat and the effect of irrigation during periods of low rainfall present as much of a dilemma to administrators as the flood situation in the lower watershed. Low flows and excessive irrigation on feeder streams have caused warning of water and destruction of trout habitat.

The anxiety of the people in the more economically distressed areas of Forest and northern Langlade County to broaden their tax base and "develop" has generally led to problems in "over-development" and destruction of fish habitat along lake and stream banks. The cover in many instances has been ruined in the so-called "cleanup" of stream banks and lake shores and has resulted in a look of artificiality. When one considers that there are over 150 spring seeps and spring ponds on the Wolf River from the County A bridge to the Menominee County line, it is understandable that the problem must be acted upon at once.

The development of the upper watershed has also been challenged by well-meaning individuals who feel that the construction of a dam will provide greater water recreation opportunity regardless of the general nature of the impoundment. It is understandable from the planner's viewpoint and the governmental officials' outlook that extremely heavy use and increased public traffic will be the picture in the future. The recent controversy over the proposal to establish a dam on a slow-moving portion of the Upper Wolf River and more recently the proposal to establish a dam in the Leeman area has aroused the ire of many sportsmen and other individuals who feel that the quality of the remaining stretches of the Wolf River, which now run unimpeded, will be injured. The proponents contend that the deleterious effects to the other portions of the Wolf River will be minimal and the benefits from new impoundments will far outweigh any damaging effects. The Wisconsin Conservation Commission has opposed the construction of such dams on the basis that trout values would be ruined on the upper Wolf and spawning migrations of sturgeon and other species of game fish on the lower Wolf would be lost and the effects would be felt on the Winnebago-Fox area as well.

It is obvious that increased boat traffic will create additional demands on the river. It is hoped that unnecessary speed and excessive horsepower can be held to a minimum so that there will be no menace to future canoeing, on the lower Wolf particularly.

Feeders to the Wolf River are generally the problem areas and will continue to be plagued with problems of pollution, destruction of land cover and irrigation. Although the main stem of the Wolf provides the name and the glamor, trouble usually centers on the feeder streams. The pollution from creameries, cheese factories and in some instances municipalities has made it necessary for the State committee on water pollution to issue orders for cleanup. This was accomplished in 1951, and it appears that good compliance is being made. On the brighter side, it has already been mentioned that the future of trout fishing, particularly in the sand country area, is improving. This outlook is enhanced by the land acquisition program on the feeder streams in these areas. If the construction of dams can be prevented and cover can be restored and protected, it is quite evident that stabilized flows and improved quality of water would be a reality.

What the future might offer for lake areas in the upper watershed is demonstrated by the intensive development around Shawano Lake and the more southerly lakes of the basin. Future demands on water recreation will be just as intense in this watershed in the future as it is in the more populous localities of the state today. Fewer people appear to be in pursuit of fishing opportunities, and the quest for swimming, sight-seeing, and relaxation is being substituted.

While the lakes furnish about 8 times more water area in the basin, the larger streams offer much more available frontage and hence will require zoning or some other control measures to provide for protection as well as orderly development.

Natural inland lakes cannot be replaced by artificial impoundments. The creation of artificial water areas generates additional problems of warming and siltation. This should be avoided.

Present forest inventory information on the watershed shows a real potential for increasing tree growth rates to one half cord per acre per year. Foresters claim a step-up of this nature could provide most of the wood for Fox River Valley mills.

In order to realize the full potential of the forest lands, woodland grazing —presently a number one offender—must be curtained drastically.

The well-forested watershed will retard runoff, promote infiltration and generally contribute to improvement of the economy.

Wildlife management is conducted as a two-pronged attack, using both public and private funds. The long-range objective is public ownership of some 10,000 acres consisting of the larger wetland areas offering choice development possibilities. These are to serve for demonstration as well as public hunting grounds and resting areas. Waterfowl and furbearers will be given top priority along with other resident species which occupy the edges. Water control and manipulation by gravity or pumping is planned.

Private wildlife management is a vast untapped potential in the watershed. The key to exploiting this tremendous resource is—technical advice! Game management planning and supervision is underway on more than a dozen private projects.

In summary we envision a network of strategically located public areas surrounded by numerous satellite management projects, privately owned. All of the game habitats mentioned are within an hour's drive of the populous lower Fox River Valley. Accessibility, along with the excellent wildlife potential of the basin, will make the Wolf River Basin an increasingly important hunting area.

Pressures from increased population in and near urban centers outside the Wolf watershed are being felt. The cry is for more recreational "lebensraum" and for more freedom in achieving it. Such forces are met with counter-pressure from within the river basin to "broaden the tax base" by subdividing private lands and platting. Interior forces in the watershed are also active in coercing town and county boards to release desirable watershed frontage land for private acquisition.

Much ready capital is needed to stimulate and carry out long-range programs for forest plantations, woodland management, resort and service business development and general recreation—vacation centered business. A great deal of local talent and knowledge is lost annually from migrants out of the upper watershed to the cities because of lack of opportunities and inadequate financing possibilities at home.

Public administrators at all levels of government within the Wolf Basin are required to analyze divergent public opinion on perplexing issues. For instance, the land developers and real estate people want to create lakes by building dams while trout fishermen, sports clubs and conservation groups want to retain the original status of the river. A fly fishing only area is accepted by only half the residents of the area since it "discriminates" against the worm fishermen.

Many citizens are clamoring for more long-range planning while others maintain that we must develop lands now to increase the tax base.

A fine project in stream habitat improvement work on the Evergreen River is criticized on the grounds that the "state should get out of the land business." Thus, the official in the watershed responsible for planning reaches an impasse trying to determine how to improve any of the basin area without adequate control of the land.

The attitudes must change or no improvement will grace the Wolf watershed. Future demands of the river basin, particularly those of recreation, must be met with an unselfish outlook. Local sacrifices must be made and state aids will perhaps be necessary. But outside help will never replace the "bootstraps" of local patience and initiative.

Where the Wolf River was an important factor in the economy of northern Wisconsin in the past, a reversal appears imminent if its future role in Wisconsin's development follows a planned course. The opportunities offered by the northern portion of the Wolf watershed are so great that little time should be wasted in getting on with a program.

Many ideal waterfront sites are available for youth camps in the Langlade, Forest and Menominee County sections of the basin. New groups are becoming interested in canoeing and by 1975 this sport will have many more supporters. Historical sites offer spendid opportunities for entertaining and/or educating the tourist. Such locations should be marked by signs and the historical value of the logging era should be stressed. Wherever possible old log flumes and other non-interfering structures should be resurrected in the streams as they originally applied to the lumber industry.

Finally, a sincere effort by all citizens and government officials in the Wolf watershed should be made to bring about an agreeable and equitable zoning system for river and lake frontage lands. Such zoning should include adequate building set-back provisions and assure protection of cover along stream banks and shorelines to perpetuate wilderness aspects.

Planning is essential in the over-all development of the resources of the Wolf River watershed. The Wolf River Basin Regional Planning Commission was authorized and began functioning less than two years ago. It can and must serve as a catalyst for the many government resource agencies, the people living in the watershed and those who will benefit from the development of its resources. Coordinating this monumental task are three commissioners from each of the eight counties comprising the Planning Commission. Their leadership must be bold—yet diplomatic, courageous—but compromising, farsighted—but practical. They are the foundation of the resource planning and development structure. Failure in the foundation or any of the agencies forming the superstructure will topple the whole.

Success is essential to the orderly, logical development of all the resources of the basin. The alternative is chaos! Mismanagement to date is apparent to anyone who wishes to view it. Witness the shacks along the banks, the house trailers on the subdivisions, the draining, the filling and a host of other helter-skelter cultural atrocities.

On the other hand picture, if you will, the clean, clear water, the managed woodlands, abundant wildlife, scenic drives, zoned land-uses, attractive cottages, a flourishing recreation industry, overlook parks, historical sites, white water, and lastly—a happy people!

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OUR NEIGHBOR: THE WISCONSIN RIVER

Robert C. Wylie, Vice-President and General Manager
Wisconsin Valley Improvement Company

Life History of a River

How do you describe a river? A river that is neither primitive or undeveloped enough to be included in the present investigations of our nation's wild rivers or unruly enough to gain national prominence in the news each year for the heartache and monetary destruction it causes by overflowing its banks.

I have tried many times to describe the Wisconsin River and have always been impressed with its human-like characteristics and the manner in which its life parallels the experiences of human life. Now, nobody really believes that a river is human, but allow me to point out the many similarities.

Birth

The Wisconsin River was born many centuries ago. Its parents were the great glaciers whose mighty force shaped and moulded the face of our state and whose melting waters, along with the vast quantities of runoff that have occurred since, helped to carve the path that the infant was to follow. This child started life in Lac Vieux Desert and as the history of the state unfolded it became apparent that it was to live its whole life within the borders of the state. It was only one of a large number of rivers in this and adjoining states that joined together to create the well-known Mississippi family. In this family it is interesting to note that the Wisconsin River is the largest child living entirely within one state, even though it is 430 miles in length. In all of the other great river families of the nation, there are only three other rivers of greater length which live in only one state—the Brazos, Colorado, and Trinity, all of which are in Texas. This new child was destined to do and see great things in its lifetime. Even as an infant it was expected to do its share of the family chores and drained 12,280 square miles, or about 25% the area of the future state of Wisconsin.

Infancy

Infancy is a time for phenomenal growth, great discoveries and marvelous adventures. There was no exception to this in the life of the Wisconsin River, which was a water highway for the Indians and other primitive people long before the coming of the white man to North America. The early explorers, such as Radisson, Allouez, Marquette and Joliet, made good use of the Wisconsin and its close proximity to the headwaters of the Fox River in their explorations more than 300 years ago. All of those who followed these explorers, such as the voyageurs in the 1700's, and the lumbermen in the 1800's were to play a large role in opening up the wilderness, and the Wisconsin was to be one of the main arteries of further discovery and a means of transporting settlers, the necessities of life, and the products of their toil.

Childhood

After infancy, each experience in childhood takes on specific meaning that can be related in later life to the overall development of the child and his niche in life. Some of the great experiences in the childhood of the Wisconsin River were the formation of this great state and the timber logging era of the 1800's.

The river was a favorite means of transportation for the fur traders, loggers, and even the farmers who used the Wisconsin-Fox waterways to send Wisconsin wheat to the eastern markets. However, the river was often an unpredictable and unwieldly child, not always obeying its elders. It was recognized that the river had great potential in the transportation and power industries, and some attempt was made to develop that potential.

The logging industry prepared great quantities of logs and lumber each winter for shipment to the markets downstream. However, there were some rough spots in the river's path that even the bursts of stream flow each spring couldn't float the logs over. Therefore, the loggers temporarily harnessed some of the youthful energy by storing runoff water in holding ponds during most of the year and releasing it during the high flow spring season to help speed the logs on their way.

I suppose you could say they were spoiling the child, by giving it is own way and increasing its flow tantrums. However, a good portion of this unruliness was already a habit, probably due to the child's heritage and origin. Many tributaries of the river originated in glacier deposited soil types that exerted no natural control over their actions. Rain and snow draining from these watersheds ran unrestrained and the soils held nothing in reserve for future stream flow needs. This helped to create conditions of flooding during the spring and fall of each year and paved the way for drought conditions at other seasons.

Other pioneers began to develop communities along the river and harness its power in other ways. The first dam on the river was built at Wausau in 1840 and used for milling wheat. Some years later in 1889 the first electricity in the valley was generated at a dam in Merrill.

As the state and the child grew, their way of life changed and became more refined. Homes needed greater conveniences and industry needed a more reliable source of power. The use of the river as a means of transportation began to wane. The forests were utilized for pulpwood in the new paper mills that were destined to become one of the major industries in the valley.

The child and its neighbors were growing up.

Teens

The coming of teen-age brings with it the realization that it won't be long before we are to become a man, and now is the time when we must begin to plan if our lives are to have meaning and purpose. In the late 1800's and early 1900's, the river was in the same position as other teen-agers and needed understanding and guidance.

The paper mill industry and hydro-electric industry were making great strides forward and many plants were being constructed along the river. The businessmen who were investing heavily in these plants realized that the river was a great natural resource and a potential source of great energy if properly channeled and guided. They were willing to become teachers and furnish guidance for this teen-ager because they knew that those young people who study their lessons and plan for the future will be the good citizens of tomorrow. They will be the backbone of our nation and the stabilizing force in our economy.

Our teen-ager's teachers realized that we must become useful—not just ornamental. People and resources are meant to be utilized and we know that they both work better if they are encouraged and not mistreated. In order to lead meaningful lives, people and resources must have a goal and need to be gainfully employed. This is what the teachers of yesterday had in mind for the Wisconsin River.

However, as is the case today, there are always a few of the teen-agers who, because of their behavior, give the rest of the crowd a bad name. A number of the western tributaries of the Wisconsin had terrible tempers and at the least provocation, because of rain or saturated ground conditions, were prone to loose a torrent of water through the valley, disrupting classes for the day, and getting everybody upset. Experience has shown that small amounts of control judiciously applied to key figures in a group can result in complete cooperation of the whole group. This the teachers knew.

They also knew that the river needed to have a reliable coordinator, or guidance director, with the authority, physical facilities and responsibility to help this teen-ager and its tributaries apply their knowledge for the benefit of all.

In 1907, the businessmen along the river, who were on their way to becoming teachers, convinced the state that they should be allowed to create a guidance director for the Wisconsin River.

As usual there were those who didn't agree that this was the way to train the child. Some, of course, felt that the child was incorrigible and not ment to be trained, or that it was not possible to retrain a wayward teen-ager to the important things in life. Others claimed that child labor was to be exploited for the great gain of the industrial barons, accompanied by a great theft of their water resources, ravaging of the north's scenic beauty, and a great detriment to the state's interest. One particular article that was written denouncing the idea poetically described the Wisconsin River and proposed reservoir system with its title, "White Coal Fields and Water Farms."

Fortunately, the good judgment of the public and state legislature prevailed and the guidance director, known as the Wisconsin Valley Improvement Company, was created.

A special chapter of the state statutes was passed granting the authority needed, listing all special conditions under which the interests of the people were safeguarded, including the placing of the overall company activities under the jurisdiction of the Public Service Commission.

The teachers had planned well, and determined that the best means of river control was to train those few tributaries that gave the whole river a bad name. They also knew that early habits were more easily broken than those that were well-established; therefore, it was important to control the headwater tributaries of the drainage system before they gathered bad habits on their way downstream.

The teachers' plan to be carried out by the guidance director called for the establishment of storage reservoirs on the river and its tributaries to store the excess water when there was an abundance of stream flow and release it for use when the natural energy of the river began to droop. In this way the destructive seasonal floods could be averted and the river would become a solid citizen throughout the entire year.

Maturity

The river was beginning to mature now. It had a plan in life. Many of the storage lakes used during the logging days were acquired by the Improvement Company and sixteen of them became "natural" reservoirs. It soon became apparent that these reservoirs were not sufficient to hold the great quantities of excess water that not only were available each spring but were necessary to sustain stream flows during the long, dry summers. Therefore, the Improvement Company began to enlarge its storage capabilities, and during the first 30 years of operation constructed five new reservoirs which now hold 75% of the total system storage. As the teachers had predicted, it was only necessary to exert some influence on a few unruly ones to bring the entire group into line so that useful, predictable stream flows could be maintained. For example:

The average annual runoff of the Wisconsin River at the Muscoda gauge is 6,160,000 acre-feet and yet the annual storage and release of the reservoir system is only 470,000 acre-fee, or 7.6% the Muscoda yield.

The teachers' theory in early training paid off, too. It was found that the control of the headwater tributaries not only was the most effective means of controlling floods but reduced the cost of control to each user because the water could be used throughout the entire length of the river. The net effect of the reservoir system was to reduce most flood flows by as much as 50% and increase dry season flows by as much as 100% or more.

The teacher-businessmen also felt some responsibility to this youngster and his education in terms of financial assistance. As a result they agreed to assume all the liabilities of the Improvement Company so that, while the river supplies the energy and water, it is kept functioning and useful through continued maintenance and repair of its control structures. In other words, businessmen, through their support of the guidance director, have paid for the education and graduate work of the pupil. And, of course, like any other private businesses, they have paid their share of the taxes that support our governments.

Through the years, the Wisconsin Valley Improvement Company has continually checked the pulse of the river and tested it. Any variations in behavior have immediately been corrected and additional lessons have been taught so that the full effectiveness of the training could be realized. In this way and with this guidance, the youngster has reached adulthood.

Adulthood

The river has come of age. It has remembered the lessons it learned as a youngster and is well along the way to becoming a good citizen. Its life has meaning now and it is gainfully employed at 26 hydro-electric dams along its course. It helps the valley paper mills and utilities provide employment for 10,000 people who receive a payroll of $62½ million each year. During its lifetime, the river has attracted industrial development along its banks and has been a major factor in the continuity of the paper mills and utility plants that now pay taxes each year totaling $23 million. The river's director, the Improvement Company, pays its own way with taxes of $110,000 each year and an annual payroll over $100,000.

Don't get the idea, however, that this river is a dullard and is only interested in working. It does find time to play, too, and provides many recreational opportunities for its neighbors. Some of the best known vacation areas in the state—Wisconsin Dells, Minocqua, Rhinelander, Tomahawk, Eagle River, Land O'Lakes—are located along the river, and are highly dependent on the river and its reservoir system as a source of recreational facilities. Although not a dramatic river in the terms of whitewater, scenic falls, wilderness vistas and hungry trout, the Wisconsin does have its moments of solitude, stretches of enjoyable canoe water, and enough changes of scenery to satisfy all but the most seasoned river traveler.

The river industries recognize the need and the value of hunting and fishing in our health and economy. They also recognize the part that their industrial forest lands, reservoirs, hydro-ponds, and bordering lands can play in providing this and other types of recreation. As a result of this concern, more than 900,000 acres of land and water owned by the businessmen who trained the river are open for use by the general public.

Thousands of acres of water in storage reservoirs or lakes behind hydro-plants are prime fishing areas and are available for use. The majority of these lakes have been man-made, and accurate sportsman's guide maps to each lake and its rugged shorelines are appreciated by the fisherman and boater. Thousands of such maps have been provided free-of-charge as a service of the industries.

Like most adults, the river tends to stray now and then, and may even revert to some of its childhood traits. Its guidance director, the Improvement Company, recognizes that some of the river's tributaries are still capable of raising some doubt in peoples' minds as to whether the river really has matured. It is common knowledge among those who are concerned that five tributaries draining only 22% of the headwaters area and only 7% of the entire basin can periodically throw the entire river flow regulation out of balance. These tributaries need some control exerted over them and the Improvement Company is proposing the construction of a storage reservoir on each stream to accomplish that control.

Whereas, the present reservoir system covers 67,000 acres, stores 17½ billion cubic feet of water, and was built with an investment of about $2 million, the five new reservoirs would cover 13,000 acres, store 5½ billion cubic feet and also cost about $2 million. All of which goes to prove that the longer you put off training the child the more troublesome and expensive it becomes.

As an adult the river has to learn to accept changes. Many adult lives are wasted because of inability to forget old ways and habits, and adapt to new ways and changing uses. The increased leisure time available to most workers today has increased the pressures on our waters through recreational uses and lakeside developments. The expanding utilization of irrigation practices in agriculture has put new dmands on our water supplies. Increased personal and industrial use of water has made some people fearful for the future water supplies of our state and nation. Through it all, however, the Wisconsin River has shown an aptitude for adjusting to all uses and pressures, and has shown that foresight and continued planning and development will help us avoid the problems of the future.

The mature adult learns to weather the times of adversity, not to get overconfident in times of good fortune and to pursue a steady course. This is also true of the river and its reservoirs. No river control system is perfect and it is impossible to foresee or build for all eventualities. Experiences of recent months have shown that a change in time-areal-quantity distribution of our available precipitation can cause temporary shortages and inconveniences. Behind it all, however, 57 years of reservoir operation has shown that the steady, relentless course is the best and will eventually prove to be the greatest benefit to all concerned.

Of course, everyone doesn't always agree with what you and I do as adults and the same is true with the river and its operation. There is always the problem of educating the other fellow as to our true intent. In these days of big government and billion dollar water schemes, it requires sound thinking and a knowledge of past accomplishments to realize that a private company can effectively develop, control and conserve a major natural resource. It requires continued education to convince others of the need for fluctuating water levels in the storage reservoirs and the part this plays in effectuating stable river flows, reliable power production, steady employment, reduction of flooding and just a plain, basic, sound economy in a river valley.

Perpetual Life

The river has lead a long and useful life. It has learned its lessons well and grown up to be a solid, dependable citizen, playing a major part in the way of life of its neighbors. It has even become the teacher in many instances. By example, one of the best ways of teaching, it has shown how water conservation can effectively be carried on while serving the multiple needs of all our water users.

The similarity between the river and humans now begins to disappear. Humans are mortal and will soon be gone, to be replaced by others with similar ideals and goals. But the river has the quality of perpetual life and will continue to serve man as it has learned in the past.

The state of Wisconsin can be proud of its citizen and we should be thankful for our neighbor—the Wisconsin River.

THE CHIPPEWA-FLAMBEAU RIVERS

Ernest F. Swift, Consultant
National Wildlife Federation

This is the story of the Chippewa River, called the Riviere Des Sauteux by the French, and its main tributary the Lac Du Flambeau. This is the story of two rivers whose turbulent history is symbolized by the once sullen power of their falls and rapids, and by the primitive solitude they watched over; rivers which demanded craftsmanship from those who dared to trespass. Craftsmanship or death; mediocrity was not tolerated. Like many rivers of their kind they begat a people of stoic courage and truculent individualism.

The Chippewa finds its source by the joining of two forks, one from the northwestern lake region, the other in the north-central highlands. Some of Wisconsin's finest lakes give their waters to make the Chippewa a majestic stream. The Flambeau, also with two forks, flows south and west from the north-central highlands; and at one time was one of the most beautiful rivers of the mid-west. Other watersheds feed the Chippewa, such as the Red Cedar, the Jump and many lesser tributaries of some individual distinction. There was a time when the rivers, those ancient highways of man, were the only practical way to penetrate this lonesome and austere north country.

Old time lumberjacks in the embrace of John Barleycorn used to brag that they helped Paul Bunyan gouge out the channels for the two rivers, but long before the riverpig grew ten foot tall in song and legend, another breed of daring men had called the Chippewa and Flambeau their own.

At the time the Pilgrim Fathers were timidly probing the Cape Cod sand dunes, intrepid Frenchmen with a genius for geography had penetrated as far as Lake Superior and proclaimed the Continental heartland as part of their Empire.

Radisson and Groseilliers supposedly wintered on a tributary of the Chippewa, Lac Court Oreilles about 1659; called Lake of the Short Ears by them and Ottawa Lake by the Indians. Some of its first known residents were Ottawas, kin folk of the Ojibwa. Both tribes in their westering migration during the fifteenth century had established themselves around the Apostle Islands; and then moving South and West began to displace the Sioux. It was during the winter at Lac Court Oreilles that Radisson recorded dire famine and starvation.

Father Rene Menard was on the Black and the head waters of the Wisconsin in 1661 and no doubt touched the Flambeau and Chippewa on his agonizing trip back to Chequamegon Bay. And to give flavor and geographic significance to the Chippewa and Flambeau, the panorama of other waterways must be woven in; of long portages, heartbreaking snowshoe treks, and of famous trading centers such as Mackinac, Fort William, La Pointe, Prairie Du Chien and faroff Montreal, where trade goods started and furs returned.

One can only speculate on the many bold adventurers who followed Radisson, Menard, Allouez, Hennepin, Duluth, Brule, in their sojourns. Le Sueur knew of the Chippewa, and Perrot with a fort below Lake Pepin had some knowledge of this wilderness watershed. But there were many lesser stars in this firmament, voyageurs with long rifles and gay sashes and an Indian family, with canoes ladened with trade goods seeking new beaver country and with the impelling urge to explore; finally poling back up the sullen current of the Riviere Des Sauteux and portaging to Gitchee Gumme with bales of sweet, greasy beaver plews. And there were Jesuits on endless treks to save heathen souls for the glory of God and the Empire.

After the French regime came the English, and one of them explored northwestern Wisconsin and parts of Minnesota as far west as the Red River of the North. His name was Johnathan Carver. He had been commissioned shortly after the French and Indian War to inventory captured trading posts and report on the fur trade.

In his extended wanderings he poled up the Chippewa, and took space in his diary to comment on the herds of buffalo, elk and deer in and around where the Chippewa joins the Mississippi. He visited Lac Court Oreilles, portaged to the Namekagon and finally arrived at La Pointe.

Although the French lost their Empire their half-breed descendants remained as a potent force in the mid-continent, and when the dour Scots from Montreal took over the fur trade these hardy natives were the key to success. With only a daily measure of cracked corn or peas and bear grease as subsistance, and through hardships beyond description, they paddled and portaged the huge trade cargoes for thousands of miles for their bourgeois. Much later their offspring became mastercraftsmen of the log drive.

In 1671, Monsieur Cadeau, a man of some breeding, arrived in the Superior country. He married the daughter of an Ojibwa Chief, and in so doing, helped create some of the great fur trade traditions of Minnesota and the Chippewa and Flambeau regions. His two grandsons, Jean Baptiste and Michel Cadotte also married Indian wives, became "Marchand Voyageurs" and fur traders and dominated the above mentioned regions for years to come. When the Northwest Fur Company was organized they joined it.

With headquarters at La Pointe, Jean Baptiste operated in what is now northern Minnesota, while Michel, using Reserve on Lac Court Oreilles as a base, traded on the Chippewa, Flambeau, Red Cedar, Namekagon and tributaries. Among his several posts he established one in 1784 on the Namekagon about two miles south of the present village of Hayward. He traded as far south as the Falls on the Chippewa. He was just twenty years old when he became a bourgeois.

These early traders of necessity developed a keen sense of geography and knew all lines of travel. Goods were brought to the Interior from La Pointe by the way of Fish Creek to the White River, then a portage to Long Lake (Lake Owen), another portage to the Namekagon, and the last carrying place to Lac Court Oreilles and Reserve. Another trade route was up the Bad—the French called it the Mauvais—then up the Bruinswieller, a portage to the West Fork of the Chippewa, down the West Fork and up the South Fork of the Chief, and then a long portage to Reserve. This was the most difficult route with several pauses.

Of course furs were taken out these two routes, but sometimes they went up the Flambeau with a portage to the Montreal River, and then to Lake Superior and finally to Montreal.

After the War of 1812 the English traders were pushed north of the new boundary between the United States and Canada, and it was now the Americans who were exploring the trade possibilities as had the English when they took over from the French.

The American Fur Company of John Jacob Astor became established at Mackinac, La Pointe, Green Bay and Prairie Du Chien. The Cadottes joined Astor.

Other names still faintly haunt the two rivers. In 1818, two Yankee brothers of Mayflower background appear on the scene. They were Truman and Lyman Warren. They married daughters of Michel Cadotte, and eventually took over the fur business from their father-in-law. Then there was James Ermatinger, another trader of note after whom Jim Falls was named.

James Doty traveled the trade routes of the Chippewa tributaries and made a report to the Territorial Governor, Lewis Cass in 1820. Henry Schoolcraft was appointed Territorial Indian Agent and preserved in his writings much of the lore of the Great Lakes and the Chippewas. His journals inspired Longfellow to write HIAWATHA.

From Prairie Du Chien other Frenchmen of the American Fur Company made their way up the Chippewa, and the influence of Wisconsin's first millionaire, Hercules Dousman, was felt on the river. Jean Brunet, who built the first saw mill at Chippewa Falls in 1836, was one of Dousman's agents. Sometime later Brunet migrated up river and built a trading post at a falls which bore his name and is now buried under a concrete dam. Here stands the village of Cornell.

Probably the most controversial man on the river at one time was Ezra Cornell. With the passage of the Land Grant College Act, officially known as the Morill Act, in 1862, Cornell came to Wisconsin and purchased 500,000 acres of finest pine land in the valley from public domain with script supplied by the federal government. Much of it was bought for 80 and 90 cents an acre and some "forties" cruised a million feet of timber. This so-called land-grab caused much bitter feeling among local people; and when sold the funds were used to found Cornell University.

In the beginning there were the two rivers in all their virgin beauty, with massive pines, hemlock and yellowbirch arching over the falls and rapids and deceptive currents, where muskellunge as long as an oar breasted the turbid waters. But the rivers were ideal for driving logs and when dammed would run sawmills.

In the 1840's, Yankee and Canuck loggers swaggered over the horizon with axes on their shoulders, a cud of tobacco in cheek, and plenty of sand in their gizzards.

Back east the slashings were getting bigger, the smoke of forest fires thicker, and the green chunks whittled smaller. Looking up through the long shadows to the green crowns, they calculated that there was enough cork pine in Wisconsin to patch hell a mile, to last forever. And when they got to the Chippewa Valley and saw the majestic sheen stretching over sylvan hills, even these case-hardened timber beasts paused and removed their battered head-gear in respect for the accomplishments of the Almighty. This reverence, however, was soon forgotten when with Yankee shrewdness they started to estimate these fabulous riches, for after all, the Valley had about one fifth of the pine of the entire state. And made to order was a growing market—the western prairies were filling up with sod-busters, and they were demanding railroads, grain elevators, stores, schools and churches; there was a great hue and cry for lumber. Manifest destiny was not to be denied.

By the early '50's, the economic, social and geographic atmosphere of the Chippewa watershed was rapidly taking on new dimensions. Not only was it a bonanza for bold enterprise, but along with other timber regions was becoming a proving ground for new methods of logging, river driving and milling machinery.

The onslaught was ruthless and wasteful beyond reason because timber was thought inexhaustible, and competition became a deadly, bare-knuckle brawl with little regard for human, social or legal niceties. Theft of government timber was common, had little stigma, and was justified in the name of progress. Timber inpectors received no local support, little from the courts, and considerable abuse from some Congressmen for being so assiduous to duty. Labor was cheap and equipment and transportation expensive; and lastly there was a greedy market on the prairies. Present generations would have done much the same under like conditions; and some are still trying.

In all, the pine era spanned about 50 years, but lumbering continued with hardwoods, hemlock and a growing paper industry. But those pine days, what hell-roaring times they were!

First came government surveyors, cruisers and landlookers, using the rivers as highways for exploration. Then followed bateaus with supplies for small camps. At first logs were cut along stream banks and skidded by travois and oxen. But soon the distance increased from timber to river. Costs had to be cut and so logging technology came into its own Twenty-man camps grew to accommodate 100 or even 200 men. Equipment improved rapidly and sleighs were built with 14 foot bunks. This necessitated better hauling roads and so some genius tried icing the ruts with a water tank on runners.

Summer crews were sent up river to build dams on the tributaries for a water supply to sluice millions of feet of logs down on the spring floods. Horses replaced oxen for hauling and skidding, and the bateau was gradually abandoned for taking in supplies when tote roads began to parallel the rivers. Big lumbering four-horse tote wagons following end to end carried plunder and grub from Chippewa Falls as far north as the Namekagon in Bayfield County, and up the East Fork to Chippewa Crossing, now the village of Glidden.

Time and adversity developed a breed of men who rivaled any on the American frontier; French and Scotch-Irish from "Canadaw," and blue-bellied Yankees from down East. At a later date there was a great influx of Scandinavians. The American lumberjack was about as tough an animal as ever walked on hindlegs.

They were a highly selective lot due to the processes of primitive survival. Nature would tolerate no mediocrity in these unshorn sons of the saw log. They were craftsmen par-excellence, with axe, saw, canthook, peavy, bateau and caulked boots; the latter often being used as weapons for rough and tumble fighting.

Logging at best was a dangerous, back-breaking job. The true lumberjacks were a laconic, proud lot, indifferent to long hours, muzzle-loading bunks, lice and the miseries of arctic winters and icy rivers. There was a standing joke that the only time the camp was seen in daylight was on Sunday. By the time there was daylight in the swamp they were at work, and were not back in camp to gorge their evening meal until after dark.

Sometimes working for slave wages, they were, nevertheless, fiercely independent, but also loyal to any man sufficiently tough and seasoned to handle them. It was in the Lake States where Paul Bunyan and Babe, his blue ox, reached the peak of their mythical fame, and along with them a vernacular developed which only woodsmen could comprehend. It was earthy, highly picturesque and to the point, be it at times profane.

When the iron hand of winter gave way to the spring breakup, the great spectacular got under way—the log drive. Immense rollways along the river banks were broken out by men with peavies, the logs cascading into the ice-filled water, and the pull of the current starting them on their journey to the mills.

This is where the whitewater burlers reigned supreme. There were long, long hours and miles of river trail to hike; there was rain, sleet and ice, and there was the everlasting danger from tons of grinding logs that could pull a man under as the riverpigs rode them down stream. They had a chanty they sang when the going got too rough for even their stoic souls: "No matter how cold and wet I am, I'm always warm and dry!"

Some who started from the upper reaches of the Flambeau or the Torch, Moose or Chief would not hit the sorting booms at the Falls or Eau Claire until July. And ever more logs with their crews poured into the main river from side streams to form a vast carpet of restless, churning timber from bank to bank and miles on end.

But there were always some who never made it back to the sinful delights of Whiskey Boulevard. There was always the risk of a widowmaker, a broken wrapper or a swamphook letting go. And the sullen river was always watching to pull a careless driver under the logs. Sometimes even the best went under; as an example; on July 8, 1905, eleven men drowned at Little Falls—now Holcombe—trying to break up a center jam.

But those that made it hit town with an explosive energy beyond the comprehension of ordinary mortals. They wanted whiskey, they wanted women and they wanted to howl. After they had rimracked the town, as so quaintly expressed, they returned to the forest solitudes at peace with the world. With several hundred healthy young Americans wanting the same thing, it can be well understood why the physical, moral and social standards of a sawdust town had to be rather flexible. Yes, it took a lot of sourdough pancakes, beans, pork and Norwegian condition powder—Copenhagen snuff—to get a log as far as the endless chain at the mill.

Each year there were more miles of slashings, each year fewer green crown of majestic pines to grace the denuded hills. Each year the primeval wilderness retreated like a wounded animal; and fires seemed to forever flare and languish or explode into a holocaust, until the smoke hung on the air from spring thaw to fall snow. And the ruby sun would stare down through streamers of smoke like the evil eye of perdition.

Sawmills were built where there was a river and a falls for power. Sawmills begat boarding houses, company stores, shanty towns and evil dives for the workers. Out of this came villages and sometimes cities. The town, the river, the mills, and later the railroads, were merely segments of the traditional sawdust trail which commenced in Maine and ended on the Pacific. It spanned a Continent, and in the making was one of the greatest sagas of American history.

Such was the history of Chippewa Falls, Eau Claire and many other towns that started on rivers. The pattern was standard, mills chewing up logs 24 hours a day during the cut, with two eleven hour shifts. Wages were about $1.50 a day.

No story of the rivers would be complete without mention of the "Stopping Places" that followed the loggers, and provided housing for men and beasts, alcoholic refreshments and on occasion, feminine companionship. A few of these also became famous in song and story, stops of brief relaxation and opportunities for fabricating garish yarns that were the sheer genius of fantasy.

And there was the pioneer farmer who also became very much a part of the Valley history. As the timber disappeared from the river banks and the back country, small patches of clearing also followed the loggers. They were painfully grubbed out by sober, God-fearing settlers. They proved a mighty impact to the Valley's economy as can be attested by their descendants with their fine farms and herds of dairy cattle. But the headwaters defied their efforts and for decades remained wild, and still are to a degree.

I once knew a genuine 23 jewel woods boss who said that he had gone up the Chippewa and seen its pine forests when they were still on the hoof. I didn't see the beginning but I saw the end; the last pine drive to go down the swirling crest of the Chippewa in 1917.

It was the last big cut of virgin pine and came from the Lac Court Oreilles Indian Reservation above the two forks. It was removed to make way for a big reservoir and more hydroelectric power. It marked the end of an era. Dams were beginning to clutter up the headwaters of both rivers.

Nostalgically I so vividly remember where all this happened, the old Indian Trading Post with its enormous pines shading the log cabins and birch wigwams, where old Indians sat and smoked kinnikinnick and the women scraped summer deer hides and scolded naked children. Ponies grazed the dancing ground, and birch canoes graced the river bank. For over forty years this touch of pure Americana has been under water.

But what a country it was when I first saw it through the eyes of youth. There was much cut-over, but still many miles of green hemlock and yellow-birch, spreading out between the two forks of the Chippewa and extending east to the Flambeau. There was ground hemlock in those days and lacy ferns whose giant fronds stretched higher than one's head. There was the silent beauty of virgin lakes, the churning of whitewater over rock faults, and in those days the occasional howl of a timber wolf; and most important there was solitude. By learning woodscraft I felt I had earned the right to call it my own, and that others had that right only through the same rugged lessons. Thus came to fruitful fulfillment a deep and abiding passion for wilderness places; those two rivers left their mark. Then ask me why I mourn?

Today people virtuously condemn their forebears for the havoc and destruction of those early logging days. Of course things will never be the same, but, nevertheless, the cry of 'Timber' is again heard in the woods. After austere years of rehabilitation, forests are again coming back to become an important part of Wisconsin's economy, and converting raw wood a billion dollar industry in the state.

But in another way this generation is duplicating the sins of past generations. It is now well recognized that timber is not inexhaustable, but it has not been recognized that outdoor recreation has definite limits. The recreationist can easily overgraze his pasture, and is being encouraged to do this by federal and state bureaus with no attendant responsibilities demanded of him. He is being taught that picnic table conservation is both an economic and recreational solution.

Up and down the two valleys as in many other areas, invasion of the sophisticated city image is rapidly destroying the last vestige of primitive elements which are the only true foundation for an outdoor experience. Commercialized recreation has taken over, in fact being governmentally subsidized, with the same thoughtless greed once attributed to the old time logger. Already there are too many roads, too many cottages, too many leaky septic tanks, too much irresponsible bug spraying, too many speed boats, too much shore filing, too many unappreciative people. It is smugly called development, a faceless, factitious term which generally means those things just listed and seldom true enhancement.

Although there is still much wanting in forest management, especially small holdings, the forests of Wisconsin will continue to thrive to furnish an economic base, but the esthetics which should be part and parcel of them is being destroyed, and in a large measure by recreational demands. Commercial recreation puts a price tag on all natural elements; and esthetics—so called—are now being sold by the pound. Now we are calling upon people steeped in unearned leisure to assume managerial responsibilities of values they do not understand or appreciate.

The primitive charm that once made the Flambeau a famous canoe stream is all but gone, and the acrid smell of chemicals floating down stream from a paper mill is an offense to nature. The State of Wisconsin has all but lost its opportunity to save a tattered bit of the Flambeau as a wilderness area; and at best it would only be a pleasing illusion of an uncut fringe along the river and elimination of numerous access roads. At least the logger left solitude.

But if you ever knew the Chippewa or Flambeau in the old days, ghosts will dog your footsteps as you look for the scenes of yesterday, and with a little imagination you can visualize a pageant of long ago; of half-naked Indians, Jesuits, traders in buckskins, and rivermen in stagged pants and caulked boots poling their canoes and bateaus up the swirling crests of the two rivers. And if you are still in this mood and are on the upper reaches in the predawn cold winter morning, you can still faintly hear the melodious call of the shanty boy from out the distant past: "R-o-o-ll Out! R-o-o-ll Out! Daylight in the Swamp!"

THE ST. CROIX-NAMEKAGON RIVERS

Sigurd F. Olson, Consultant
U. S. Department of Interior

I want to thank you, Dr. Ihde, and all those who during the past months have sent me material on the St.Croix-Namekagon complex, which I read with great interest and profit. It would be presumptuous to add to it, so I will merely speak from my own personal experience and draw a few general conclusions. I have been intrigued by the papers which preceded mine—a wonderful background for the river proposals this panel is considering. I feel happy to be asked to be a member of this panel because I've had a love affair with wild rivers most of my life.

I tried to fly in yesterday but the weather didn't permit my landing, so I came down on a bus from Ashland coming through country which at one time I knew very well. I thought of my early Wisconsin experience and how it would apply to what I'm going to say this morning.

I thought of a little creek which so far as I know has no name even today, where I caught my first brook trout, somewhere out of the Phillips-Prentice area which I came through last night. I wasn't more than seven or eight when I caught that trout, a tender age, but catching that trout and seeing a wild little creek affected my life. That's where my love affair started.

The last few days I've been in Hayward, which is close to the headwaters of the Namekagon. Living at Ashland for a while and Hayward, I became familiar with the country Ernest Swift described so vividly. In my memory are strange names such as the Chippanazee Creek, Big Brook, Branch Brook, the Mosquito, the Ounce, the Tobitik, not Totogotik as it is on the map, but Tobitik, countless little streams and tributaries of the upper Namekagon. Those streams are woven into my life and they have colored my whole attitude toward wild rivers. I fished the Namekagon fifty years ago when it was full of brook trout before the browns came in and when it was unusual to catch a Northern or a bass.

I made a sixteen day canoe trip once from the Kettle River at Sandstone, Minnesota, down to the St. Croix and down the St. Croix to Stillwater and beyond. I'll never forget that trip. There were no portages on the rivers in those days, and I ran the famous Kettle Rapids; six miles of white water with no chance of getting out, and I broke quite a few ribs in my old canoe in the process.

While at the University of Wisconsin, I spent a summer on the Wisconsin Geological Survey under Mr. Bean, who was state geologist at that time. Our headquarters were Stanley and Danbury. I surveyed the Yellow River at that time, waded all the way from its beginning to where it joins the St. Croix, got to know it and its tributaries well. Since then my love of rivers has carried me into many strange places. I have followed the great Canadian rivers from the International Border up to the Arctic Coast, rivers with such names as the Churchill, the Athabaska, the Great Bear, the Slave, wild and inaccessible, even today. In July, I followed the Gods River and the Hays down the fur trade route from the north end of Lake Winnipeg to Old York Factory on Hudson Bay. My involvement with rivers has been a lifetime affair. Wherever there's water, I have a penchant for getting into a canoe to explore them. Just a year ago I made a canoe trip down the Swanee River from the Big Okefenokee swamp in Georgia down to the sea. The year before that I made a trip down the Lewis and Clark section of the Missouri. I've canoed the Current River in Arkansas and Missouri, known the Allagash in Maine. Last year, I followed the Namekagon from the headwaters to Hayward, a sentimental journey for me.

These trips have given me a feeling for wild rivers, a sense of their importance. Rivers were the first highways of America—first the Indians, then the French and American fur traders, finally the loggers and the settlers. Rivers are woven into our lives. Many here today can trace river travel in the history of their families.

The first highways of America—paths of exploration, trade and development; now we're looking at rivers to see if they have other values. The very fact that the first morning of this important meeting of the Wisconsin Academy of Sciences, Arts and Letters is devoted to the preservation of wild rivers is significant.

Yesterday morning I walked down to the banks of the Namekagon. Mrs. Olson's old home is on its banks between Hayward and Cable. I had brushed out a trail down to the river some years ago, a lovely trail, paralleling a little creek rising in a swamp and following the river for probably half a mile. It was a misty morning. I stood down there by the river and listened and looked. It hadn't changed much in fifty years. The water was fast and high and flecked with foam from rapids above. There was constant movement. The birds were singing. The white throats weren't back yet but the chickadees were giving their mating calls and a flock of red winged blackbirds were in a tall tree. Then I heard a mallard coming down the river, a greenhead. It lit in the river in front of me; I was hidden behind a big cedar root. Soon it was joined by two others and then there were three greenheads there. They paddled around in the river and watched the foam, picked up an occasional bit of food (I couldn't tell what), dove, swam upstream and down for about an hour. Standing there by the river watching these mallards, listening to the flow of the water, I thought: the Old Namekagon epitomizes the interest and the love of people for all wild rivers. Here was the same silence I had known as a boy. Across from where I stood were two old cedars. I used to catch a trout there once in awhile, a real brook trout. There was movement and aliveness and silence. I could hear cars occasionally on Highway 63 but the sound ebbed and flowed. Most of the time was the feeling of wilderness that the Namekagon used to have. I thought to myself as I stood there, and this part of the Namekagon is not included in the study, how wonderful it would be if others could come back as I had done fifty years or so to hear and see what I saw.

Walking back to the house I took a different trail, wound up on a road, and there was a sign: *River Front Properties For Sale.* The Namekagon, the Wolf, the Chippewa, the Flambeau, and the St. Croix are disappearing before our eyes. The rivers are not disappearing, but their wild quality is changing fast.

I am glad that the St. Croix-Namekagon complex has been given me to talk about this morning. The St. Croix boundary line between Wisconsin and Minnesota was a suitable subject because I've lived part of my life in northern Wisconsin and part in Minnesota, so am qualified, I think, to speak for the project. The river has the same kind of history that other rivers have. It's a large river, larger than most being considered, about sixty-five hundred square miles, roughly five million acres for the watershed. It too was once a famous highway for the Indians. It had Indian villages, battle grounds between the Sioux and the Chippewa, and early fur trading posts. During the logging era, when five and one half billion feet of logs were sorted in the Stillwater area, it was the great highway. From the standpoint of size and significance this complex is worth considering.

Just how the Interior Department study teams arrived at their conclusions I do not know, but I know they started out with six hundred and fifty potential streams. After a great deal of research, many meetings and pairings, they cut this vast number down to sixty-four, and this sixty-four eventually to twelve. What guided the committees in their final choices was national significance. The St. Croix is a large river, has important history, and is still untamed enough to qualify as a wild river.

I have a great deal of respect for the study teams and the work they are carrying on. The more I study the material that has already come out, tentative ideas, surveys, and suggestions, the more I am impressed with the tremendous amount of research going into these projects. Here is a challenge never faced before in the preservation of wild country. Trying to figure out the ownership pattern of a national park, a national recreation area, or an historic area is simple compared to what these teams face in their study of rivers. Here are no solid blocks of land, but long ribbons along the rivers which may be from one hundred to two hundred miles in length. Here they face different kinds of cooperation—federal, state, county, with a complex of private ownership that's sometimes baffling, legal complexities which will take all the ingenuity, brains and analytical ability the study teams possess.

The twelve national rivers were chosen because of their proximity to great populations and their recreational potential, as well as beauty and charm. There are many other factors going into their choices for the kinds of rivers picked for this first study. I merely want to say to these teams: do not underestimate the importance of your studies. Those of us who know, recognize the tremendous difficulties you're faced with. If you come up with fairly firm conclusions by the end of the year, which is your hope, remember that you are laying the groundwork for a new system to be called "The Wild Rivers of America", something different than has ever been done before.

"The Wild Rivers of America" is a challenging concept. I'll never forget when Secretary Udall came into office. He had a big map of America laid out before him, had marked in red dozens of rivers, most of them the headwaters of huge drainage systems. He said, "I hope the day will come when we can save a few of these rivers in a wild or wilderness condition, when the American people will realize that some rivers are more important from the standpoint of aesthetics and recreational use than as sources for power and water storage. We'll have to move fast because these opportunities are disappearing."

In the Department of Interior, with its various agencies—the Bureau of Outdoor Recreation, the National Park Service, the Fish and Wildlife Service, Reclamation, and other, and with the cooperation of the Department of Agriculture the Forest Service, there has finally come into being a definite determined program to save some of these rivers while there is still time. I hope that the twelve which are now being studied in depth will be increased shortly to maybe twenty or thirty. I hope those that the federal government is not studying will be studied by the states, the counties, and local governments.

I hope the day will come when such beautiful rivers as the Wolf, if it does not fill the criterion for national designation, will somehow have woven around it a protective design. Back in the thirties I made a survey for the Bureau of Indian Affairs of all the Lake States' reservations, spent considerable time on the Wolf and had a delightful assignment to also fish the Evergreen which up to that time was denied to white people. You can imagine how difficult it was for me, being an old trout fisherman, to go into the Evergreen with an Indian friend with the express purpose of seeing what was there.

It's hard to make comparisons, difficult to compare one river with another. They're all different and worthwhile. An encouraging thing about this wild rivers movement is that studies are being made by men as conscientious as any I've ever known—men who have an emotional involvement in rivers as I have. If these men didn't have a deep feeling for rivers, if they didn't wear their hearts on their sleeves so to speak in the work they're doing, their work would not be significant. Joseph Wood Krutch of Arizona said once, "Conservation without love is a meaningless activity." I am sure all of you embrace that philosophy whether it's the wild rivers program or any of the many facets which may be discussed here today. All conservation is the same, and all conservation work done by people such as you and the organization you represent, is done for love and the deep feeling you have for the land, and your envronment—not only rivers, but forests—and swamps—and fields, the total human environment we're trying to save. Wild river studies are part of this pattern.

An old Greek philosopher said, "Life is a gift of Nature, but a beautiful life is a gift of wisdom." How right he was. A beautiful life *is* a gift of wisdom. What we're trying to do in this wild river study is to gain wisdom, wisdom on how to cope with all the technical problems confronting such preservation. In order to have wisdom we must have knowledge, studies in depth that have to do with the physical terrain through which a river flows, the kind of stream it is, the kind of water, ownership patterns, legal complications, federal, state and county divisions, the complexities of zoning, purchase of easements, and other facets that are part of the overall effort.

I want to sound a few precautions regarding rivers. Let's never try to balance the economic potential of wild rivers against the dollars and cents of economic statistics so easily available. I've always felt in any of these struggles that to talk of aesthetics, intangible value and the spiritual, the emotional impact on people, with the complex of the dollar sign, is a losing battle. We cannot ignore the dollar sign, but let's not try to make any wilderness reservations justify themselves from the standpoint of economy alone.

Secondly, I would say the important thing in protecting rivers is to save the streamsides by the creation of inviolate strips along them. How wide they should be depends on the terrain itself. A river shorn of its trees is a changed river, a river logged to its banks, a different ecology from what it was before.

Thirdly, let us not overdevelop these priceless rivers. As I stood by the Namekagon yesterday, alone in the mist watching those mallards and listening to the birds, I thought of what maximum recreation use could do to a river like that. I thought of thousands of canoeists coming down the Namekagon, not only canoeists but boats with uptilted motors, and I thought," Why stress this matter of maximum use? Why not face up to the real issue, the preserving of something wild for its own sake, for the days when our population will be three hundred million instead of one hundred and ninty?" We must look to the future not the next decade, a future of fifty, one hundred years, or a thousand.

I was delighted to see you at this meeting, Senator Nelson. I thought I'd said goodbye this morning but evidently the planes are not flying. I want to compliment you for your vision, for the leadership Wisconsin took in its fifty million dollar natural resource fund. I must also tell you that due to our jealousy regarding the lead Wisconsin took, we did the same thing in Minnesota. You set an example which is being followed all over the United States.

I couldn't be here last night to see the Brandywine film which I viewed some time back, but I did want to hear the speaker again; nor did I make it to see the Apostle Island films because my planes weren't flying either. I saw the film in Washington and was impressed. Living at Ashland I knew the Apostle Islands, once was storm bound there on a little sand spit of Long Island for several days with nothing to eat. I know the Kaukaugan sloughs and the Chequamegon sloughs at the end of the bay. It would be a wonderful thing if the dream of providing protection for this unusually historic complex of islands, rivers, and sloughs would come into being.

I don't think any of us still face up to the fact that time is running out, that we're faced with a population and industrial expansion which will destroy many of these things we're talking about unless we move now. That's why this meeting is important. There is an urgency that cannot be avoided. The day is going to come when any place of wilderness will be so precious to our people that even to go there and look is enough without having to paddle down it, swim or water ski, or catch fish. The important thing is to save places with wilderness quality to which the people of the future can repair for their spiritual well being.

I remember Justice Douglas on our C & O Canal hike of ten years ago when we walked one hundred eighty nine miles from Cumberland to Washington. He and I were on a radio program one night when he said, "We establish sanctuaries for deer and ducks and fish and all sorts of creatures, but what we really need to do is establish sanctuaries for men."

MINERALS, WATER AND SOILS IN NORTHERN WISCONSIN

George F. Hanson, State Geologist and Director
Wisconsin Geological and Natural History Survey

Geologically speaking, Northern Wisconsin is the very heartland of the state. It is here that the rocks of the so-called "basement complex" have been uplifted and exposed at the surface by erosion.

These rocks are extremely complex and record over 2,000,000,000 years of geologic history. They record the presence of ancient seas whose boundaries have long since been obliterated but whose deposits are represented by sandstones, now quartzites, such as we see in Rib Mt., and by other marine deposits now so highly altered that their origin is often barely discernible.

They record the activity of volcanoes, some quietly extruding basaltic lavas that covered hundreds of square miles, others erupting with explosive violence and emitting deadly clouds of incandescent dust such as annihilated the inhabitants of Pompei and St. Pierre. They record periods of intense crustal deformation when mountains were built, and periods of quiescence when the mountains were reduced to plains on which rose hills of more resistant rocks such as quartzite. During the final minutes of the last scene glaciers covered the land leaving on their retreat a blanket of debris which all but obscured the underlying rocks and which radically changed the preexisting features of the landscape.

Such then is the geologic setting of our mineral resources, our water resources and our soils.

Of all the mineral resources of the north none have been more important historically than iron ore. This was originally deposited as a marine sediment and consisted of thin, alternating layers of silica and iron carbonate. As these sediments were subjected to various geologic stresses with the passage of time, their nature changed; in some areas the iron and silica combined to make iron silicate minerals; in others the iron carbonate changed to magnetic iron oxide and in others to non-magnetic iron oxide; locally the silica was leached away, leaving masses of high-grade iron ore scattered as plums in a pudding. It was in these high-grade ore bodies that the iron mines on the Penokee-Gogebic Range were developed. The first production was in 1884 from the Colby mine in Michigan, and two years later the Montreal and Cary mines in Wisconsin began production.

Although the iron-bearing formation itself was extensive, the high-grade ore bodies were scarce, and as early as 1924 work was started to produce a high-iron concentrate from the low-grade iron formation or, as it is commonly called, "taconite". At first this was uneconomical, but as mining and concentrating techniques improved, and as the cost of mining the high-grade ore rose, the cost-benefit ratio began to favor the production of taconite. Imported ores of exceptionally high-grade also appeared on the market. It became apparent that the iron mines of the Penokee-Gogebic Range, some of which were operating from 3–4000 feet underground, would soon be unable to compete economically. In 1962 the Montreal Mine was abandoned after having produced almost 45,000,000 tons of ore, and although the Cary Mine is still producing, its future is most uncertain.

The era of high-grade iron ore mining in Wisconsin is drawing to a close and the future lies in "taconite". Substantial quantities of "taconite" are known to be present on the west end of the Penokee Range near Mellen; in the vicinity of Butternut, in southern Ashland County; at Pine Lake, south of Hurley in Iron County; and at Black River Falls in Jackson County. It is very possible that there are unknown deposits awaiting discovery. Although it is uncertain when taconite mining in Wisconsin will become a reality, I have little doubt that it will ultimately be of as great, or greater, economic importance to the north as has the mining of high grade ore.

Although iron is the only metallic mineral that has been produced from the northern part of the state, it was another metal, copper, that captured men's imagination at the turn of the century. It had been shown that the same geologic formation that was host to the rich copper deposits of the northern peninsula of Michigan extended across northern Wisconsin to Minnesota; some outcrops showed traces of copper mineralization, and on the basis of this information a full-fledged copper boom was promoted. Mining companies pointed to the fabulous success of the Michigan mines and sold stocks with the assurance that "all risks had been eliminated." This rosy picture was clouded when, in 1900, the state survey issued a report stating that although some copper mineralization was apparent there was no evidence from the outcrops and test holes that had been examined that ore bodies of commercial magnitude were present. This report created an intense furor but it has stood the test of time, and although there has been exploration during recent years by some of the world's largest copper producing companies, we still await the discovery of a commercial ore-body. In spite of these discouraging results, I feel certain that such ore-bodies do exist and may be discovered in the future as new exploration techniques are developed.

Although metals have much popular appeal, non-metallic minerals are of no little importance. Among the non-metallics produced in northern Wisconsin are large quantities of sand and gravel for highway and other construction purposes. Crushed stone for roofing granules is produced in Marinette county and also at Mosinee just north of Wausau. Quartzite is quarried for abrasives at Rib Mountain. Wisconsin granites are known throughout the nation and indeed there are none finer. Occurrences of some rather exotic minerals such as talc, molybdenite, asbestos, zircon, thorium and the rare earths are also known and may point to the discovery of deposits of commercial grade.

The soil and water resources are both legacies of the Ice Age. Our information is insufficient to reconstruct the pre-glacial physiography with any degree of accuracy. The topography was probably somewhat more rugged; there was certainly a well developed drainage system with few, if any, lakes; ground-water supplies would have been hard to obtain as the crystalline rocks store negligible amounts of water, and the residual soil would have been highly leached of its nutritive elements.

The material that was deposited by the ice sheet consisted of unsorted debris composed of fragments, scoured from the rocks over which it passed, ranging in size from large boulders to rock flour. In general these deposits are quite high in nutrients. As the ice receded, streams took up new courses and lakes were formed in the depressions created by dammed valleys and the melting of stagnant ice blocks buried in the glacial debris. In many places the glacial sediments were redistributed by water from the melting ice and sorted into various sizes depending on the velocity of the current. Coarse materials such as sand and gravel were deposited in broad, flat, "outwash" plains close to the margin of the melting ice; the finer materials were carried greater distances and were deposited in the still water of lakes, which were then of much greater extent than those of the present day. In some areas a fertile layer of wind blown silt, called "loess", covered the ground to a depth of several feet. Thus a brand new landscape, new soils and a new water regimen were created.

The sands and gravels act as a highly permeable sponge to soak up rainfall, store it temporarily as ground water, and release it slowly to streams to maintain cool and steady flows. In such areas wells can be drilled to yield large quantities of water. However, in areas where sands or gravels are lacking, and especially where the glacial deposits are thin, ground-water may be extremely difficult to obtain, even in such limited quantities as are necessary for domestic and live-stock use. If surface water supplies are readily available these may be developed, but quite often they may be highly polluted or may lie far enough away that the cost of obtaining, processing and transporting the water is beyond the economic capabilities of the communities involved. In such areas the lack of water may seriously limit the growth potential. Thus, although northern Wisconsin is water-rich overall, the local availability of water for domestic, municipal, industrial or agricultural use may vary from that of extreme plenty to that of critical shortage.

The soils of the northlands are by and large quite fertile, and in 1921 the state survey issued a bulletin extolling their virtues. However, the agricultural boom, like the copper boom, failed to materialize. Although some areas support a healthy dairying industry, the growth of diversified crops is limited by the short growing season. Within recent years, however, a significant new development has taken place, namely growing specialized crops, such as potatoes, on the sandy soils with the aid of supplemental irrigation. This activity is bound to increase in the future, and, hopefully, attract processing plants that will further add to the economic base.

I do not, in this extremely brief discussion of the mineral, soil and water resources of the northern part of the state, wish to leave the impression that we know all there is to know about the subject.

In the field of bedrock geology, much could be learned from an aeromagnetic survey. This technique measures differences in the magnetic attraction of rocks even when deeply buried. Such work recently delimited a large iron ore body in Missouri and possible ore bodies in Iowa and southeast Minnesota. We have done some reconnaissance along these lines and will attempt to obtain support for continuing the work.

The needs for information on water resources are legion. Detailed work should be done in areas of water shortage to locate sand and gravel beds that may lie in buried valleys; information is needed on the relationship of ground water to surface water and of streamflow characteristics to geology and climatology; the biologic effects of pollution and the aging of lakes demand study. A bill to initiate such studies passed the Wisconsin Senate without a dissenting vote during the last session, but is currently held up in the Assembly.

Agricultural studies on soils will always be important, but the emphasis is shifting towards interpreting data on soils for many other uses, such as their engineering properties for highway construction; suitability for on-lot sewage disposal systems, for recreational uses, game management, timber production and scores of other purposes. We intend to devote a major part of our rather meagre funds for soil surveying to the study, mapping, and classification of Wisconsin soils for multiple purpose uses.

In short, northern Wisconsin has a potential that is far from well known, but we shall continue to work to obtain the necessary support to enable us to contribute to a fuller understanding of its basic resources.

THE FOREST RESOURCES OF NORTHERN WISCONSIN

John A. Beale, Chief State Forester
Wisconsin Conservation Department

It is most appropriate at this meeting, with its theme of "The Natural Resources in Northern Wisconsin," to consider a resource which at one time was the North's number one industry—the forest resource. It is unlikely that the industries using the wood resource will ever again completely rule Wisconsin business, but they are presently a much larger force in the economy of the North and the State than most people realize. It is apparent, too, that they will remain one of the dominant segments of the Wisconsin business community in the future. The forest resource is the most important resource in the North, yet it is synonymous with the so-called depressed areas of our state.

To serve as background material, I would like first to outline the present status of the forest resource in the North—its volume, growth and changing character. Secondly, I would like to mention some of the principal problems and goals in management of both public and private forest lands. And third, I deem it appropriate to discuss the present forestry program in the North, both public and private—or, in other words, what all types of land managers are doing to solve their problems and meet the needs of the future. Finally, I would like to touch on the outlook for the resource as it affects northern Wisconsin and to offer a few suggestions for speeding up the process of rehabilitating the forests of the North.

Presently, 69%, or ten and one half million acres, of the northern twenty-one counties is in forest land, and the total volume of wood in these forests is just about sixty-two million cords. If cut in eight-foot sticks, it would fill 3,000,000 railroad gondola cars; and if stacked up four feet high, it would make a continuous pile alongside 47,000 miles of road in the state. If the resource were static, that is, if it could be banked, with no change, it would supply the paper industry for nearly thirty years at the present rate of consumption.

Unlike some other resources, however, forests are dynamic—ever-growing and ever-changing. The nonstocked, cutover forest area in the North has steadily declined with successful fire protection and forest plantings over the past twenty-five years. The acreage of sawtimber has decreased from the days when Paul Bunyan traveled these parts. The acreage of small seedling and sapling stands has decreased markedly; and the acreage in pole-size timber, that is trees from five to eleven inches in diameter, has doubled in the last twenty years. Today, northern Wisconsin is covered with a young, changing forest and is shaking itself free from the results of the logging done at the turn of the century and the fires that followed.

The species composition of these northern forests has changed also. The acreage of aspen, paper birch, white pine and balsam fir has decreased; the acreage in maple, hemlock, yellow birch and black spruce has remained about the same, and the acreage in jack pine and red pine has noticeably increased.

The volume in sawlogs has increased within the last twenty years, but the trees are smaller in size and of poorer quality than the original stands. We have less sawtimber in the more desirable species such as sugar maple, yellow birch and hemlock but more in oak, basswood and elm. The pulpwood volume is mainly concentrated in these northern counties of the state. The northeast and northwest areas have about equal volumes, and together they account for about four-fifths of the available pulpwood in the state. The forests of the North are growing rapidly. The net increase is about 2.4 million cords annually or somewhat more than the yearly harvest. This might seem to be a pretty good sign for the future for this area, but the average growth rate is only about one-fourth of a cord per acre. With more intensive management, growth of one cord per acre is easily possible. So we have a long way to go to reach full productivity, and this is one of the major goals of forest managers in the northern counties.

This, then, is what we have to work with in Wisconsin's "north woods"—a growing forest, but growing only about one-fourth as fast as it could; mostly hardwood, mainly in the five to eleven inch diameter class; a small but increasing volume of sawtimber, small in tree size and low in quality; between 500 and 600 thousand acres of planted forest, mostly pine; a pulpwood industry with a healthy appetite to satisfy; a lumber and veneer industry in need of quality logs to remain competitive; and the more recent concern that the forests of the North are important not only for timber supplies but also for water, wildlife and recreation. Those are the pieces of the puzzle that we are trying to put in their proper places to achieve full benefits from the forest resource for the people of the northern community, for the industries dependent upon the forest resources, and for the people who use the forest for other activities.

What about our aims? What are we shooting for tomorrow or 1980 or 2000? Basically our goals are much the same as they were thirty-five or forty years ago—reducing fire losses, improving forest management and having the forest resource of these northern counties contribute more to a better way of life for the people in the area. Besides these goals, though, we look forward to:

1. The increased growth of a highly integrated and automated forest industry based largely upon *Wisconsin-grown wood* and producing a wide variety of finished products, some of which we do not even conceive at this time. The Conservation Department has seen fit to put a utilization and marketing specialist to work full time to help the industries and counsel new industries in an orderly expansion of the vital wood-using industries.

2. The increased growth of a modernized, commercial recreational industry based on clean water and an attractive forest background. This endeavor should not be the responsibility of the state alone but is one where we are willing to offer noncompetitive cooperation so all lands and landowners can play a key role in shaping the economic health of the North. This is compatible with growing and harvesting timber and is an added benefit and source of income that must be developed.

3. Advances in technology and research in equipment and in trained manpower to open the way toward better management of the available forest area with less expense. The wood products harvested in the North in the next 30

years must come from trees presently growing in the forests of the area. The advances made in management and utilization of this crop will determine the resource base that local forest industries can tap for raw materials in the future.

In the attainment of these goals, a number of new or accelerated accomplishments must come to be:

1. Increased and modernized forest fire protection as the timber stands grow up and the hazards of crown fires are magnified.
2. Reduction or elimination of excessive taxation of forest land—a problem since the early logging days and still with us.
3. New uses for wood and improvement of existing manufacturing and marketing methods so annual allowable harvest can be utilized.
4. A speedup in the program of intensive forest management which will result in a greatly increased output of available forest products, providing a firm basis for the economic growth of the North.
5. Modern transportation methods have done much to bring the distant timber supplies close to the mill. Despite increased mobility, freight rate structures and highway shipping limits are deterrents to full utilization. These increased competitive costs need study and change.
6. Improvement of safety conditions in woods work to lessen the cost of necessary insurance programs for woods workers and the industry.
7. Improvement in the detection and control of forest pests, both diseases and insects.
8. Improve conservation education or, rather, I should say, resource management education to mold public understanding of the importance of conservation in general and especially the forest resource. This need was most apparent to me in the recent election when a referendum to increase the mill tax for forestry purposes was defeated by the electorate. Voters in only three northern counties favored the change, and they are the recipients of most of the benefits. Too many of our so-called conservationists are concerned only with the frosting on the cake—the fish, ducks and deer, while they are either unaware of or choose to ignore the rest of the cake, the real basic elements of resource management—water, soil and forests—without which there would be no frosting.

These then are the major goals and some of the problems we face in reaching them. The question next is: What are we doing now to meet our goals, to solve our problem, and what else should we be doing? This list is not as long as we might like, but it shows that the forest acreage of the northern counties is some of the most intensively managed, studied, manipulated and most promising land in the state. Let's take a close look at some aspects of progress in the management of the timber resource of the North.

1. We have a forest fire protection program that is of prime essence to the growing of renewable timber crops and justifies the expenditure of time, money and materials in a forestry program.
2. We have a cooperative agreement with the northern counties in the management of nearly 2 million acres of forest land that last year alone produced over 2.6 million board feet of sawlogs and nearly 100,000 cords of

pulpwood. In addition to supplying raw materials to the industry, these figures represent jobs for people in this area and money that is earned on a year-round basis, not seasonal in nature.

3. Reforestation is moving ahead at an encouraging rate. All landowners, state, federal, county, industrial and private, have been actively engaged in restoring the production of the area to stands of timber which will assure the forestry future of the North.

4. An increasing number of acres in all ownerships are being managed under intensive multiple use. These acres are producing raw materials for the local industries, recreation for tourist, and increased levels of wildlife for sportsmen or for that segment of the public that merely wants to see the animals of the forest.

5. The forest survey and timber resource data are constantly being evaluated and used by industries interested in planning plant locations and expansions. I might add here that we had hoped to update this survey in the near future, but the failure of the recent forestry referendum has dimmed chances of this because of the shortage of funds for this purpose.

6. The forest research program has given us answers to many problems directly related to growing timber and protection against insects and diseases.

This type of research must continue. We must also find answers to problems of marketing, forest taxation, utilization of low-grade wood and less expensive methods of timber management.

Contrary to much that has been said about the economic future of the forest areas of the North, I am inclined to be optimistic. It is apparent, I hope, to many of you that we have not been sitting on our hands for the past 30 years. We must realize that over a period of about fifty years from the Civil War to World War I, the North was relieved of a timber resource so great that the original timber supply is hard to comprehend. Such a resource is not to be restored overnight, but it can be restored and it is being restored.

What about the future? So far, I have talked about what has been and is happening in the forests of the North. A look at what we can expect by 1986—only twenty-two years away which is relatively short by our time schedule—shows an expected 43% increase in timber volume. Timber cut will be 40% higher than in 1964. This looks promising for the North but I feel we can and should do even better. With expansion of the forest industries of the state a substantially higher proportion of the wood they need will come from Wisconsin forests. It is also my belief that we will be doing a better job of forestry in the woods. This means more growth and more timber available for cutting, more jobs and more residents earning a suitable livelihood.

All forest owners, public and private alike, must make a greater effort to recognize the inherent public interest in all the forest lands of the North and manage these lands to provide wood products for our state industries, jobs for the residents of the North and a more stable, flourishing economy for the entire northland. Much has been happening in the forests of the North. The outlook is good if we continue to progress as we have during the past 25 years. It can be excellent if we put a little more effort into it. We are determined to do just that.

LAKE MANAGEMENT FOR RECREATIONAL USES

Edward Schneberger, Superintendent
Research and Planning Division
C. W. Threinen, Supervisor
Lake and Stream Classification
Wisconsin Conservation Department

Wisconsin is a humid state with large amounts of surface waters moving from the higher elevations to the major water courses. Wisconsin is endowed with thousands of pits or blocked drainages as a result of glacial action and man's works. With much water running off in streams and collecting in pits or impoundments—better known as lakes—it is only natural that waters are an important part of our landscape and that they are the focal point for an immense amount of recreation.

What are the types of water recreation sought and what are their requirements? Knowledge of this kind is essential to chart the course of future surface water management to provide the pleasures desired. Most analyses of water recreation have simply viewed water as unlimited space to which only the parks and accesses need to be opened up, under the assumption that then all the bounty can flow from this opening. But there is more required than that. Every duck that is shot, every fish caught, every boat anchored and every beach appropriated for swimming has space requirements, which may be in conflict with other requirements.

The primary recreational activities on water may be lumped in these categories: fishing, boating, swimming, hunting and trapping, esthetics, aquatic life study or observation. Besides recreational activities there are numerous nonrecreational activities which utilize surface waters such as irrigation, navigation, dilution of wastes, power generation and industrial uses of water, all of which can be competitive with and often are detrimental to surface water use for recreation, through in some certain instances they are complementary. In the following paragraphs we shall define these activities and furnish a picture of their requirements. With such a background, waters classification comes into focus.

Fishing

From the standpoint of welfare there is no finer participating sport than angling. It takes the individual outside and it furnishes "a pleasureful use of time not spent at work" during all seasons of the year. It furnishes healthful, moderate exercise, offers a mental challenge, provides an element of chance and, as a bonus, it can provide meat on the table for the skillful (or lucky) fisherman. Clearly with all these values we need to provide just as much fishing as we possibly can.

The requirements for fishing have several dimensions, beginning with the space or habitat requirement for rearing the fish. The first essential will be to provide water with qualities acceptable to fish. Space does not permit a discussion of the various types of pollutants and the effects of pollution on water quality. It will, therefore, suffice to state that every effort must be made to protect our surface waters from these destructive forces. Where waters are polluted it should be public policy and civic pride to clean up the situation as soon as possible.

If we are to maintain quality fishing, a minimum requirement will be to keep the BOD (biochemical oxygen demand) of our waters as low as possible. Subtle changes can occur if we fail to do so. In the clearest and deepest, cold-water fish such as cisco and trout will disappear. Important invertebrate food can be lost to the environment, and pleasant weeds can be displaced by filamentous and bluegreen algae. Lack of attention to water quality will result in a harvest of less desirable fishes instead of the highly prized game fish such as walleye, muskellunge, bass, perch and bluegills.

The second requirement is adequate habitat. For some species this will be cover in the streams, stable water levels during rearing periods, weed beds for nursery areas, unmolested spawning grounds, adequate food resources and many other not-easily recognizable requirements. A sampling of some requirements will partially illustrate this point. The muskellunge and northern pike spawn in shallow marshy bays. What will happen to these spawning grounds when these areas are filled in for cottage sites? The trout fingerlings hatched in midwinter are completely at the mercy of the stream cover. If cows have stripped all the cress beds, water buttercup clones or over-hanging brush or grass, their lot is simply food for others. Even big trout face the same problem —having escape cover—when attacked by otter, merganser or heron.

There is subtle interplay among all species of fish. If the habitat is shifted slightly in one direction or another, a different species may be given advantage. Reduction of weed cover favors plankton eating species such as crappie. The crappie is commonly the most abundant species in relatively weedless flowages with fluctuating water levels and in lakes which have had vegetation reduced by carp action. We shall reap a harvest of the types of fish the environment will produce. This can be a high value crop or a low value crop.

The fishing space required by fishermen is a subtle thing. Fishermen seldom appreciate having others around them. It will never do to have two trout fishermen on the same hole. On lakes an angler systematically working a few acre weed bed for muskellunge will be intolerant of another invader.

Many uses of water can interfere with fishing without actually destroying the fish themselves or damaging the habitat. For example, some pollutants can and do contaminate the flavor of the fish so that they are unpalatable and thereby decrease the value of the fish population as a recreation resource.

Many municipalities find that surface water courses are either needed to "flush" water off the landscape or store water in times of peak runoff. The former requires a ditched and straightened stream and perhaps one that is cemented in. The storm sewer belching unsavory water into streams or lakes is not an asset. Agricultural enterprises also find it convenient to ditch many streams that have a fishing value. Water which is used for power purposes is not in itself seriously harmful, rather it may do some good. Many waters were created or enlarged primarily for power production. The Chippewa Flowage is the largest of our flowages and has provided much to the recreational assets of the area. Water is stored for subsequent industrial use. There are several similar flowages, but much smaller in size. Considerable study and research is needed on these flowages to clearly understand how to manage them so that industry and recreation are in concert to the best advantage of both.

Irrigation is a consumptive use that takes water away from fish. This conflict is especially keen on trout streams mainly because the geography that provides trout streams is also the geography that favors an irrigable crop, mainly potatoes. The first and almost immediate effect is felt by the trout fishermen.

Other activities on water can subtract from the fishing experience. The presence of numbers of motor boats, especially when associated with water skiing, will drive fishermen off the water. It is common to watch fishermen leave the water when their solitude is broken by the whirring, wave-creating motorboat and the "splish splash" of the water skiers.

Swimming

Although swimming, as a sport in the open air and pursued on surface waters, is confined to the warm months, usually from Memorial Day to Labor Day, it is a favorite sport of many. The requirements for swimming are clear water and sandy beaches, and therefore shore property owners willingly pay twice as much or more for firm frontage with sandy beaches as for water frontage with soft bottoms. Estimates indicate 45 or more percent of the public indulges in swimming and the greatest number of participants is among young age groups. Swimming and its counterpart sunbathing are healthful activities, gentle, complete, and relaxing, and should rightly be favored by public policy.

Swimming can be most easily adversely affected by water quality. A heavy algae bloom or water that is too turbid will be shunned by the swimmer. This sport has been hurt on some waters in this state by water enrichment, notably in lakes below sources of sewage effluent. It has also been hurt by the industrial wastes. Sewage contamination frequently requires the closing of swimming beaches. Health authorities generally use as a basis for pollution a *B. Coli.* count of 1,000 per cc.

Interference with swimming aside from diminution of water quality is not great. Only fast boating pursued close to shore and use of shore for marina facilities can be cited as causing interference. Use of shore for cottages is a means of providing relatively exclusive swimming opportunities, although this is certainly an extensive use of shore.

Swimming occupies the littoral zone and if heavily pursued little other activity can take place. The littoral area will be barren of vegetation and will have a barren sand bottom. These conditions will not be optimum for fish and certainly if the real deficiency is nursery areas, such losses could be significant. Consequently clean water and space are the primary prerequisites and must be jealously guarded if we are to give this use the optimum benefit it deserves.

Boating

Boating has much variety to it, and includes rowing, canoeing, sailing, speed boating, water skiing and ice boating. When boating is practiced with moderation, we can say that exercise, the opportunity to be outdoors and the opportunity to enjoy the esthetics of water from boats, are all very much in the public interest.

Rowing and canoeing furnish exercise and have low consumption of water space. Today, although little rowing is practiced, canoeing is increasing in popularity. Such activities interfere but little with other activities. Sailing is largely confined to the larger lakes, and to the center of these waters where abundant maneuvering room is available. Sailing does not cause significant interference, either because of its location, or slower speeds. However, motor boating presents entirely different situations. Most modern boats are the planing type designed to take advantage of hydraulic lift. They skim over the surface of the water at speeds generally in excess of ten miles per hour. The speedboat ripping and roaring around the lake or river surface will cover a great deal of space in a short period of time and will, therefore, be destined to interfere with more tranquil activities. Water skiing may be regarded as a fine sport, but it is without question the most space consumptive of water sports. We have indications that each water skiing unit requires about 20 acres of water surface before these units begin to force each other off the water.

Motorboating, unless water skiing is involved, has less necessity for clear water than many other activities although the boating experience can also be enriched if it has plenty of clear water to complement it.

The consequences of fast boating and skiing in relation to spatial limitations have to be weighed against welfare objectives of the recreational enterprise.

Waterfowl Hunting and Wetland Trapping

These activities are declining as time goes on because both are based on an extensive use of land and they are faced with sharply declining habitat. The number of hunters is little more than 2 percent of the population, and trappers are but a few thousand for the whole state. From the standpoint of recreational values, however, both activities should rate high on the welfare scale because they offer a distinct outdoor challenge during periods of the year when other uses are lower. However high they rate, a drawback always exists in the amount of space required for their pursuit. For example, to provide a blind on every 150 or 200 yards of shore on all the lakes in three southeastern counties would permit only 2,700 blinds for the 20,000 licensed hunters.

Hunting and trapping do not seriously interfere with other activities except with wildlife observation. The untrapped animals and unmolested waterfowl contribute to wildlife observation. But the interference of other activities with hunting and trapping is major. Converting the wild shores, particularly the marshy stores, to human uses is a net subtraction from the habitat requirements of waterfowl for nesting areas and for feeding areas.

At best, faced with habitat decreases, waterfowl hunting and trapping will be a declining activity and only a few can be participants.

Wildlife Observation and Study

This field of activity is pursued by the many Audubon Clubs, biology students and doubtless any youngster who has played along the shores of water. The number of participants at any one point in time will probably not be so large as many other activities, but the activity is nevertheless important.

It has similar spatial requirements to hunting and trapping, namely wild shores that provide nesting, resting and finding habitat for marsh birds and animals, and the homes for amphibians and reptiles. The littoral zone with its great variety of fish has interest also.

The activity is increasingly limited as habitat is gobbled up for home sites, marinas and other human uses. One cannot picture a frog croaking at the site of a house nor a turtle sitting on the end of a pier. The family of young ducks will not find much peace as water skiers race in and out, nor will they find much food along shores that have had chemical weed control. Almost any intensive human activity has an element of interference with wildlife.

Besides the micro aquatic life furnishing recreation of a desirable type, aquatic life of all sizes serves an educational function. No biology class was ever complete without a crayfish or a frog for dissection.

Esthetics

From what vantage point do the events of nature unfold with the greatest intensity? Over water of course. The esthetics associated with water are one of its greatest uses. No one is restricted from this element of enjoyment by age nor is anyone hampered significantly by economic means.

Aspects of aesthetics associated with water are so numerous it is difficult to mention them all. There is space, motion and setting. The ability to look out across the expanse of water rather than staring at a house or an apartment; the ability to watch waves, babbling brook or ripples dimpling the surface of calm waters; the ability to enjoy contrasts of sailboat and water surface, hill and flat surface; all these are ingredients of this value. The soaring white gull is not nearly so striking over the rough landscape as it is over the flat water scape. The white water lily in summer or tawny bullrush stand in fall would not strike the viewer with the same gorgeous intensity without the blue and green back drop of the water surface. In reality, water and the esthetics values it offers contributes much to the recreational activity on water. It is hard to believe so many would choose to build cottages on the shores of a lake or river if it were not for these values.

These values are, however, not all secure; they can degenerate. Should the water take on foul odors from pollution or excessive algae blooms, the intrinsic enjoyable qualities can disappear. Also if water becomes scummy with algae or too thick with weed growth, its visual attraction will diminish. Many attractions on water are based on natural vegetation and animal life. Their habitat must therefore be protected.

The Overview

A large percentage of us are trying to get close to water to better enjoy its pleasures. The situation will be public beach, commercial establishment or cottage-house site. The greatest demand currently is for the cottage-house site. The banks of all our significant waters are becoming lined or ringed one deep and sometimes two and three deep close to the big cities. The consequences begin to tell. Certain species of fish drop out of the picture because their spawning grounds have disappeared. The water grows more undesirable weeds and algae and perhaps for the first time winterkill will be felt. We catch more bullheads than walleye. The ducks no longer visit the lake. The peace and quiet and many elements of beauty have dwindled. It is well to ask, is this what we want? Don't we want to maintain the maximum package of values? What does it take to do this?

With the pure market place and personal utility to guide the allocation of space, we would find the shores and water dominated by the biggest and fastest. The fish or ducks cannot lay out cash for a home site. If these fish and wildlife values are to be maintained, man has to be thinking of them.

The circumstances cry out for a system of waters classification to help define what should happen where. Happily, the barest elements of this need were provided in a statute that required the Conservation Commission to set up a system of classification of lakes and streams by use. Most will think of this legislative mandate only in terms of boating because it was precipitated by the conflict between water skiing behind fast boats and fishing and swimming. Waters classification is much more than that. It involves first of all maintaining a resource for optimum use and secondly, it involves apportioning the use when conflicts between uses become excessive.

This mandate was the basis for initiating an inventory of waters by which facts on the surface water resource could be provided. The inventory and other data are giving us the basis for suggested lines of action. To bring the suggestions before the public, the Department has initiated a series of recommendations that would contribute to water resource protection and lacking authority to implement them, they have been given widespread publicity.

Although the first few recommendations concerned boating, more recent ones have also paid attention to shore uses because after all it is from the shore that most uses of water originate. The recommendations are briefly reviewed as follows:

1. Lakes of less than fifty acres not part of a connected chain are too small for motor boats.
2. A shoreline activity zone 200 feet wide in which the speed of boats should be limited is needed for all lakes.
3. Overnight camping, drifting or mooring of boats on the open water on which people are living does not have a place on inland lakes because the density of users is high and the capacity to assimilate wastes is low.
4. Public landings do not have the space to accommodate mooring of boats on the water or shore. This conclusion was amplified by the observation that boats under most circumstances are used only seldomly.
5. Lakes in the 50–200 acre size range and in some cases larger lakes will become crowded when they become heavily used.
6. Slow moving activities and shore activities such as swimmers, slow moving boats or anchored boats and the shore need to be separated from fast activities.
7. If we want to have recreation from small rivers and streams, movement up and down the banks will be necessary. This is incompatible with any amount of housing or development on the banks.
8. Many values associated with the inland lakes are based on the existence of some wild shore. Therefore preservation of some shore of this type is needed.

These are merely suggestions—planning if you will—for steps to be taken and there are many more suggestions that are warranted. What will really count is implementation—placing needed measures for water protection and equitable use in operation. This involves necessary boating controls, protecting the necessary wild land and shores through zoning and acquisition and arranging public use facilities compatible with space available. Many positive steps can be observed such as the land acquisition program of the Conservation Department and positive zoning steps which give waters protection and more equitably allocate uses.

None of us wish to observe with increasing frequency in years to come such symptomatic comments as "winterkill", "closed to swimming", "carp", "scummy waters". We cannot infinitely keep pyramiding uses and crowding in on the shores of our waters. We had better take stock and figure out the best approach for their use. Once the marshes are filled, the streams straightened and water quality impaired, correction measures are beyond our reach.

SOME ASPECTS OF WILDLIFE AND HUNTING IN NORTHERN WISCONSIN

Robert A. McCabe, Chairman
Department of Wildlife Management
University of Wisconsin–Madison

Concealed in the theme of this conference, "The Natural Resources of Northern Wisconsin," is the fact that these resources cannot be thought of or dealt with as a single entity, except in a very broad context. They are renewable and non-renewable; commercial and non-commercial; public and private; physical and metaphysical; sought after and ignored; loved and despised . . . The regard in which they are held depends upon the attitude of the viewer.

When appraising wildlife as a resource, and hunting as one way in which it is used, we must understand the animals and the environment in which they are found. From a hunting point of view, there are three main species which are of recreational and economic importance to the north; they are the white-tailed deer, ruffed grouse and sharp-tailed grouse. Other kinds of hunted animals could have been used as examples but the problems and solutions would not be greatly altered.

The role of these three species in early Wisconsin has been described in the scholarly contributions of A. W. Schorger.[1] The white-tailed deer in Wisconsin has also been treated historically by Swift,[2] Dahlberg and Guettinger,[3] and Bersing.[4] The thread of unanimity among these accounts is that deer and the two species of grouse were present, but not in great abundance, when white men came to Wisconsin. Deer, for example, were scarce in our pristine north woods by comparison with game abundance in the post-lumbering period.

The fur trader and the missionary left no marks upon the land; trappers were little more than transient; and homesteaders created and ultimately left behind only small bare patches in the northern forests. It was the lumber barons who, by reckless exploitation of our forests, prepared the stage for major changes to occur on the land and set in motion the dynamic processes whereby northern botany still struggles to regain its lost grandeur. Fortunately such havoc to mature forests will likely not take place again in the life of this nation.

Constant change in our northern environments has continued to the present time and will be an inevitable part of the future. At various times, the changing plant mantle of our state has had a profound effect on wildlife and the sport of hunting. Indeed the economy of the north is influenced by the persistent changes in the succession of plant types that keep Wisconsin green.

Each of our key species will be treated separately in relation to this dynamic process of environmental change in northern Wisconsin.

White-tailed Deer

In early historical accounts, deer were recorded to be both scarce and plentiful. The tall pineries with little understory, heavy snow, and a population of wolves and Indians accounted for the sparse occurrance of deer on the southern shore of Lake Superior, according to Schorger.[1] Shiras,[5] Doty[6] and McKenney[7] support this position. Cram,[8] discussing the Lac Vieux Desert of Vilas County, claimed that deer were found in reasonable abundance in 1841. Malhiot[9] also states that deer were plentiful in the Lac du Flambeau area in the early 1800's.

In the years before the sawyers scattered pine chips and sawdust over the trailing arbutus on the forest floor, only wolves, hide-hunters and Indians made inroads on the moderate deer numbers in northern Wisconsin. Severe winters, however, were perhaps the chief decimating factor.

By 1840, the fledgling logging industry, spurred by a growing nation, gave evidence of its prowess. By 1870, lumbering was our number-one industry. At the turn of the century our major rivers of the north were tinged brown with pine tannin and only dynamite could dislodge the displaced forests that had piled up like jackstraws in these same rivers. From this point, with the production of over three billion board feet of lumber in 1900, we were rapidly moving downhill as a lumber-producing state and were reduced to secondary scavenging for big timber by 1930. The cut-out and get-out policy in handling this "inexhaustible" resource produced slash which became the punk waiting only for the steel and flint of a droughty autumn.

The first major spark flew in 1871, and over a million acres of timber and 1200 human lives were lost in the Peshtigo holocaust. The loss to recuperative power of the soil and its water-holding capacity caused by this and other fires was severe. Swift[2] records other large fires in 1880, 1891, 1894, 1897, 1908, 1923, 1925, 1931 and 1936.

Opening the forest floor to sunlight by ax and fire fostered a growth of plants which formed a superb food-and-cover base for a deer population. The response was immediate. Deer range was extended and hunting opportunities expanded. The legal bag for deer has since then been altered many times in response to fluctuating populations and to public pressure. (These two forces are not synonymous.)

In time, the lush first growth of woody ground cover so desirable for deer began to shelter commercially-important tree seedlings. Deer do not recognize the silvicultural alternation of the habitat, and the herd was soon literally eating into the economic value of the newly emerging forests. Wood-using industries justifiably objected, and so did thinking hunters. Aldo Leopold—forester, college professor, game manager extraordinary—pressed hard for a harvest of does to reduce the growth rate of northern deer herds. He, along with others, reasoned that this would bring deer numbers in line with available food and, at the same time, protect the economic investment in our forests. The first antlerless-deer season since 1919, took place in 1943. The kill jumped from 45,188, in 1942 to 128,296 in that fateful season.[4] "The deer herd has been ruined by this slaughter," was the hue and cry up and down the state. The unkind things said and printed about Leopold's part in this management effort underscored the lack of understanding and short-sighted emotionalism by a

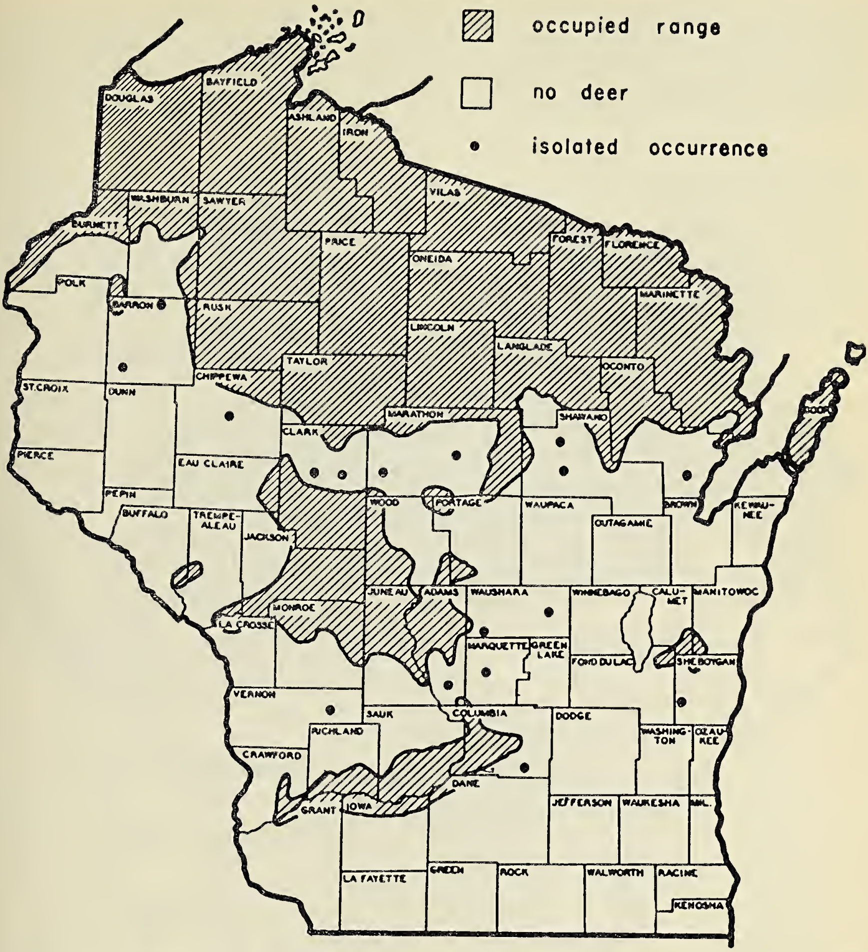

FIGURE 1. Wisconsin deer range about 1929 (after Leopold, 1931). (This map is Figure 4 from "The White-Tailed Deer in Wisconsin," by Burton L. Dahlberg and Ralph C. Guettinger.)

noisy minority associated with this resource. In the next ten years, hunters took from the "slaughtered" herd 745,337 deer. In some years, the hunters' success ran as high as 56%.[10] Aldo Leopold was not alive then to say: "I told you so." He doubtless would not have said it in any event, but I would, and did, and do so now.

Deer hunting is an economic factor in the north. Stores, motels, resorts, gas stations, restaurants and farmers benefit from the annual nine-day bonanza. Today our basic problem is to keep deer and deer habitat in balance and to encourage maximum allowable harvest for the good of the deer, the forest, the hunter and the economy of the north. In my opinion, one of the major game-management accomplishments in recent years has been the "variable quota" system of deer harvest developed by the Wisconsin Conservation Department. In brief, it attempts to promote harvest in accordance with deer abundance.

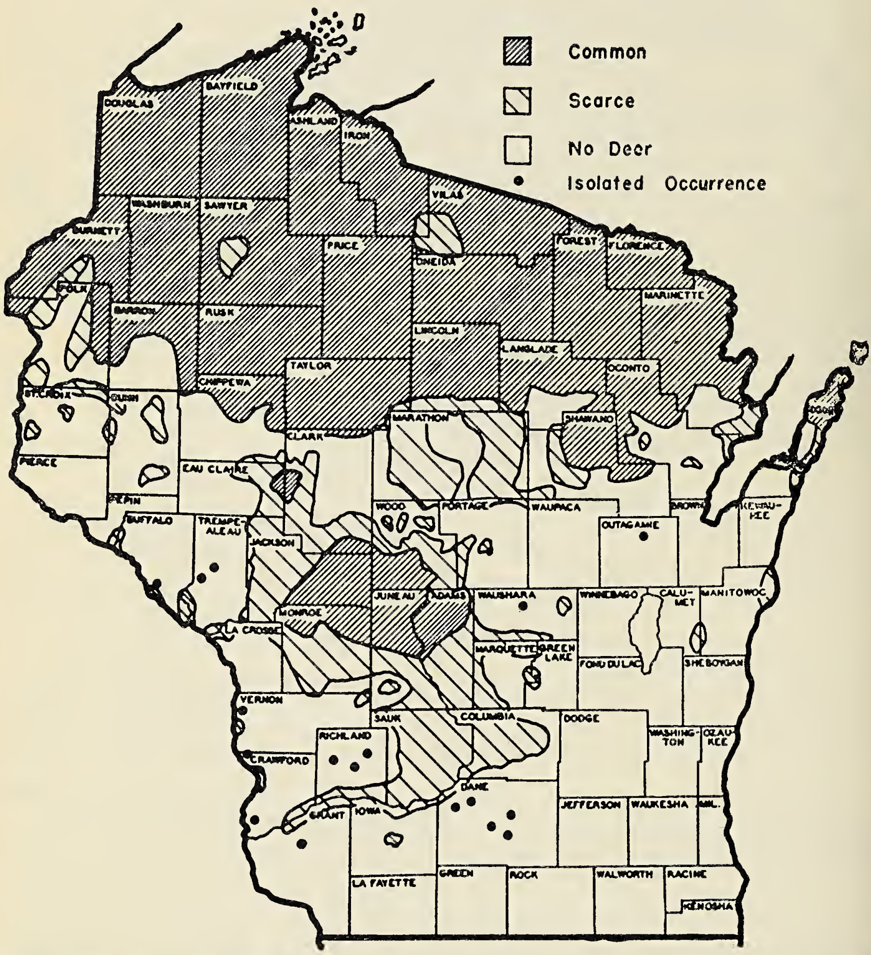

FIGURE 2. Wisconsin deer range about 1938. (This map is Figure 5 from "The White-Tailed Deer in Wisconsin," by Burton L. Dahlberg and Ralph C. Guettinger.)

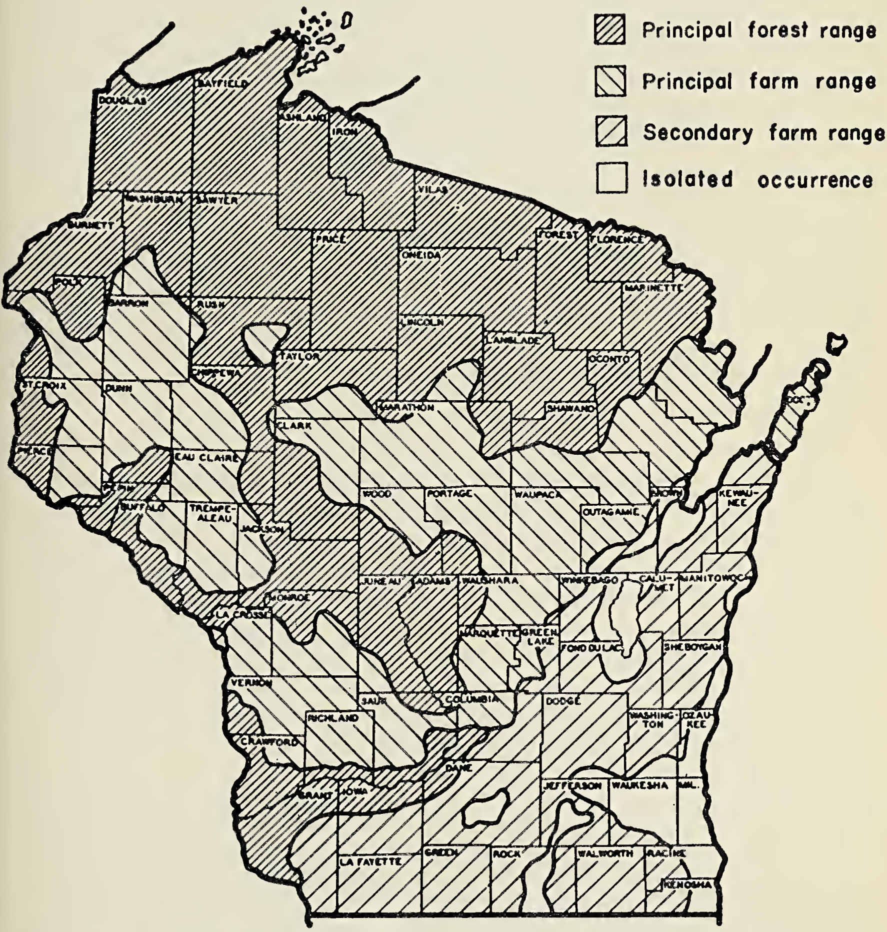

FIGURE 3. Wisconsin deer range in 1954. (This map is Figure 6 in the Wisconsin Conservation Department's recent book, "The White-Tailed Deer in Wisconsin," by Burton L. Dahlberg and Ralph C. Guettinger.)

Ruffed Grouse

No other non-migratory game bird has as wide a geographic range as this species. It is regarded by some, myself included, as the finest of all game birds. It is commonly called "partridge" or, in very early accounts, "pheasant." The partridge finds optimum habitat on the edges of cover where various plant types meet. It is found in abundance where the interspersion of cover types is at its best. Generally it is a bird of the thickets both in high ground and low, in hardwoods and softwoods, in the south and in the north. Populations become high periodically (ca. 9–11 years) followed by periods of scarcity. Early historical records mention this bird frequently, but little is said concerning great abundance in the north. By 1850, newspapers carried accounts of abundance and scarcity, according to Schorger.[11]

The plant changes of the post-lumber period altered northern monotopic mature forests into massive areas of interspersed second growth, which were periodically reduced by fires to seedling beds. These changes presented to the ruffed grouse as well as the sharptail large areas of ideal habitat. Newspaper accounts in the north were quick to report on the response by the grouse and on the economic capital that was realized.

Schorger[11] quotes an early writer as follows:

> the number of partridges that were being shipped from Ogema [Price Co.] was something almost past belief. He said that time and again he saw heaps of partridges piled up at station platform in piles reaching almost as high as his head. Shipments of 400 and 500 a day from that one point alone were the ordinary thing during the open season. . . . The local shooters are paid 40 cents for each bird they kill, sometimes as high as 50 cents. The bags run from twenty to forty birds a day to each man. . . . One man said he had shipped 1,500 birds last fall up to date, and he was still shooting, and had 75 ready to ship. This man said that he had paid off the mortgage on his farm by means of his market shooting.

And again:

> Levin and Son are not what would be considered extensive buyers, yet during the hunting season they have bought and shipped to Milwaukee parties, 2,000 birds. For these they paid to hunters on an average 20 cents apiece, a total of $400. Other concerns in this city did an equal and possibly a better business. From the hundreds of towns along the different lines of railroad in this part of the state, thousands of these birds were shipped.

Today we still have abundance and scarcity but it is doubtful if the magnitude of abundance will ever approximate these early records. It is more than likely that our now fire-free maturing timber has a dampening effect on each period of partridge abundance. Management efforts will alleviate local limiting factors and concentrate birds, but large-scale abundance will come through no direct human effort. The local effort may be all that is needed to promote hunting and entice the sportsman's dollar.

Sharp-tailed Grouse

The last of our three typically northern species is the one whose survival is in greatest jeopardy. Early records of abundance or occurrence are vague, since the bird was frequently confused with its close relative, the true prairie chicken or pinnated grouse. Its numbers varied perhaps in relation to the age of its fire-created habitat.

This bird is truly a phoenix for, out of the ashes of pine, hemlock, birch, maple, tamarack, and black spruce, came the brushy species and young forests, and with them sharp-tailed grouse in great abundance. Here is a bird of the postburn scrub, the bog edges, the recently abandoned fields and the off-sight aspen.

Its habitat is guaranteed only by fire, frost or infertility. In the mid-1930's Wisconsin developed a forest fire protection network that has, since 1936, prevented any large-scale fires . . . and so the forests have been growing uninterrupted to this moment. The forest protection program is a monument of efficiency; we would not want it otherwise, but it has also choked off the sharp-tailed grouse by its own too much.

From Arbor Day elms to the jack pine of frost pocket bogs, we have oversold reforestation as a panacea for all times and places in the north. That there were areas best suited to game which should be devoid of trees was an idea foreign to most old-school foresters.

Today, however, many foresters are ecologists and are interested in more than cellulose. The multiple-use concept of forests is finding a place for sharptails and deer. Controlled burning is being used for game management and even blueberry production on wild lands in northern Wisconsin. These concepts ten years ago were sacrilegious.

Schorger[11] was optimistic in 1944; he said: "The anticipated extinction of the sharp-tailed grouse has not been realized nor is it within the realm of probability."

Hamerstrom *et al.*[12] were pessimistic in 1952. Speaking of loss of sharptail habitat, they said: "In all of northern Wisconsin we have found not one single piece of uniformly excellent wildland habitat as large as a township in size; we know of not a single township of even moderately good wildland range with an even chance of being equally productive five years from now, if the present trend [of deterioration] continues."

The adaptive aspects of evolution which prescribed that sharptails shall be a bird of the young forests or open bogs did not count on a forest-protection program or the tractor-driven tree planter. To save the sharptails, we must first want to keep them as an integral part of our northern fauna, then develop a plan of action, and finally take action. The growth of plants will not wait—we cannot afford to.

These three key species continue to struggle against time and cell division while man adjusts his behavior so that his predation on these species does not impair their survival.

The impact of these species on the economy of the north is almost impossible to evaluate from data currently available, but these figures seem significant: In the last ten years, the northern counties (the northernmost two tiers, including: Ashland, Bayfield, Burnett, Douglas, Florence, Forest, Iron, Marinette, Oneida, Price, Sawyer, Vilas and Washburn counties) held 12.8% of the deer licenses when 44% of the state deer kill was taken from these same counties. In the years for which we have records (1948–56), the northern counties held 7.4% of the small game licenses when 45% of the ruffed grouse and 41% of the sharptails were taken in these counties.

The excellent shooting ability of northern hunters notwithstanding, the influx of outside hunters and the dollars they carried could account for the harvest figures and in the apparent increase in cash register activity.

Let me speculate on one aspect of the hunting-economic picture which may dispel undue optimism regarding sportsmen's dollars for the north.

In the past ten to fifteen years, our southern forests and the woody vegetation of non-agricultural lands like those in the north have been growing. The food and cover produced waited only for a seed stock of deer to re-establish a southern deer herd. A series of mild winters allowed for deer movement and thus completed the picture. The range maps (Figure 1) produced by Cory,[13] Scott,[14] Leopold,[15] and Dahlberg and Guettinger[3] tell the story of deer range expansion, and today there is no township in southern Wisconsin devoid of deer. What does this mean to the southern hunter and his dollar?

1. He no longer needs to go north of Wausau to hunt deer.
2. He can spend his nights and eat his meals at home.
3. His travel budget is spent where he hunts.
4. His hunting conditions are often less severe and his chances of getting lost are virtually nil.
5. He is no longer a captive of his sport.

Need I go on?

How much southern Wisconsin deer hunting means to northern pocketbooks, I do not know, but if it is serious or only disconcerting, one must remember that there was nothing that the north did or did not do to inherit this competition. Time and the continuum of plant change wait for no man. He can slow down or delay this process but he cannot eliminate it. He exerts control only through great striving, and if his efforts are relaxed, this continuum will dictate his actions and govern his economy, and eventually determine his biological resources.

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NORTHWESTERN WISCONSIN RECREATIONAL POTENTIAL

Harold C. Jordahl, Jr., Regional Coordinator
U. S. Department of Interior

Introduction

I propose in this paper to do the following; first, to describe briefly the history of exploitation which accounts for the present resource distress in the region; second, to urge comprehensive planning not only for the area but for the entire Upper Great Lakes; third, to suggest public works as a means of easing the hardships of people caught in a resource use transition period; and fourth, to analyze major resources in the region, problems of developing these resources and the potential impact on recreational values. Lastly, several recommendations are presented.

To list the major recreation resources of the region or to discuss in any detail their recreation potential would be superflous duplication of the many fine reports of the Wisconsin Department of Resource Development, the University of Wisconsin, the Conservation Department, Federal agencies, and others. Rather, a list of references is attached to which an interested reader can turn for more careful and leisurely study.

Resource Exploitation

Generally, I shall confine my remarks to the Lake Superior watershed; Douglas, Ashland, Bayfield and Iron Counties.

These counties are characterized by a present imbalance of people to resources. As a result, the region suffers from economic depression; there are more employable people than job opportunities. Although outmigration generally exceeds natural population increases, the transition rate is so slow that numerous people of productive ages still live here. These facts are thoroughly documented in recent reports of the Wisconsin Department of Resource Development and the University of Wisconsin. Unless there is a basic change in the economic status of the region, it will be several decades before a reasonable balance is achieved. In fact, estimates indicate continual decline through the year 2000 at which time a condition of "stability" may occur.

In the meantime, there is poverty. Unemployment, for example, in some areas where mines have closed is still in excess of one-third of the employable labor force (a 15 to 20% unemployment rate for the entire region during winter months is not uncommon). Workers are being forced to make difficult relocations of their families into strange urban environments where their skills are not in demand, or to continue to live within the region slowly exhausting unemployment compensation and life savings and struggling along at subsistence levels.

The various economic forces tend to accelerate each other and the impact on local economies. As workers move out, as homes are abandoned, as business establishments are closed, the costs of maintaining essential governmental functions—schools, fire and police protection, streets, etc., are borne by fewer and fewer people. And as productive workers in the middle age groups leave, the proportionate costs of educating the children and caring for the elderly increase.

The situation today is the net effect of a series of devastating blows to the natural resource base. First, was the exploitation of the timber resources around the turn of the century. Logging of the pine was followed by a second and third cut of lower value hemlock and hardwood. Subsequent forest fires then destroyed much of the remaining wood producing potential. Thousands of people either directly or indirectly employed in the timber industry were thrown out of work. They turned to employment in the mining, commercial fisheries or agricultural industries, or migrated out of the region.

Agriculture in the cut-over, burned-over region expanded and flourished for about a quarter of a century. Demands for food and fiber generated by two major wars accounted in part for a successful agricultural economy. However, as production in more fertile regions increased, farmers in the northern Great Lakes were faced with economic competition which they were unable to meet, and today the area is still in a last stage of transition to forests—a transition which the New England area experienced more than a century ago. (In spite of this general trend, on the red clay soils, average number of acres per *farm*, productivity and value of farm products is increasing.) Again, many people in the region were faced with unemployment, or a level of subsistence scarcely meeting minimum standards.

Mining, especially of iron ore, brought many communities in the region (especially in Iron County) great economic prosperity which lasted much longer than the short-lived boom and bust economy of logging and to a lesser extent, that of agriculture. Massive demands of the two wars accelerated depletion of the rich hematite deposits in the Gogebic Range which were within economically efficient reach of deep shaft mines. Exhaustion of these rich direct shipping ores, along with an increase in imports of high grade foreign ores to American blast furnaces, dealt the mining industry and the region another blow which has thrown thousands of people out of work. The transition and human adjustments to this problem are still in process.

Coupled with the above, and taking place within the last 15 years, was the complete destruction of a healthy lake trout fishery by the parasitic sea lamprey. Although not as spectacular as the decline in the minerals, forestry and agricultural economies, the collapse of this fishery had a considerable effect on many small communities along the Great Lakes shoreline, which had, through many years, maintained a healthy, stable economy. And most recently, the unfortunate deaths of a number of people from eating fish from the Great Lakes area which were contaminated with Type E botulism toxin all but wiped out the remaining fishermen. Although these botulism outbreaks can be traced to improper care of fish after leaving the producer, the attendant publicity has collapsed the market for Great Lakes fish.

Planning

The University of Wisconsin, the Department of Resource Development under the Ten Year $50 Million Resource Development and Conservation Act and the State Planning Program, and the Northwestern Wisconsin Regional Planning Commission are doing a splended job of planning for these lakeshore counties. Their work, however, needs to be related to larger planning parameters in the resource depressed Upper Great Lakes Region. Transportation systems are vital to regional development and require unification. Not every community on Lake Superior, for example, can profitably invest in a recreational boating harbor. The demand is capable of supporting only a limited number. Obviously, a plan is required. Lack of planning, or perhaps of conscious decision, is also evident when examining the new highway patterns for the Lake Superior area. Both Upper Michigan and Northern Wisconsin are by-passed by the new systems and already a decline in tourists visiting these two states has been noted. Hopefully, this is only a temporary phenomenom.

Community facilities, which are generally good, should not, in the main, be permitted to deteriorate. Regional service centers can be identified and governmental programs used to strengthen these centers as locations for universities, vocational education and welfare institutions, etc.

In essence, most governmental programs, including those which focus on recreation in the northern Great Lakes area are today too scattered. In place of a shotgun approach, they need refinement and focus based on a general plan of development. The Federal government has been studying this matter since the Land and People Conference at Duluth in September of 1963. The experience of the President's Appalachian Regional Commission, which last week reported to President Johnson, and the reaction of the Congress to the proposals for development of that area of great distress, might provide clues to the possibility of comparable programs for the Upper Great Lakes. Significantly, the PARC report makes numerous recommendations for recreation resource development.

Public Works, Area Redevelopment and the Economic Opportunity Act of 1964

Within most of the four county area, outmigration and population decline will continue for another forty years. Vocational training, retraining and massive educational investments are required. In the meantime, the existing manpower reservoir provides an opportunity for long-term investments in recreation resources by government which the private sector of the economy cannot afford. Public investments of the type made under the Accelleratest Public Works Program, the various facets of the Area Redevelopment Administration program, and the proposals in the Economic Opportunity Act of 1964, which is now before the Congress, will assist these people in making gradual and less distressing adjustments. Furthermore, it will improve the economic potential for resource development in future years.

Thousands of man years of constructive employment opportunities are available on the more than one-million acres of public land in the four county area county forests, Chequomegon National Forest, state park forests, fish and game areas, etc.) Several examples which have recreational value are as follows:

1. Hiking trail layout, clearing and marking. (The proposal for a Keweenawan Hiking Trail from the St. Croix Valley through the Gogebic-

Penokee ranges and thence into Upper Michigan and the Keweenaw Peninsula is a splendid example of what could be accomplished.)
2. Cleaning canoe trails.
3. Park improvements (camp and picnic sites, beach improvement and numerous other high labor input work on intensively used mass recreation areas).
4. Boat launching facilities.
5. Stream, lake and game habitat improvement.
6. Plantings on recreational corridors to enhance beauty, especially along highways and waterways.
7. Streambank fencing and red clay stabilization.
8. Lake, pond and marsh construction. Although the four counties have considerable water, well spaced new lakes, ponds and marshes will improve the recreation development potential especially in areas where surface water is at a minimum; Ashland County, for example.

Water Resources

The area is bounded by Lake Superior, the greatest fresh water body in the world with a shoreline of 325 miles (175 miles of this total is in the Apostle Islands). There are 534 inland lakes with a surface area of 81,588 acres; 210 trout streams of 1346 miles.

The water resource provides an untapped potential for industrial uses which will increase as regional and national supplies become scarce. Chemical, chemical base treatment, pulp and paper and minerals industries all appear possible as future developments. If such developments occur, extreme caution must be taken to insure that there is no major infringement on recreational values in water.

Presently, the surface water is the resource base for recreationists and the tourist-vacation industry. Abundant opportunities exist to establish additional public facilities, parks, camp grounds, boating waterways, etc. adjacent to the water base.

Within the area are more than 200 miles of canoe streams. The most famous is the Brule River in Douglas County, which the legislature in an historic act in the 1920's protected, by prohibiting any dams. (Some 40 years later the legislature gave portions of the Wolf River comparable protection.) In our work on the recreation plan for Wisconsin we suggested that consideration be given to preserving at least one-half of the important canoe routes by acquisition of the fee or of scenic easements.

The resort industry needs modernization; capital financing problems are acute. In general, the industry is plagued with inefficient operating size. Lack of planning, unwise lakeshore subdivision and destruction of scenic beauty along shorelines require correction.

Land Resources

In general, agriculture is concentrated on the better soils of the region, especially on the red clays near Lake Superior (some 600,000 acres are red clay). Forests and swamp occupy the balance. Reversion of agricultural land to forests continues. About one-fourth of the total land area is in farms. Tillable acreage represents about one-third of the total farm acreage. The small operating size of farms, low soil fertility and adverse climate will force further land adjustments. A general plan of development should focus on preservation of the best soils for agricultural use to supply local markets and to meet food needs of a developing tourist-recreation industry. At the present time most of the food requirements generated by the thousands of tourists who visit the region are imported. Marketing mechanisms, open air markets for example, through which small producers can sell their produce will help to increase income and generate demands for additional production.

Potential combinations of farming, woodland management and private recreation development by farmers in the four county area offers another potential. Considerable research has already been done on the ways by which these resources can be combined to maximize profits. Required at this time are highly trained resource economists to work in the region to provide individual land owners with technical advice. Managerial ability also needs to be developed.

The forests, about 2.5 million acres, which provide a backdrop for a fine recreation environment, are in need of improvement; many acres still require planting and timber stand improvement. A potential for pulp and paper production exists which is being studied for the four county area. A major gap exists on management of the numerous small forest land ownerships. Ownerships need stabilization and encorporation into larger holdings, or integration into economic forest management units. As plans for the various types of holdings are developed, it is incumbent upon the resource manager, privately or publicly employed, to consider recreation values in forest lands. For example, we should be able to find one good remnant stand of virgin hardwood and hemlock for preservation for scientific and recreation purposes. Likewise, typical examples of the boreal forest, the northern hardwood type, the "barrens" of the Plainfield sands, and the pineries should be preserved.

Commercial Fisheries

The Commercial Fishery of Lake Superior has been on the decline since 1954, primarily because of sea lamprey predation on lake trout. The botulism outbreak furthered this decline.

As a result, there has been an increase in populations of other species; lake herring, smelt, alewives, etc. The States and the Bureau of Commercial Fisheries have been conducting basic biological research on these species, and developing techniques for harvesting, processing and marketing. Lamprey control now shows great promise and lake trout restoration hopefully will be completed in Lake Superior by 1970.

In the meantime, sports fishermen are once again finding sufficient stocks of lake trout to make fishing interesting. Also, a new sports fishery has developed on brown trout which are caught in the shoal areas of Lake Superior. (Fisheries biologists have known about this population for years; sportsmen are just beginning to realize its existence.) And the well established steelhead fishery receives more attention each year.

Future conflicts may well develop unless the issue of commercial fishing vs. sport fishing in the waters of Lake Superior are resolved today. Fifteen years ago it was not uncommon to see several hundred people on the ice in the Apostle Islands region "bobbing" for lake trout. Numerous "deep sea" sports trollings boats plied the off-shore shoals for lake trout. As the fishery is restored, pressures between the two groups will develop unless the advice of the fisheries biologist, who tells us the two are compatible, is heeded.

Indian Resources

The four county area has two Indian Reservations; Red Cliff and Bad River. The Tribes, working with the Bureau of Indian Affairs, are attempting to develop recreation on the reservations as an economic stimulus. Their interests will be carefully safeguarded in the studies which will be made of the proposed Apostle Islands Region National Recreation Area. Hopefully, means can be found in that proposal to improve their economic lot, which by our standards is poor indeed.

Mineral Resources

Minerals must be considered in any resource program for the four county area and careful attention given to the potential impact on recreation values.

Problems associated with the minerals industries fall into three elements. First, although considerable knowledge exists regarding iron ore resources, little is known of the existence of other minerals and whether commercial exploitation is feasible. Geophysical surveys of the entire Lake Superior area should be completed at an early date. Aeromagnetic and gravity surveys followed by intensive exploration on the ground may open up opportunities for development not being considered today. Although the costs of such studies are formidable, only through such investments can we secure a more firm future for the region.

Second, investigations and research into problems associated with separation of low-grade iron ores from the surrounding rock, and preparation of beneficiated products for a high grade blast furnace feed need intensification. Recently, the Bureau of Mines announced a new technique of combining scrap iron as a reducing agent in processing non-magnetic iron ores to produce a material suitable for use in blast furnaces. If this proves successful, the abundant low grade hematites and semitaconites in Iron and Ashland Counties may be commercially exploitable.

Third, government and industry must work more closely together in the planning of mining operations. The traumatic effects of sudden mine closings, forcing thousands of miners out of work and forcing undue hardships on the miners and their families can be, in large measure, avoided by careful planning. We can bring to bear on these problems our knowledge of world-wide, national and regional conditions to forecast future trends and to provide for orderly and planned transitions in the mining industry.

An investment in joint planning by the industry, private developers and government, for example, at Mt. Whittlesey in Ashland County, which consists of low grade magnetic iron ore, might make possible a ski development which would materially improve the economic well being of the little village of Mellon.

Most importantly, our combined talents can be applied to surface mining operations in such a way that the over-burden and the tailings can be placed to create a pleasing land form once the pit is exhausted. Such land forms, if coordinated with plans for the future use of the pits for lakes, for example, can leave a surface mined area with an outdoor recreation potential. Strip mining does not have to mean devastation of the landscape and a complete destruction of the landscape for any other alternative future use. Required to accomplish these goals will be the talents of dozens of different specialties—economics, mining, landscape architecture, fisheries, game management, forestry, recreation, etc. The splendid work done by Professor Zube of the University of Wisconsin as reported by the Wisconsin Department of Resource Development on this subject illustrates the potential. I urge state officials to continue this fine start so that mining, when it does come to the four county area, will have maximum economic value to the region and to the state, and will not ravish the countryside, but leave it in some semblance of order.

Federal Recreation Projects

The Lake Superior region with its vast forests, clean lakes, and rivers and its summertime air conditioned environment offers a great playground for the vast urban areas in the upper midwest.

The nine upper midwest states contain some 50 million people. They are bisected by many fine highways providing ready access to all points of the compass for recreational purposes. Much of mid-America is flat or gently rolling prairie, plain and field and has a relative scarcity of water and topographic resources for recreation purposes.

Mid-Americans making plans for vacation and recreation activities look to the Ozarks in the southwest, to the Smoky Mountains in the southeast, or north to the Lake States and Ontario for outdoor recreation.

The states along the Mississippi River are developing the Great River Road Parkway. Minnesota plans to extend it to the Canadian border which will provide ready and scenic access to residents in Illinois, Iowa and Missouri. An interstate highway will link metropolitan Minneapolis and St. Paul directly with Duluth. Michigan has completed a major north-south highway and is planning an extensive system of scenic shoreline drives around the Michigan Great Lakes. Detroit, and Toledo and Columbus, Ohio residents now find several hours cut from their travel time to the Lake Superior area. Wisconsin, likewise, is completing an interstate network which will tie together the great Chicago metropolitan area with Milwaukee, Madison, Minneapolis and Duluth and some day will probably develop a major system of north-south routes to provide improved and faster access to the Lake Superior area. And only three short years ago, the Canadian Government and Ontario completed the Great Circle Road around the north shore of Lake Superior.

These vastly improved new highways and those which are planned will provide the arteries along which will flow the people in vast mid-America to the Lake Superior area for recreation and a change of scene in one of the great unspoiled areas of our land. A great opportunity exists here to achieve both the social goal of providing our citizens with facilities for recreation and the economic goal of stimulating the economy.

The Department of the Interior has initiated studies to develop a coordinated recreation area plan for the region. Federal projects already underway or being studied, and which may form a part of this system, include the following:

1. *Voyageurs National Park—Minnesota.* This proposal which is currently being studied by the Department, includes a forty mile portion of the Voyageurs route along a superb system of lakes and wilderness waterways, including Rainy, Kabetogama and Namekan Lakes.

2. *Quetico—Superior Canoe Area—Minnesota and Ontario.* The two countries have agreed to preserve in a semi-wilderness condition the magnificent canoe country located on the Canadian shield between the proposed Voyageurs Park and Lake Superior. Mounting use pressures threaten this area and studies to mitigate problems are underway.

3. *Grand Portage National Monument and Pigeon Point Indian Park.* Grand Portage on the Minnesota–Ontario border was designated as a National Monument in 1960 to preserve the historic portage route between the Great Lakes and the fur country to the west.

Pigeon Point, next to the Monument, is one of five acres identified by the National Park Service as being of special significance. The area is presently being developed as an Indian Park.

4. *Isle Royale National Park—Michigan.* This area was established in 1940 as a gift to the Nation from the State of Michigan. It is an isolated segment of the Great Lakes and north woods country and in a future National system in the Upper Great Lakes Region will be a wilderness area serving landward parks much the same way the high Sierra country serves the lower region of Yosemite and Sequoia as wilderness.

5. *The Apostle Island National Recreation Area—Wisconsin.* This proposal provides the next link in the system under study and will be discussed in greater detail later.

6. *Pictured Rocks—Michigan.* This area on the southeast shore of Lake Superior, has been proposed as a National Recreation area. It consists of 15 miles of 50 to 200 foot multi-colored cliffs, 12 miles of undeveloped beach and five miles of Great Sable dunes. This proposal is presently before the Congress.

7. *Wild Rivers—Wisconsin and Minnesota.* The Department of the Interior and the Department of Agriculture are currently analyzing the potential of a preservation system along the famous Namekagon–St. Croix Rivers. The joint report will be complete in July, 1964. The goal, expressed in its simplest terms, is to achieve some balance in river systems development. Obviously, we can't preserve all rivers in a wild condition. By the same token, it is important to preserve some free flowing streams.

8. *Other Projects.* Three other projects in this region are the National Ice Age Scientific Reserve in Wisconsin, the Sleeping Bear Dunes proposal in Michigan along the Lake Michigan shore, and Indiana Dunes near Chicago. All are before the Congress. These areas, along with such notable projects as the Great River Road and other state and local projects, will provide the recreational stepping stones—the stopping off places—for people headed towards Lake Superior.

It is within this framework that the Department is currently analyzing the proposal for a National Recreation Area in the Apostle Islands Region of Wisconsin.

The idea for a National Area originated with Gaylord Nelson while he was Governor. He proposed it to Secretary of the Interior Stewart Udall in 1962. Several Federal inspections have been made since then. President Kennedy made an aerial inspection of the aerial in September of 1963 and said, "Anyone who flies over those islands, as we just did, looks at that long beach, looks at those marshes, looks at what a tremendous natural resource this can be, and is now, for nearly 50 million Americans who live in this section of the United States in the coming years, must realize how significant this occasion is . . .

"Lake Superior, the Apostle Islands, the Bad River area, are all unique. They are worth improving for the benefit of sportsmen and tourists. In an area of congestion and pollution, man made noise and dust, Lake Superior has a beauty that millions can enjoy. These islands are part of our American heritage. In a very real sense they tell the story of the development of this country."

Secretary of the Interior Udall on April 2, 1964, announced the formation of a special task force consisting of Interior representatives, the State of Wisconsin and members of the Bad River and Red Cliff Indian Tribal Councils. This committee will study the three units in the proposal; the 22 islands in the Apostle archipelago, the tip of the Bayfield Peninsula and the Kakagon–Bad River sloughs. In brief, the area will be studied in depth and a complete report prepared. Of prime concern will be the relationship of the area to the criteria for National Recreation Areas which have been adopted by the President's Recreation Advisory Council.

Regional Recreation Needs

In the Wisconsin recreation planning work of the Department of Resource Development, estimates through the year 2000 were made for needs in a nine county area of northwestern Wisconsin which includes the four counties along Lake Superior as follows: 880 acres of new swimming beaches; control of 194 miles of canoe routes; canoeing pressures will exceed acceptable standards by three times; 2,111 acres of new picnic facilities; 2895 miles of new hiking trails; provisions for 16,950 persons to camp in contrast to a 1960 capacity of 2196 persons; boating demands will exceed surface acreage unless boating controls are instituted; sightseeing will increase from three million to sixteen million; pleasure driving will increase more than three fold; and lastly better harvests of game animals are needed.

These data not only represent needs, but a challenge.

Recommendations

Throughout this paper numerous recommendations have been made; the more important are as follows:

1. That the studies of the Department of Resource Development on this four county area be published at an early date. This work contains the framework for a fine recreation development program.

2. That the comprehensive planning program of the Northwestern Wisconsin Regional Planning Commission be supported at every level. That the fine work being done in this area by the University of Wisconsin through its Land Use Coordinator Walter Rowlands, and the Extension Division be supported at every level.

3. That towns, counties, cities and the state government make an increased effort to develop the fine recreational resources in this region.

4. That recreation resource programs be developed along the "environmental corridors" identified by Phillip Lewis of the Department of Resource Development working with other state agencies. These linear patterns which are characterized by topography, vegetation and water, in one or more combinations, are abundant in northwestern Wisconsin; for example, the magnificent waters of the Brule River, the adjacent bogs which are virgin remnants of a northern ecological type, and the sandy headlands; or the sweep of sky and landscape which unfolds from the tops of the Gogebic–Penokee ranges, a mountain range of ancient vintage; or the union of beach and sandstone cliff, sedges, heaths, bog and boreal forest along Lake Superior; or the unique island archipelago on which grow forbs, and forests and which join with beach and rocks; or scattered bits of prairie flora intermixed with jack pine, scrub oak and Juneberry, where a diligent observer may, on a quiet spring morning, still watch sharptail grouse in nuptial display.

5. That major revisions be made in land use controls which were developed more than 30 years ago and which were limited to agricultural and forestry zones. The missionary-like zeal of Walter Rowlands, L. G. Sorden, Fred Trenk, Fred Wilson and others is needed again today to protect recreation values. Billboard blight continues its ugly spread along major scenic routes; subdivision practices which have not changed in a century continue to despoil the remaining lake and stream shore areas. For example, how much sense does it make to permit a developer to subdivide land into little bits of less than 100′ in depth along the Namekagon River and located between busy state trunk Highway 63 and the river? A serious highway safety problem is created. Moreover, scenic beauty was destroyed by cutting most of the trees. The land will sell for $5.00 per foot! Imaginative approaches, cluster layout and design for example, need actual testing; approach areas to villages and cities continue to be developed in traditional fashion—junkyards, billboards, shoddy service centers and general blight are the rule, not the exception. Cities, county and town boards have the power through zoning to control the use of land—zoning can be used as a positive device to enhance economic values. It also makes esthetic sense. In the absence of local action, should regional governments be considered to deal with the problem, or should the state reassume these powers?

6. That the historical wealth of the region be recognized and developed. Man lived here through the Upper Mississippi and late, middle and early Woodland periods, a thousand years before the birth of Christ. In later years this was the home of the Dakota, a Sioux tribe. It was also a period of aggressive westward movement of the Chippewa who eventually controlled the Lake Superior shore. There were numerous battles among the Dakota, Chippewa, the Fox. The French and English names are a mix of the famous explorers and developers of the North American Continent; Menard,

Duluth, Brule, Cadotte, La Prairie, Conner, and later Schoolcraft, Allen, John Jacob Astor. The region has examples of most of the archeological and historical resources of the continent. A splendid job has been done by preserving some of these evidences at the little museum on Madeline Island. Historical markers are scattered throughout the region. The potential, however, has hardly been scratched and a combination of private and governmental efforts are required to accelerate the modest efforts of today.

7. A system of scenic highways needs to be developed, utilizing the existing state, county and town road systems. Some new road construction and/or relocation may be necessary. Land use controls adjacent such a system are as important as the roads themselves. And means must be found to preserve roadside strips of forests and other plant communities characteristic of northern Wisconsin. A combination of easements and zoning controls offer potential.

8. Massive effort of red clay stabilization is required. Practices requiring high labor inputs, such as fencing along important streambanks under the Agriculture Conservation Program, will pay major dividends in terms of soil, water and fisheries conservation. Esthetics will be improved. Moreover, unemployed labor will be put to productive tasks. More expensive and refined techniques—channel improvements—should be used in future years.

Agricultural drainage and practices which increase rates of surface run-off into streams on red clay soils need to be held to absolute minimums. Officials charged with highway maintenance and new road construction need to view their responsibilities with new insights. Typical road practices in use in the region today aggravate the erosion of the unstable clay soils and materially affect stream resources.

9. The recommendations of the Department of Resource Development regarding protection of canoe streams and the Conservation Department recommendations regarding preservation of 25 percent of the land adjacent surface water resources should be thoughtfully reviewed and implemented wherever possible.

The framework for development decisions in northwestern Wisconsin is at hand. Our Wisconsin citizens as represented by their government have the opportunity to develop wisely one of the fine, still relatively unspoiled regions of Wisconsin. The challenge exists. Can it be met?

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THE RESORT INDUSTRY OF WISCONSIN

L. G. Monthey, Extension Specialist
Travel–Recreation Industry
University of Wisconsin–Madison

Perhaps a more appropriate title for this paper would be "The Resort Industry—What Is It?" I say this because there is some confusion in this area, and many people would like to know more precisely what the resort business does include—or does not include—and how it operates.

The resort business is certainly not an "industry" in the usual sense of the word, because no products are extracted, produced, or processed. It does involve a rather large array of services—as well as some goods—and primarily those associated with people on vacation trips. However, the primary service is lodging or rental housing, usually referred to as "accommodations." For this reason, and because the word *resort* is often used rather loosely, we prefer to use the terms "vacation accommodations" or "visitor-housing business"—instead of resort industry. But more about this later.

The resort business, or vacation accommodations, is an important segment of Wisconsin's growing travel-recreation business (often referred to as the "tourist industry" or "touristry"). However, the latter includes all types of visitors, not just vacationers, and all commercial recreation activities—and probably involves $10 in gross income for every $1 taken in by resorts as such.

With this in mind, we will attempt to define a few words, present some current statistics, outline some basic problems, and identify a few trends in the vacation accommodations business. A detailed report would take more time and space than our program permits.

Some Definitions

First, we should consider a few definitions in this general field:

Tourism—Travel in general; the promotion of tours.

Tourist—Any traveler; a person on a recreational trip away from his home area.

Touristry—The art and business of catering, selling and renting to tourists who visit our area.

Visitor—A tourist in our community; a customer from outside of our regular trade area.

Vacationer—A tourist on a recreational trip of 3-days duration or longer.

The travel-recreation business, or tourist industry, involves visitors of all types who travel with a recreational purpose. In fact, several states (notably Colorado) refer to this trade as their *visitor industry.*

There are many ways of classifying tourists, or visitors. One method, based on length of stay in the community, is as follows: (a) day visitors; (b) overnight guests; (c) week-end visitors; (d) vacationers (3 days to 1 month); (e) seasonal residents (1 to 6 months). Each category can be further subdivided.

Each class of visitors has certain characteristics, including rather specific spending habits. Day visitors, for example, may spend anywhere from 10 cents to $10 or more per day, depending on age, purpose, resources, available time, and so on. Each category makes a measurable contribution to the economy of a community, a county, or a region where it is served. Each town or area has a certain "tourist mix" from all visitor classes, and this determines the total gross income per year from its travel-recreation business. Thus, statewide average figures don't mean too much in any given area.

Visitor Expenditures

Wisconsin's touristry, or travel-recreation industry, now totals over $600 million a year—and possibly as high as $650 million in 1964. It has increased from approximately $581 million in 1960, when a University of Wisconsin Commerce School study was made by I. V. Fine and E. E. Werner.

Table 1 gives statewide totals and a classification of visitor spending, based on this U. W. study. It also includes a breakdown of the 1960 tourist dollar.

It is noteworthy that the tourist-lodging business derived $154 million in income, or 26.4 per cent of the total spent by visitors. The resort business, or vacation accommodations, is an important part of this tourist-lodging industry in Wisconsin. It probably accounted for 25 to 50 per cent of the 1960 total, or between $40 and $80 millions, depending on how the word "resort" is defined and what we include under vacation accommodations.

Table 1. Volume and Nature of Visitor Expenditures in Wisconsin and Breakdown of the "Tourist Dollar" in 1960 (U. W. Study)

Nature of Expenditure	Type of Business Service or Product	Total Expenditure	Tourist Dollar
			(percent)
LODGING	Resorts—no meals	$ 71,897,000	
	Hotels, AP resorts—w/meals	42,757,000	26.4
	Motel, tourist homes, etc.	39,113,000	
FOOD SERVICE	Groceries	73,292,000	
	Restaurants, drive-ins, etc.	56,894,000	22.4
RETAIL PURCHASES	Sports equipment, etc.	64,652,000	
	Gifts, souveniers, sundries	26,607,000	19.4
	Clothing, dry goods	21,344,000	
RECREATION	Amusements, attractions	41,662,000	
	Licenses, guides, fees, etc.	22,482,000	11.0
TRANSPORT.	Gas, oil, car service	57,984,000	10.0
MISC.	Unclassified	62,612,000	10.8
	TOTALS	$581,296,000	100.0%

What Is a Resort?

Dictionaries offer several definitions of the noun "resort," but not one refers to a business as such. For example, Webster's International (unabridged) Dictionary defines a resort as "a retreat and place of refuge," "a place of entertainment or recreation," or "a place of frequent assembly."

Actually, the word "resort" is more meaningful and appropriate to our purpose when used as a adjective (denoting a "recreational" or "vacation-like" environment) to describe an area, town, or establishment. Thus, we have resort hotels, resort motels, resort communities, etc. However, it is still widely used as a noun in our Midwest region and for our purposes, the word will be used to identify a business establishment as follows:

Resort—A tourist facility or visitor-lodging business located in a scenic and/or recreational environment.

(In Wisconsin we think of a resort in more specific terms as a "vacation accommodation overlooking a lake or river." However, the first definition is somewhat broader and hence preferred, especially since all types of visitors and not just vacationers must be considered.)

A wide variety of businesses might be classified as *resorts* under our foregoing definition. In Wisconsin these usually include cabin-cottage establishments, motels, hotels, youth camps, tourist homes, vacation farms, etc.—provided they have guest accommodations and are located in a recreational or scenic setting.

Inventory of Accommodations

To obtain a reasonably complete inventory of Wisconsin tourist-lodging businesses, including resorts, we utilized the State Board of Health mailing list and other data. The information is presented herein on a county-by-county basis and includes data on the number, type, size, distribution and seasonality of establishments that furnished rental accommodations in 1962.

Four major categories were used in classifying tourist-lodging businesses, and the firm name was used to categorize each establishment. For example, the RESORT category includes all businesses that used one or more of the following key words in their title:*

resort	landing	cottage
retreat	cabin	lodge

* 2,257 used the word "resort" or "lodge" in 1962, while 2,301 used "cabin," "cottage," etc., in their business title.

Table 2. Types and Seasonality of Tourist-Lodging Establishments in Wisconsin (1962)

Type of Business	Total No. of Establishments	Year-round Establishments		Seasonal Establishments	
		No.	%	No.	%
RESORTS—including cabins, cottages, lodges, landings, etc.	4,558	287	6.2	4,271	93.8
HOTELS—including motor hotels, inns, etc.	620	488	78.8	132	21.2
MOTELS—including motor courts, tourist courts, etc.	1,004	692	69.0	312	31.0
OTHER—including camps, clubs, tourist homes, etc.	1,533*	485	31.6	1,048	68.4
TOTAL	7,715	1,952	25.6	5,763	74.4

*About 974 of these were tourist homes with less than 5 bedroom units.

On this basis the resort category included 4,558 establishments of the total of 7,715 that were licensed by the Board of Health as of April 1, 1962. A summary of Wisconsin tourist accommodations by type and seasonality is given in Table 2.

Approximately 75 per cent of *all* tourist-lodging establishments were seasonal (open for less than 6 months of each year). Almost 94 per cent of the resort-type establishments were of this type, whereas only 21 per cent of the hotel businesses and 31 per cent of the motels were seasonal in nature.

The 5,763 seasonal establishments—largely resorts, resort hotels, rural motels and tourist homes—had a total of almost 48,000 bedroom units.* The 1962 year-round businesses had 32,600 bedroom units, so the total of rental bedroom units in Wisconsin was just over 80,000 in 1962.

Nature of Resorts

Let's examine the 4,558 resort businesses (cabin-cottage-resort-lodge establishments) of Wisconsin in more detail.

In addition to being highly seasonal (94 per cent), these resort establishments are of small size. Whereas year-round operators averaged 17 bedroom units per firm, the seasonal operators had an average of 8.3 bedroom units. (Many rental cabins or cottages have 2 or more bedroom units.) The average cottage-resort business in two Wisconsin areas had about 6 cabins or cottages, or approximately 9 bedroom units, our studies show.

As Table 3 shows, only 1.7 per cent (76 establishments) had more than 30 bedroom units in 1962; and only one-third (33.2 per cent) of all resorts had more than 10 bedrom units to rent to visitors. Of the two-thirds with less than 10 bedrooms, slightly over one-half (1,576 or 35 per cent of all resorts) had less than 5 bedroom units.

Of the 4,558 "resort" firms in 1962, approximately 10 per cent (or about 450) were American Plan or European Plan establishments, which provide complete food service for all guests at the resort. Of the remaining 4,100 in 1962, an estimated 500 were roadside businesses situated on state or federal highways, offering overnight cabins or rooms to travelers or transient guests (in the nature of "tourist courts").

The final 80 per cent (or approximately 3,600 establishments) are in the cabin-cottage class, and these—almost without exception—are located on the water and cater to vacationers rather than short-term tourists. About 3,000 of

* A bedroom unit is a room that is adequate for sleeping one or more adults (at least 400 cu. ft. per person).

Table 3. Size and Seasonality of Resort-type Establishments in Wisconsin (1962)

Size of Establishment (in Bedroom Units)	Seasonal Operations	Year-round Operations	Total Businesses
1 to 4 units	1,479	97	1,576
5 to 9 units	1,371	98	1,469
10 to 30 units	1,358	79	1,437
31 and over	63	13	76
TOTAL	4,271	287	4,558

these cabin-cottage establishments are usually referred to as *housekeeping-cottage resorts,* since the guests have facilities to prepare their own food. However, there is a growing objection to the term "housekeeping" because it suggests work for the lady of the house. Instead, the terms "efficiency units" or "self-service cottages" are now proposed for this important type of vacation accommodation.

Certain Resources Needed

The resort business of Wisconsin is largely a resource-based enterprise. It is directly related to the geography and distribution of certain natural resources, notably water—lakes and rivers—and good quality shoreline. The 4000-plus resort establishments located on the water's edge in Wisconsin utilize an estimated 450 miles of shoreline and approximately 45,000 acres of choice waterfront real estate.

There are five major types of lake (or river) shoreline in Wisconsin which might be classed as follows:

Soft Shorelines	*Hard* Shorelines
A. Bog	C. Beach
B. Marsh	D. Bank
	E. Bluff

Virtually all of the present resort establishments utilize either Class C (Beach) or Class D (Bank) shorelines, which are the most desirable and valuable types available. Most resort developers prefer at least some sandy beach area, and this class of shoreline is largely confied to the 1,134 *named lakes* that are over 100 acres in surface area. (Wisconsin has about 8,700 lakes, of which 4,138 are named. Of those named, 70% (3,004) are under 100 acres.) As a consequence, only a small percentage of the resort establishments are found on Wisconsin lakes that are less than 50 acres in size. And certain large lakes with predominantly "soft" shorelines have relatively few resort operations on their margins.

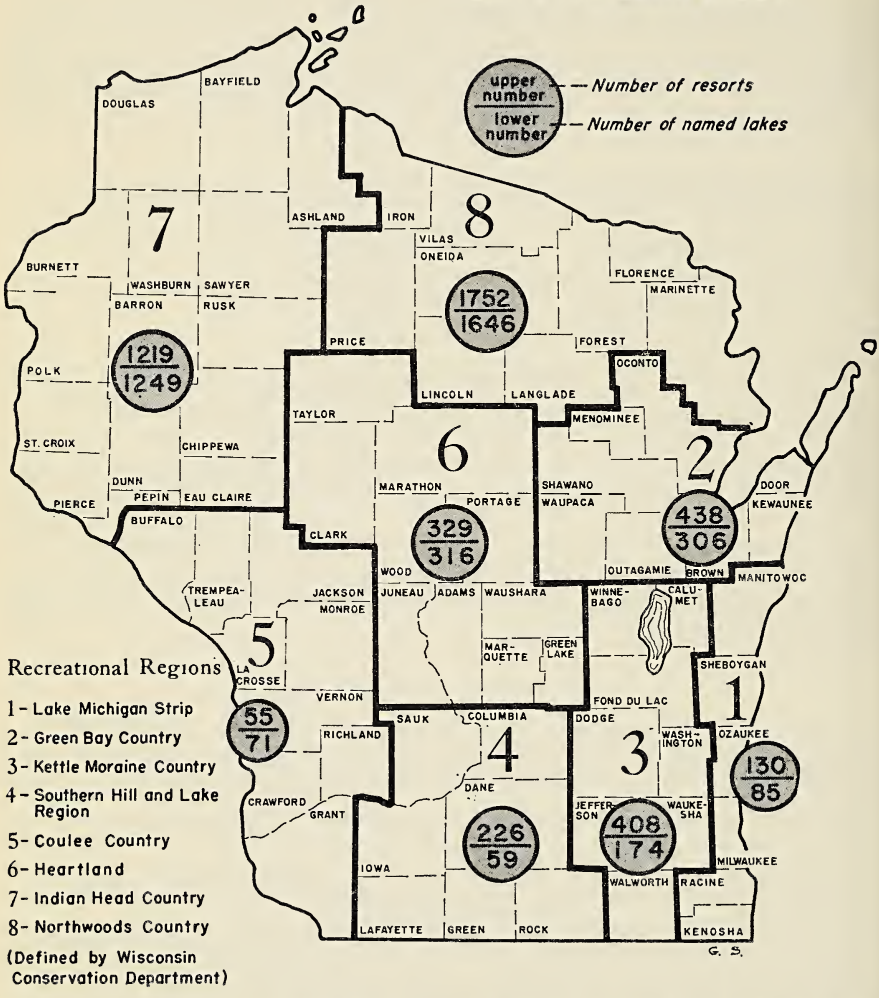
Geographic Distribution

The regional distribution of resort establishments in Wisconsin bears a striking resemblance to the distribution of named lakes over the State. Note Figure I, which shows resort numbers and named-lake distribution in the recreational regions of the State, as outlined by the Wisconsin Conservation Department. For example, The Wisconsin Indian Head Country (an area of 15 counties in Northwest Wisconsin) has 1,249 named lakes and 1,219 resort establishments. The Wisconsin Northwoods Region (a 9-county area of Northeast Wisconsin) has 1,646 named lakes and 1,752 resort establishments. In Northern and Central Wisconsin the ratio of resort numbers to named lakes is about 1:1, but it runs about 1.5:1 in Eastern Wisconsin and over 3:1 in Southern and Southeast Wisconsin, where population is heaviest. The latter regions have a preponderance of roadside cottage businesses in certain areas.

There are 25 counties in Wisconsin which have 50 or more named lakes apiece, and 20 of these counties rank among the top 25 "resort counties" (in terms of number of resorts). Thus, resort distribution is closely related to lake

FIG. I
RELATIONSHIP BETWEEN RESORT FREQUENCY AND DISTRIBUTION OF NAMED LAKES IN WISCONSIN (BY RECREATIONAL REGIONS, 1962)

BY L. G. MONTHEY



and river distribution in our State. In any county or area, the number is almost in direct proportion to the total mileage of good quality shoreline (on lakes over 100 acres in size).

About two-thirds of the resort establishments (3000-plus) are located in the counties north of State Highway 29, which runs east-and-west across the state from River Falls to Chippewa Falls, Wausau, and Green Bay. In fact, 15 of the 20 leading counties—as far as resort numbers are concerned—are located in Northern Wisconsin.

Only two Wisconsin counties (Oneida and Vilas) have more than 500 resort businesses (and Sawyer has 332), but a total of 12 counties have 100 or

FIG. II

DISTRIBUTION OF RESORT ESTABLISHMENTS IN WISCONSIN BY COUNTY (1962)

BY L. G. MONTHEY

Each dot represents one resort establishment.

Dots do not show actual location of resorts but indicate county totals.

Table 4. Relationship of County Resort Totals to Frequency of Named Lakes (All counties with 75 or more resorts in 1962)

County	Resort Establishments		No. of Named Lakes	
	Total	Rank	Total	Rank*
Vilas	620	1	497	1
Oneida	538	2	366	2
Sawyer	332	3	138	8
Door	194	4	8	....
Washburn	186	5	153	6
Walworth	174	6	34	....
Burnett	163	7	163	4
Lincoln	119	8	88	16
Bayfield	118	9	217	3
Barron	113	10	84	17
Waushara	112	11	51	25
Columbia	110	12	20	....
Iron	94	13	127	10
Price	91	14	91	15
Langlade	89	15	125	11
Marinette	88	16	141	7
Oconto	85	17	159	5
Douglas	84	18	105	14
Forest	83	19	131	9
Waupaca	79	20	78	18
Marquette	79	21	35	....

*Rank is shown among the top 25 counties only.

more resort establishments apiece (See Table 4.). Of these 12 counties, only 3 (Columbia, Walworth and Waushara) are south of State Highway 29. Figure II is a graphic presentation of the state-wide distribution of resort-type establishments in 1962.

Only four (4) counties in Wisconsin don't have a single resort, lodge or cabin-cottage establishment (Lafayette, Menominee, Outagamie and Ozaukee), but 11 other counties have less than 5 such businesses per county. Table 5 shows the resort distribution among Wisconsin counties by frequency brackets.

Table 5. Resort Frequency Among Wisconsin Counties

Frequency of Resorts	Number of Counties
0 to 4 Establishments per county	15
5 to 9 Establishments per county	10
10 to 50 Establishments per county	18
51 to 100 Establishments per county	17
101 to 200 Establishments per county	9
201 or more Establishments per county	3

Some may desire more detailed information on the classification and distribution (both as to size and location) of tourist-lodging establishments in Wisconsin. Table 6 provides 1962 data of this type on a county-by-county basis.

Table 7 gives further details on the size and seasonality of resort-type businesses (resort, lodge, cabin-cottage establishments) on a county-by-county basis.

TABLE 6. CLASSIFICATION AND SIZE OF TOURIST-LODGING ESTABLISHMENTS IN WISCONSIN COUNTIES (AS OF APRIL 1, 1962)

County	Type of Accommodations and No. of Establishments											
	Cabin Courts, Cottages Lodges or Resorts			Hotels, Inns, or Motor Hotels			Motels or Motor Courts			Camps, Clubs, Tourist Homes		
	Bedroom Units			Bedroom Units			Bedroom Units			Bedroom Units		
	1–9	10–30	31+	1–9	10–30	31+	1–9	10–30	31+	1–9	10–30	31+
Adams	13	4	0	1	2	0	4	2	0	5	0	0
Ashland	36	18	0	2	3	1	10	8	0	21	3	0
Barron	61	49	2	1	5	1	5	14	0	19	7	0
Bayfield	85	31	2	4	3	0	3	2	0	31	3	0
Brown	4	1	0	2	2	5	12	5	4	8	2	0
Buffalo	6	0	0	1	4	0	4	3	0	4	0	0
Burnett	84	79	0	4	2	0	3	2	0	13	4	0
Calumet	2	1	0	4	2	0	2	3	0	1	0	0
Chippewa	47	17	1	1	6	1	5	10	0	11	2	0
Clark	6	0	0	5	3	0	5	2	0	2	0	0
Columbia	69	39	2	5	6	5	27	48	4	41	11	0
Crawford	5	2	0	2	2	1	9	5	0	10	0	0
Dane	32	11	2	6	7	10	15	28	4	29	4	0
Dodge	42	10	0	3	2	2	3	5	0	8	2	0
Door	124	63	7	4	9	7	13	15	0	60	9	0
Douglas	65	19	0	5	2	4	6	14	0	18	4	0
Dunn	5	1	0	0	2	1	2	2	0	3	1	0
Eau Claire	0	2	0	0	3	3	5	10	0	2	0	0
Florence	25	5	0	1	1	0	3	1	0	6	1	0
Fond du Lac	29	3	0	3	3	3	12	7	0	27	3	0
Forest	59	24	0	3	1	1	0	1	0	22	1	0
Grant	4	1	0	2	6	1	4	8	0	14	3	0
Green	0	1	0	2	3	1	2	2	0	7	0	0
Green Lake	39	13	0	1	3	0	1	5	1	27	0	0
Iowa	1	0	0	1	1	1	1	3	0	3	0	0
Iron	57	37	0	3	2	0	6	4	0	15	5	0
Jackson	17	2	0	3	0	1	6	3	1	14	0	0
Jefferson	31	6	1	2	3	2	5	4	0	14	2	0
Juneau	13	3	1	1	7	2	15	6	0	18	3	0
Kenosha	39	16	0	5	5	4	11	14	0	24	4	0
Kewaunee	5	0	0	0	1	0	3	2	0	4	0	0
La Crosse	2	1	0	3	1	4	11	14	4	5	1	0
Lafayette	0	0	0	4	1	0	2	0	0	5	0	0
Langlade	63	25	1	4	1	2	8	4	0	14	4	0
Lincoln	79	36	4	3	0	3	5	5	0	27	5	0
Manitowoc	10	0	0	4	4	2	4	6	1	6	5	0
Marathon	12	2	0	5	5	2	7	12	1	6	0	0
Marinette	64	23	1	2	6	2	11	7	0	23	0	0
Marquette	58	18	3	3	1	0	4	1	0	18	2	0
Menominee												

TOURIST ACCOMMODATIONS IN WISCONSIN

TABLE 6. CLASSIFICATION AND SIZE OF TOURIST-LODGING ESTABLISHMENTS IN WISCONSIN COUNTIES (AS OF APRIL 1, 1962)—CONTINUED

COUNTY	TYPE OF ACCOMMODATIONS AND NO. OF ESTABLISHMENTS											
	Cabin Courts, Cottages Lodges or Resorts			Hotels, Inns, or Motor Hotels			Motels or Motor Courts			Camps, Clubs, Tourist Homes		
	Bedroom Units			Bedroom Units			Bedroom Units			Bedroom Units		
	1–9	10–30	31+	1–9	10–30	31+	1–9	10–30	31+	1–9	10–30	31+
Milwaukee	3	0	0	10	8	30	15	30	10	13	4	0
Monroe	4	1	0	2	3	2	4	8	0	13	2	0
Oconto	66	18	1	6	2	0	1	3	0	23	3	0
Oneida	336	192	10	4	13	3	13	15	1	102	21	2
Outagamie	0	0	0	0	2	2	3	10	0	4	0	0
Ozaukee	0	0	0	1	3	0	2	4	1	2	0	0
Pepin	2	0	0	2	0	0	1	2	0	2	0	0
Pierce	4	0	0	0	1	1	1	4	0	1	0	0
Polk	40	20	2	1	6	0	6	2	0	10	1	0
Portage	11	1	0	3	2	1	0	6	1	5	0	0
Price	68	21	2	5	5	0	4	5	0	23	3	0
Racine	26	6	2	3	3	5	7	6	2	8	0	0
Richland	1	0	0	1	0	1	1	3	0	5	0	0
Rock	8	3	0	0	2	6	4	15	1	10	0	0
Rusk	20	7	0	0	3	1	2	5	0	4	1	0
St. Croix	1	1	0	2	1	2	2	3	0	1	2	0
Sauk	42	14	2	2	2	3	14	26	2	36	5	0
Sawyer	173	155	4	7	2	1	6	2	0	36	9	0
Shawano	59	11	0	6	6	1	7	4	0	10	3	0
Sheboygan	21	6	1	5	2	7	3	5	3	59	1	2
Taylor	9	2	0	1	3	1	1	1	0	3	1	0
Trempealeau	1	1	0	2	3	0	2	3	0	5	0	0
Vernon	7	0	0	3	2	1	9	1	0	6	1	0
Vilas	340	265	15	7	8	3	11	12	1	86	23	0
Walworth	141	31	2	5	14	6	15	24	0	158	10	3
Washburn	101	83	2	4	3	1	3	8	0	29	7	0
Washington	25	6	1	3	2	2	6	1	0	9	2	0
Waukesha	35	6	2	8	6	4	3	10	3	9	2	1
Waupaca	68	11	0	4	7	2	5	6	0	23	0	1
Waushara	104	6	2	1	3	0	4	3	0	21	2	1
Winnebago	30	5	0	2	3	5	5	12	2	12	0	0
Wood	6	3	0	2	7	3	7	10	0	16	0	0
TOTALS	3045	1438	75	207	247	166	421	536	47	1329	194	10

Table 7. Cabin, Cottage, Resort and Lodge Accommodations in Wisconsin for Vacation and Overnight Tourist Housing (Number and Size of Establishments is based on 1962 Board of Health data)

County	Seasonal Establishments — Bedroom Units				Year-Round Establishments — Bedroom Units				Total Resorts
	1–4	5–9	10–30	31+	1–4	5–9	10–30	31+	
Adams	9	3	4	0	1	0	0	0	17
Ashland	13	20	15	0	1	2	3	0	54
Barron	22	37	49	2	0	2	0	0	112
Bayfield	42	33	26	0	6	4	5	2	118
Brown	2	2	0	0	0	0	1	0	5
Buffalo	2	4	0	0	0	0	0	0	6
Burnett	34	46	78	0	2	2	1	0	163
Calumet	1	1	1	0	0	0	0	0	3
Chippewa	18	25	16	0	1	3	1	1	65
Clark	5	1	0	0	0	0	0	0	6
Columbia	33	32	37	2	2	2	2	0	110
Crawford	3	1	1	0	1	0	1	0	7
Dane	17	9	9	1	4	2	2	1	45
Dodge	24	15	9	0	3	0	1	0	52
Door	74	49	61	7	1	0	2	0	194
Douglas	21	35	17	0	6	3	2	0	84
Dunn	2	2	1	0	1	0	0	0	6
Eau Claire	0	0	1	0	0	0	1	0	2
Florence	12	12	5	0	1	0	0	0	30
Fond du Lac	26	3	3	0	0	0	0	0	32
Forest	29	20	22	0	6	4	2	0	83
Grant	2	2	1	0	0	0	0	0	5
Green	0	0	0	0	0	0	1	0	1
Green Lake	26	12	12	0	1	0	1	0	52
Iowa	0	0	0	0	1	0	0	0	1
Iron	27	27	36	0	1	2	1	0	94
Jackson	10	5	2	0	1	1	0	0	19
Jefferson	21	8	6	1	0	2	0	0	38
Juneau	3	10	3	1	0	0	0	0	17
Kenosha	20	14	15	0	1	4	1	0	55
Kewaunee	4	1	0	0	0	0	0	0	5
La Crosse	2	0	1	0	0	0	0	0	3
Lafayette	0	0	0	0	0	0	0	0	0
Langlade	33	27	23	1	1	2	2	0	89
Lincoln	34	39	36	3	4	2	0	1	119
Manitowoc	6	1	0	0	2	1	0	0	10
Marathon	3	5	1	0	4	0	1	0	14
Marinette	22	35	21	0	3	4	2	1	88
Marquette	35	19	17	3	1	3	1	0	79
Menominee	...	...	...	...	...	...	...	...	...
Milwaukee	3	0	0	0	0	0	0	0	3
Monroe	2	1	1	0	0	1	0	0	5
Oconto	32	29	17	1	5	0	1	0	85
Oneida	143	180	184	9	5	8	8	1	538
Outagamie	0	0	0	0	0	0	0	0	0
Ozaukee	0	0	0	0	0	0	0	0	0
Pepin	1	1	0	0	0	0	0	0	2
Pierce	3	1	0	0	0	0	0	0	4
Polk	21	17	19	2	0	2	1	0	62
Portage	11	0	1	0	0	0	0	0	12
Price	27	34	20	2	1	6	1	0	91
Racine	12	7	4	1	2	5	2	1	34
Richland	0	0	0	0	1	0	0	0	1
Rock	3	5	3	0	0	0	0	0	11
Rusk	7	10	6	0	3	0	1	0	27

TABLE 7. CABIN, COTTAGE, RESORT AND LODGE ACCOMMODATIONS IN WISCONSIN FOR VACATION AND OVERNIGHT TOURIST HOUSING (NUMBER AND SIZE OF ESTABLISHMENTS IS BASED ON 1962 BOARD OF HEALTH DATA)—CONTINUED

County	Seasonal Establishments Bedroom Units				Year-Round Establishments Bedroom Units				Total Resorts
	1–4	5–9	10–30	31+	1–4	5–9	10–30	31+	
St. Croix	0	0	0	0	1	0	1	0	2
Sauk	17	24	14	2	1	0	0	0	58
Sawyer	47	120	152	4	2	4	3	0	332
Shawano	28	31	10	0	0	0	1	0	70
Sheboygan	18	2	5	1	0	1	1	0	28
Taylor	6	3	1	0	0	0	1	0	11
Trempealeau	1	0	1	0	0	0	0	0	2
Vernon	3	1	0	0	1	2	0	0	7
Vilas	141	186	260	15	4	9	5	0	620
Walworth	99	34	25	1	4	4	6	1	174
Washburn	32	62	78	2	2	5	5	0	186
Washington	19	5	3	1	0	1	3	0	32
Waukesha	21	10	4	0	2	2	2	2	43
Waupaca	43	22	10	0	1	2	1	0	79
Waushara	75	24	6	1	4	1	0	1	112
Winnebago	25	4	3	0	1	0	2	0	35
Wood	2	3	2	0	1	0	1	0	9
TOTALS	1479	1371	1358	63	97	98	80	12	4558

SIMILAR TO AGRICULTURE

There are several problems peculiar to the resort industry which confront today's owners and operators of vacation accommodations. We can discuss them only briefly here. Before doing so, however, we would like to emphasize the close similarity between the resort business and agriculture in our State. In many ways, a cottage-resort is almost like a small farm—with many of the same characteristics and problems. Here are a number of ways in which the two types of business resemble one another rather closely:

(1) *Short season.* Resort establishments and farms are quite seasonal, and both are subject to a fairly short season in Wisconsin. Cottage-resorts are pretty well limited to a 10 to 14 week vacation season in northern Wisconsin, whereas farms in this same area are limited to a 90–100 day growing season.

(2) *Weather.* Both resort and farm operations are dependent to a great extent on weather conditions. A cold summer is not the best for either business. Prolonged drought (summer or winter) can affect both farms and resorts. Storms, unseasonal frost, and insects are other problems which often face both farmers and resorters.

(3) *Resource depletion.* Soil erosion and fertility depletion lower farm productivity. Similarly, lakes can be too acid, too infertile (sometimes too fertile), discolored, polluted, weedy, or silted so as to affect their productivity and quality for water users. Thus, both farms and resorts are dependent on basic resources, which must be conserved and properly managed for best results.

(4) *High investment.* Both resorts and farms require a heavy initial investment in proportion to the annual gross income. Even on many good farms, the annual gross income seldom exceeds 30 per cent of the total investment in land, buildings, livestock and machines. Similarly, the annual gross income from a cottage-resort located on a good lake is seldom over 20 per cent of the total investment (or replacement cost) of the establishment. Most cottage resorts, like small farms, are part-time enterprises since additional income is needed.

(5) *Family business.* Both the cottage resort and farming business are family-type enterprises. Because of the low income in relation to the money invested, it is difficult to hire much outside help and thus all members of the family must "pitch in" to operate the business. Small resorts, like small farms, provide very few job opportunities in the community, aside from family employment.

(6) *Way of life.* Both cottage-resorts and small farms are often a "way of life" for many families. These people would not be happy doing anything else, despite the relatively low income possibilities afforded by the business. Both businesses give ample opportunity for outdoor work and pleasures, with a minimum of restrictions and a maximum of independence. Many people would rather do resort work or farm work more than anything else in the world, and thus they tend to stay in the business despite little or no net income above costs.

Short Season Is Problem

Perhaps the most serious problem of all is the extremely short guest season for cottage resorts, the bulk of which are not located near winter-sports areas in Wisconsin. Most of them enjoy only 8 to 12 weeks of fairly good business each summer. It is true that some successful operators are extending the season to 14 and even 16 weeks, but they have had to build up this business by skillful advertising and by providing more services for their guests.

The short season is not a matter of climate alone, although 16 weeks is getting rather close to the limit in terms of good, warm weather. The biggest problem is the school-vacation term which is always a factor in the vacation plans of city families. The big city school systems seldom close before June 15 and most families with children like to have a week or two at home before school begins in the late summer. Thus, there are only 75 to 80 days available for vacationing city families with school-age children.

On the plus side, however, we are developing more and more activities that can utilize the good weather of May and early June, plus September and October, in addition to weekends the year around. Winter sports, especially skiing, which got under way as recently as 1946 in Wisconsin, is a good example of an "off-season" activity. But there are many other things, such as nature study, conventions, shows, contests, spring attractions, autumn festivals, and so on that could be highlighted during the period from early fall to late spring, which embraces a good eight months here in Wisconsin. Much more attention will be given to developing off-season attractions and events in the years ahead.

Resources Deteriorate

Another problem that is already troublesome in some areas is lake and stream deterioration. Overcrowding of these waters, as well as misuse and pollution, leads to such problems as siltation, weed growth, fish kills, algae infestation, and loss of esthetic values. For example, one lake of 970 acres in Vilas County already has 46 summer resorts plus more than 100 summer cottages. As a consequence, this lake has only about 21 acres of available water surface per resort. The weed-growth, fertility, and siltation problems increased at a rapid rate until 1962, when action was taken to reduce shoreline erosion, sewage fertilization, and so on.

In addition, overcrowding has led to serious conflicts between speedboaters, water skiers, fishermen, canoeists, swimmers and other users of the water resources. Excessive use of speedboats and water skis can lead to destruction of spawning grounds near shore and create other fish management problems.

Another problem that is plaguing resort operators in certain areas is the matter of obsolete facilities. This is particularly true where the resorts were built from 25 to 50 years ago and still remain on the same sites. Many of the earlier resorts, particularly those built between 1900 and 1940, were designed for sportsmen and were in the nature of fishing camps. Thus, the cottages were largely of cabin size (less than 300 usable square feet) and had to be expanded for rental to family groups later on. Since many of the structures were not especially suited to expansion and modernization (installing running water with modern toilets and bath fixtures), the results were often not satisfactory. Since World War II, with the advent of larger families and predominantly family vacationers in some areas, these housing units have become less and less desirable to vacationers and even weekend guests. The best solution, in many cases, is to raze the structures and start out again with a new layout and new buildings, if the owner wishes to stay in the vacation-accommodation business.

Vacationers and other visitors in this modern era insist on a wide range of special services beyond the lodging and usual waterfront activities. Unfortunately, many of our housekeeping-cottage resorts in Wisconsin have not kept pace with this demand and still have little to offer the public beyond lodging, a boat, and access to water. Since the visitors of today are much more mobile and can go much farther afield in seeking the guest services and recreational activities they want, many of the older resorts are not getting the percentage of "repeat business" that is necessary to stay in operation.

In our observations, at least one-third of the cottage-resorts in Wisconsin are not offering the type of service that family vacationers desire and can afford in 1964. The usual complaint among operators is that the people want good accommodations, plus all these services, for $50 a week or less. Unfortunately, this claim is usually not true because family income levels are at an all time high in our Midwest Area (over $7500 per household in 1964). Progressive resort operators have shown that many family vacationers will readily pay from $100 to $150 a week for spacious vacation homes with a wide range of resort services provided. In addition, the newer resort hotels and camp grounds are "siphoning off" some of the trade that formerly went to cottage resorts—particularly the marginal ones.

There is a general lack of professionalism among cottage-resort operators, many of whom came to this business after being mechanics or storekeepers or factory workers most of their lives. (Not just a few are retired or semi-retired people!) As a consequence, they have had little or no experience in catering to the traveling public, nor have they had sufficient experience in tourist-business management. The University of Wisconsin Extension Service has been conducting a series of seminars and workshops to help meet this problem, but further educational work is needed.

Trends and the Future

There are several rather noticeable trends in the resort business of Wisconsin. During the past three years the author of this paper has had a chance to visit several hundred resorts in every corner of the state and he has talked to hundreds of local people and community leaders in resort areas.

One of the most noticeable trends is the decline in numbers of small establishments. This is particularly true in the case of housekeeping-cottage resorts on popular, well-known lakes such as Lake Minocqua in Oneida County and the Eagle Chain of Lakes near Eagle River and Three Lakes, Wis. These small establishments are being sub-divided and sold as individual cottages or as waterfront lots to people who wish to own summer cottages or year-round homes in these areas.

Part of the reason for this decline in small resorts is the increasing land costs, since good lake frontage property has been appreciating in value at the rate of about 10 per cent a year since 1946. This means a much higher land cost and higher taxes for housekeeping-cottage resorts which have, in most areas, shown gross incomes of only about $700 per cottage per year. Thus, the cottage resort's waterfront land is often sold and goes over to a "higher use"—either residential buildings or intensive resort operations. (The same is true of the smaller American Plan resorts that have a capacity for less than 50 guests.)

Hand in hand with the decline of small establishments has been the increase of larger resorts and resort hotels in some areas. It appears that approximately 20 average-to-good cottages are needed to provide a reasonable profit to the seasonal operator with 10 to 14 weeks of business (at 80 per cent occupancy). Many of the newer resort-type establishments are of the more efficient motel or apartment type, particularly where the season can be extended.

There is also a definite trend toward *complete* resorts which can offer lodging, food service, car service, private airstrips, gift shops, sports apparel and equipment shops, beverage service, entertainment, meeting rooms, swimming pools, marina service, and a variety of personal services—all at one location. Although the number of such establishments is quite small at the present time, at least a dozen have been built or developed since 1960. Some of these do not offer the entire range of services yet, but the increase in number of motel-supper club establishments in our resort counties is quite noticeable. Many of these are not located on the water, but instead are situated near a town or on a well-traveled highway within easy driving distance of a dozen or more lakes, rivers, sports areas, etc.

Another noticeable trend has been the development of "off-season" activities and facilities, which tend to lengthen the visitor-lodging season in many areas. Perhaps the development of winter sports areas has been most noticeable. The first commercial ski area in Wisconsin was started in 1946 with a single rope tow and tarpaper shelter. In 1959–60 there were 37 major ski areas in Wisconsin, and 44,000 ski enthusiasts were contributing about $4 million a year to our economy. By the winter of 1963–64 the number of winter sports areas had increased to 53, and the total gross income from 100,000 or more skiers and ski followers (over 450,000 skier-days) probably exceeded $10 million.

There are many other examples of winter, spring and fall activities that have meant more weekend guests and visitors for Wisconsin, even the northern areas. Convention business, contests, festivals, guided tours, nature study, historic sites, factory tours, and many other things have helped the cause. In addition, more and more people, particularly our senior citizens, are taking vacations in the spring and fall months, and this trend will continue. There was a 17 per cent increase in the number of people over 65 years of age between 1950 and 1960, and this group can take recreational trips at any season. Additional opportunities for more off-season vacation business develop each year.

As for the future, many of us feel that Wisconsin is big enough and has natural resources enough to have both a good volume of tourist business and an abundant supply of natural resources of good quality. However, it will take both individual and organized efforts by progressive operators and communities to guide future developments along proper lines.

Even if the total volume of travel-recreation business were to increase to $1 billion by the year 1975, which some travel experts now predict, we feel that this can be done without despoiling our valuable water, forest and wildlife resources. After all, these primary natural resources are the very basis of our vacation resort business and—to some extent—our entire travel-recreation industry. Abundant outdoor recreation and activities, plus a wealth of scenic and sightseeing opportunities, can assure Wisconsin's future in this important business.

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A COMPREHENSIVE LONG-RANGE PLAN FOR RESOURCE DEVELOPMENT IN NORTHERN WISCONSIN

Walter K. Johnson, Deputy Director
Wisconsin Department of Resource Development

The Department of Resource Development about two years ago initiated a comprehensive planning program for the State of Wisconsin. In connection with this program, major segments of which are now nearing completion, special attention is being given to Northern Wisconsin's problems and needs. A prime objective of this effort is to identify the projects and programs that governments and citizens should undertake to assure for the north country, an economy and a standard or quality of living that compares favorably with the rest of the nation. This emphasis is justified on the grounds that Northern Wisconsin has experienced a lagging economy throughout most of the Twentieth Century, and is part of one of the nation's large depressed regions. These regions are characterized by high rates of unemployment, declining populations and a relative lack of economic opportunity.

There are several general observations that need to be made about the Department's state level planning program before outlining the specific subjects with which it deals. In the first place, it is not conceived to be a single-shot effort, instead it should constitute only a beginning, the foundation on which long-range improvement programs can be built. Fifty years of decline, almost certainly, will not be recovered overnight by some magic stroke. Since unlimited public funds are not available to pour into any depressed area, the best use needs to be made of all public investments—an objective that can best be achieved through planning them in advance to assure that each new investment complements and supplements those already made and those to be made in the future. Under such a program, even the smallest investments contribute to the total effort. But, time is an important factor because continuing attention to problems of development and underdevelopment can achieve for an area gains which would not otherwise be realized.

The Department's planning efforts are described as "comprehensive." By this we mean that the program involves not just an analysis of economic conditions, or land uses, or resources, or transportation problems or public facility needs—rather it is an effort to see all of these aspects of development in a single perspective. Also, the state planners engaged in this undertaking are not expected to draft detailed plans or working drawings for specific public works or development projects. The State's many action agencies have able personnel assigned to these tasks. The job of the State's central planning office, in the Department of Resource Development, is to suggest, somehow, an arrangement of the many on-going activities of state government so that public programs are tailored not only to present, but to future needs as well; so that public projects complement, rather than compete or conflict with one another; and so that economic and social benefits are the deliberate result, rather than only a possible, incidental by-product of the many development activities of the state government.

The Department's state planning effort involves three types of tasks—data gathering and analysis, plan formulation, and plan implementation. Each of these was covered in a general way in seven reports published last year. More detailed analyses are now underway. The population and economic studies will be completed this year. Work is also proceeding this year on analyses of land use, transportation and state facility needs. Plans dealing with each of these areas of concern will be formulated next year. Implementation will be a continuing responsibility thereafter.

The analysis of Northern Wisconsin population, economic and resource problems that has been undertaken to date reinforces, in general, the accepted image of it as an area of declining population slowing economic activity and depleted resources. But a closer look at the data reveals that these characteristics aren't as immutable as most people might have been led to believe. For example, the population trend of Northern Wisconsin counties has been generally downward throughout most of the Twentieth Century because many young people have left the area due to a lack of job opportunities. Northern Wisconsin is now left with a relatively aged population. Since elderly people don't have babies, the area's population could continue to slide downward unless job opportunities and living conditions there make the area more attractive to young people. Planning studies will identify the governmental actions that might be taken to reverse these trends and to stabilize the area's population. Knowledge of the cause of problems leads to discussion of means of alleviating them. And knowledge of the many possible action alternatives will, we hope, stimulate new efforts to reverse the area's long-term decline. Government programs—local, state and federal—largely determine the living amenities of an area. Local educational facilities, municipal services, streets and highways, libraries, parks, beaches, forests, colleges, hospitals and many other facilities and services provided by governments make an area competitive insofar as living conditions are concerned. Many jobs are created in the process of providing such facilities and services and new private enterprises can be attracted to an area simply because people like to live there. The government programs needed to strengthen the living conditions and amenities of the Northern Wisconsin area will be identified in connection with the State's planning effort.

Northern Wisconsin once had a magnificent forest resource, but by 1920 it had been virtually demolished. Conservation efforts and forest management have done much to repair the damage, and industries using forest products now support fourteen percent of the State's population; still much remains to be done. Resource-based industries are doubly beneficial to an area because they support not only those engaged in manufacturing operations, but also those who produce the raw materials and bring them to market. If the demand for goods made from wood products continues to grow in the future as it has in the past, and if forest management practices enable the State's Northern Counties to realize their full forest-production potential, this resource will constitute an increasingly strong element of the economy of Northern Wisconsin. It took government, as well as private, action to restore the forests to their present levels of production. New efforts will be needed to make these practices even more widespread and effective.

Iron mining operations contributed heavily to employment of people in Northern Wisconsin for several generations. It now appears that the best part of that resource in the state has been used. The future of this industry in Northern Wisconsin, therefore, appears bleak. But if the State wishes to attempt to rejuvenate this industry, at least two things might be done. The first is to press for research efforts directed toward eventual utilization of the taconite deposits still available. The second is to obtain a magnetic survey of the State to identify mineral deposits not yet measured or discovered. The benefits from these efforts would admittedly be somewhat conjectural and long term, rather than immediate.

After the forests were removed from the Northern Counties of Wisconsin, the popular belief was that it could become an area of flourishing farming activity. It was discovered, too late for many people, that most of that area's soils would not sustain agriculture. As farming operations became more mechanized and competition from more productive areas became more severe, the agricultural economy of Northern Wisconsin lost ground. While certain types of agricultural activities are still feasible in certain locations, most areas that were once farmed should likely be returned to forest uses or held in a land bank status for possible future use. State planning studies will outline the means of achieving such objectives and the relationship between such efforts and development possibilities in both the urban and rural communities of the Northern Counties. Experts in agriculture, at both the state and federal level of government, will play an important role in both the formulation and the implementation of such programs.

The Northern Counties of Wisconsin still have a great water resource—ground water is readily available and fresh water abounds in its lakes and streams. The streams have their origin in the forested highlands, and with the improvement of forest management and farming practices water quality has remained high. In recent years, however, there has been a brisk market for waterfront cottage sites, and development of such sites has proceeded with very little thought given to the long-term efforts of these actions. Sites are bought, then ground cover is removed in preparation for construction. Rains come and wash debris and soil into the water. Cottages are built with septic tank facilities, usually discharging effluent into the water. When this process continues unabated, waters become murky and warm, algea and plant growth is stimulated, and fish spawning grounds and wildlife habitat are ruined. The very things that attracted people to the waterfronts are destroyed, and unlike the forest resource, the water resources cannot readily be restored to their original condition. The damages can be repaired only at great cost. The counties of Northern Wisconsin might benefit temporarily from exploitation of water resources, but such actions will almost certainly bring about a low grade of development that will create long-term problems and hardships. Through improved development practices, the Northern Counties can have their water resources and use them too; and they can, in this way, build an even stronger economy for their area. An objective of the State's planning efforts is to identify the specific means whereby, through joint local-state programs, a higher standard of water related developments can be assured.

A resource important to Wisconsin, but given little attention to date, is its scenery. Today more people engage in viewing scenery than in any other recreation activity. The Northern Counties of the State have a great variety of scenic resources. Its highlands, forests, water and many points of historic or scientific interest contribute greatly to its living amenities and to its attractiveness to tourists. Like all other resources, its scenic resources need to be developed with foresight. Carefully planned roads, selective cutting of trees and provision of overlooks, waysides and recreation facilities all contribute to the scenic resource. On the other hand, billboards, honky-tonk developments, junk yards and dumps destroy scenic resources. State and local governments have the power to control both public and private developments so as to minimize the possibility of damage to the scenic resource and to enhance that resource wherever possible. The objective of planning efforts—state, regional and local—must be to effectively guide developments so that Northern Wisconsin can enjoy the economic benefits that flow to an area that has a reputation of being beautiful and livable, as well as functional.

Planning for Northern Wisconsin should deal with all aspects of its development. Of basic importance is its human resource. Fortunately, Northern Wisconsin has a high-grade human resource and because of this fact, the North will never sink to the level of Appalachia. This is not to disparage the good people of some of our southern states. The fact is that state governments in that area of the country, years ago adopted a practice of providing only minimal education, transportation and health and welfare services to their people. As a result, those people do not have the capacity to cope with problems of a complicated society that cannot any longer use their labor. Great numbers of them have become dependent on public grants of one kind or another.

The State of Wisconsin has prided itself on the quality of services it provides its people. High levels of education have been encouraged. Adequate, and for the most part even excellent, health and welfare facilities have been provided. Without the programs that progressive state and local governments have provided in the past, residents of Northern Wisconsin would likely now be a despondent, dependent liability. Instead the human resource of the North is viable, capable and independent. The State's past investments are, therefore, paying off in a much greater way than is generally appreciated. The interest shown by county and local officials in improvement programs for the area is evidence of this fact. Most Northern communities are now engaged in planning programs. Five counties have joined hands in establishing the Northwestern Wisconsin Regional Planning Commission. Others have joined the eight-county Wolf River Basin Regional Planning Commission. These new inter-county efforts to deal with area-wide problems demonstrate a capacity and desire on the part of the people of the North Counties to face up to the problems of today and to build a better environment there for future generations. Also, they have joined hands with the government of the State to insure that programs developed for their areas will be appropriately related to the needs and development activities of the state as whole. With the overview that the Department of Resource Development has of all the activies of state government, the Northern Counties should achieve through state and regional planning efforts the added benefits that result from effective co-ordination of all local, state and even federal programs. If a full measure of the possible benefits from all these programs can be realized, the future for the Northern Counties can be bright. But without some such concerted effort, its future would be dim. Fortunately, the state and the people of the North country counties have decided that their future will not be left to chance. All of the information, all of the knowledge, all of the experience that can be brought to bear on the problems of the North will be utilized in the planning programs that have now just been started and will continue to bear fruit in the future.

Northern Wisconsin can encourage developments that are consistent with the goal of preserving its natural resources. It can plan for public investments that satisfy human needs and improve its human resources. It can achieve a diversified economy, not dependent on a single industry or resource. It can realize these objectives through planned government actions and free, private enterprise. Finally, Northern Wisconsin can, through its efforts, demonstrate to the Northern depressed areas of its sister states, a way out of the downward spiral that has engulfed the region. Its leadership in developing a planned approach to the solution of its problems might, indeed, be regarded as a contribution of national significance. The staff of the Department of Resource Development is pleased to serve this effort in partnership with local and regional groups.

AN INDUSTRIAL APPROACH TO RESOURCE MANAGEMENT

M. N. Taylor, Executive Director
Trees for Tomorrow, Inc.
Merrill, Wisconsin

In selecting the subject, "The Natural Resources of Northern Wisconsin," the Wisconsin Academy has focused on one of the most important facts today—that people of urban centers are taking time to study natural resources, to become acquainted with them, and to learn how to use them wisely.

Wisconsin is a land of wonderful resources. Early explorers found dense forests, wide prairies, innumerable lakes and streams, and an abundance of fur bearing animals. Jean Nicolet, searching for a route to China, reached Red Banks near Green Bay, in 1634. Radisson and Grossilliers reached Chequamegon Bay in 1659, returned with canoes piled high with furs. Menard arrived in 1660. In 1698, Hennepin called southern Wisconsin the charming land. For many years the voyageurs and missionaries journeyed through this land of promise.

People, hearing of the wealth of resources, came from many countries of the world. Though not always understanding good management, they developed the country. However, 300 years passed from the time of the first explorer, before people realized that the resources were not inexhaustible.

We now have a complex and diversified economy in Wisconsin: in the south and along the rivers—highly developed industrial areas; in the central plains—an agricultural empire; in the north—a background of green forests and water for the wood using industry and for recreation.

The paper industry produces $958,507,000 worth of products each year, employs nearly 43,000 or about 10% of the manufacturing personnel of the state. Wages and salaries come to more than $258,236,000. Capital investment is $657,618,000; current average annual investment $50,000,000. Paper mills buy $18,200,000 worth of Wisconsin grown pulpwood, or approximately half of their wood requirements each year.

On the rivers, a series of dams and reservoirs, owned by the power companies and mills, provide vast hydro-electric power and an even flow of water for industrial, community, agricultural, and recreational use. Power companies plant trees to protect their watersheds. Members of Trees for Tomorrow alone own 950,000 acres of industrial forests.

The recreation industry provides jobs for people of the north and a vacation land outstanding in this country.

During the course of this meeting, you have heard from many different agencies who work with many different resources. It is my pleasure to give a thumb nail sketch of Trees for Tomorrow and its broad industrial approach to resource management.

Trees for Tomorrow is a non-profit, resource management organization, sponsored by 14 Wisconsin paper mills, six Wisconsin power companies, and one Michigan power company. Membership includes the bulk of the paper and power producing capacity of Wisconsin.

Trees for Tomorrow's main office is in Merrill; the Camp at Eagle River. Four foresters are on the staff.

Our objective is to build a sound forest economy for Wisconsin and Upper Michigan. Folke Becker, president of Trees for Tomorrow from 1944–1961, said in a 1953 address, "We have our goal, a background of green forests for Wisconsin, increased employment, protection of our watersheds, and, most important, informed citizens who realize that large scale, long range resource building requires coordinated effort and that it cannot be accomplished overnight by decree."

When Trees for Tomorrow was founded twenty years ago, our original research revealed that any forestry program could accomplish little if it was not directed to the small private forest landowners, who own 68% of the forest land in the state. The following figures emphasize this factor. Only 28 private landowners in the state own 5,000 to 50,000 acres or more a piece. As many as 146,000 landowners own only 100 acres or less a piece.

The first five year work area was confined to the Wisconsin River valley. Today, our forestry work area covers 34 counties. Fifty percent of our time is spent in helping small landowners develop the potential of their woodlands; fifty percent in conservation education. The latter phase of our program is directed toward building a sound concept of resource management for the future. This brief paper will touch on the philosophy back of this program, how it operates, and some of the progress.

It is highly interesting for an individual or a group that begins to work with the renewable natural resources—soils, forests, water, and wildlife—to learn how these resources are intricately related to one another. This has been the experience of Trees for Tomorrow, over a span of two decades.

Each phase of the program is designed to provide an action outlet for any individual whose interest has been stimulated in the field of reforestation, forest management, or resource education.

Trees for Tomorrow's work falls into these areas:

1) Distribution of free trees, which provides an opportunity for action to many people who never thought of planting.

2) Machine planting, which introduces people to resources and the delight to be found from making their property productive.

3) Preparation of forest management plans, which shows a landowner where to plant, where to harvest, where to let grow, in short, how to put each of his acres to its best use.

4) Resource education at Trees for Tomorrow Camp.

Free Trees

Objectives of the free tree program are to stimulate interest in forestry, to expand reforestation, to create an opportunity for our foresters to get on to the land, and to project the idea of self help.

Self-help is essential. We have found that people accomplish most when they help themselves. Landowners receive 500 free trees each year for two years. They are then encouraged to buy trees from the state or private nurseries.

Trees for Tomorrow distributes 350,000 free trees each year. Trees are from member mills' industrial nurseries. From 1944 to 1963, a total of 10,350 landowners received and planted 9,716,000 free trees. Landowners who have received free trees buy an additional 4,000,000 trees each year. Making a survey of state nurseries in 1957, we discovered that people who had received free trees, had bought and planted an additional 58,000,000.

Machine Planting

Objective of the machine planting program is to encourage large scale reforestation. The landowner buys his trees from state or private nurseries. Trees for Tomorrow inspects the planting site, prepares a planting plan, routes trees from nurseries, furnishes the technical assistance of foresters, tractor, planting machine and crew. Cost: about $30 per 1000 trees, including trees.

Machine planting demonstrations are staged to encourage banks and others to buy machines. A total of 1.2 million acres still need reforestation in Wisconsin.

Trees for Tomorrow machine planted the 10 millionth tree near Minocqua recently. On a spring day as we neared the site to take a picture, a huge truck load of logs rolled out of the forest. Here was a dramatic example of harvesting mature trees while machine planting new trees. By the end of 1963 Trees for Tomorrow had machine planted a total of 10,490,000 trees for 610 private landowners.

Forest Management

Objective of the forest management program is to increase sustained yield forestry on privately owned woodlands. Under this plan, Trees for Tomorrow: 1) secures aerial photos, 2) makes in-the-field surveys, 3) furnishes type maps, 4) submits written supplements, 5) encourages self-help.

There is another sidelight along the idea of self-help. In 1953, we made a survey to learn to what extent landowners were implementing the plans we had drawn for them. Up to this time, we prepared management plans free of charge. Our survey revealed there were conflicting ideas about our services. Some people thought they could not harvest trees unless we gave them permission. Still others thought there must be some gimmick connected with this free service, which required the technical services of a forester over a period of several days, a week, or a month.

As a result of this and other factors, in 1953, we initiated a fee system. The results apparently bear out the idea that people appreciate most those things for which they have invested some time, labor, or money. Another thing, signing a forest management agreement and paying a fee is an accepted business transaction with which they are familiar. As a result, our requests for forest management services increased 56% over the former five year period.

Forest management services include: 1) general reconnaissance survey, self-help fee 20¢ per acre; 2) intensive forest management plan, self-help fee 30¢ per acre; 3) estimating and marking, self-help fee $4.00 per hour; 4) supervision of harvest, self-help fee 10% of gross; 5) retaining fee, 500 acres or more, 5¢ per acre.

Trees for Tomorrow has prepared management plans (which cover a ten year period) for 295,400 acres owned by 769 landowners; marked for harvest 3,000,000 board feet of sawlogs, 21,190 cords of pulpwood.

The above is a thumb-nail sketch of our forestry activities. In forestry we deal with people who own land. But these landowners comprise only a small fraction of our population. Because of urban population trends and the demand for outdoor recreation, it is indeed apparent that the 4,000,000 or more people in Wisconsin and Upper Michigan must have a basic understanding of our natural resources, how they should be used, and how they should be renewed. Creating this understanding is the function of the Trees for Tomorrow Camp.

Resource Education

Widespread appreciation of the social and economic values of our natural resources is the objective of the Trees for Tomorrow resource education program at Trees for Tomorrow Camp. Here more than 4,000 citizens register annually. The workshop curriculum covers forests, soil, water, and wildlife.

There is an effective thread of cooperation that winds its way through all of the educational work at Trees for Tomorrow Camp. A great deal of assistance and technical guidance are given by public agencies, the University of Wisconsin, the state colleges, the State Soil and Water Conservation Committee, and others who believe in the important role of this conservation center.

Workshops at Camp are geared to the interests and vocations of groups. Among these are newspaper men, who own their own 78 acre forest three miles south of Eagle River, bankers, women's clubs, civic and service clubs, industrial foresters, sports club leaders, executives of Trees for Tomorrow, teachers for whom seven different courses are scheduled, as well as more than a thousand high school pupils who attend a series of 3-day workshops on school time each year. (1,251 pupils took part in 25 workshops in 1963).

Communications

Communications are maintained with the public through our bulletin Tree Tips, through talks, two movies in the library at the University of Wisconsin, news releases, magazine articles, and exhibits.

In summary—since 1944, Trees for Tomorrow has distributed nearly 10 million free trees, machine planted more than 10 million for private landowners, put under management nearly 300,000 acres of privately owned forest land, helped establish 42 school and six memorial forests, which more than 50,000 people have studied resource management at the Trees for Tomorrow Camp.

These figures are significant, not merely from the standpoint of numbers. They serve as a guide post in a new pattern for an industrial approach to resource management. At the Camp and in the field of forestry, Trees for Tomorrow plays a role seldom, if ever, approached by other industry in the country.

On tours from Camp, within the distance of a few miles, you will see a cross section of Wisconsin's working resources. Because of these resources Wisconsin is a wonderful place in which to work and to live. This state has had a colorful and exciting past. With good management of the renewable natural resources, Wisconsin will have a colorful and exciting future.

NATURAL RESOURCES—A HISTORY IN HUMAN TERMS

Leslie H. Fishel, Jr., Director
Wisconsin State Historical Society
L. P. Voigt, Director
Wisconsin Conservation Department

An anonymous but perceptive observer once quipped that no woman could be married to the same man for fifty years because after the first twenty-five years, he was not the same man. It is certainly true that people change from year to year and from decade to decade and perhaps marriage is one cause. But there are many other causes and it is with one of these and its history that this paper is concerned. Wisconsin's natural resources have a natural history all of their own and as man has impacted himself on the countryside, land and water, he has changed the course of this natural history. Conversely, as nature has changed or been changed, man has reacted in new and different ways. To cite one obvious example, as second growth forests have been preserved, hunters, hikers, fishermen, campers and many others have altered the patterns of their lives to use of these newly-created resources.

It was only a short time ago, as nature measures time, that the idea of preserving the human history of Wisconsin's natural resources story bubbled to the surface. Quite naturally, the man who made the bubbles and brought them to the top is a conservationist in every bone and fiber of his body, and more importantly, in heart and spirit. C. L. Harrington, retired Superintendent of Forests and Parks of the Wisconsin Conservation Department, is an effervescent and tenacious conservationist with a sharp, observant eye toward history. He fathered the idea of preserving the human history of Wisconsin's conservation effort, an idea which, as he wrote in a letter in January, 1960, should include "the field of natural resource conservation in its entirety."

With Harrington, this became more than an idea; it became a goal. He quickly involved his friends in the State Historical Society and the Conservation Department, preaching the gospel from one person to another, from one agency to another. It is important, he wrote to the Society in the same letter, that "the effort have your official approval. . . ." and he cagily spread a little butter on the toast with a remark that an agency as efficient as the Society could handle this project without missing a step. He worked over the Conservation Department too, to the point where the Director sent out a memorandum (draft dated May 19, 1960) to all Department supervisory personnel urging their cooperation with what was then called by various names, but later became known as the Natural Resources History Project. The Director appointed Walter E. Scott to serve as a liaison with the Society and specifically asked supervisors to report names and addresses of "old-timers" in conservation, and record any anecdotes or details about conservation history. Harrington's bubbles had begun to form a visible pattern.

But it was only a beginning. As the Society and the Department worried over other matters, the project seemed to move too slowly, at least for one as spirited as C. L. Harrington. He intensified his efforts, pushing for a mutually acceptable title for the project and trying to transform the agencies' enthusiasm into greater action. The results were beneficial. The Forest Advisory Committee of the Conservation Department passed a resolution recommending that the Conservation Commission support the project. Shortly thereafter, the Commission so resolved.

Two important barriers remained, the second depending largely upon the first. The project needed money. The Society, which was to house and operate the project, estimated that it would take two years and cost a total of $25,000. It took more planning and paperwork to begin to raise this money than those responsible had calculated, but the project prospered. By the spring of 1963, the project received half of the needed amount, $12,500, from such interested donors as the *Milwaukee Journal*, Consolidated Paper, Inc., and some private individuals. The project was ready to face the second barrier—hiring a young historian who could devote time to it. Fortunately, the Society located Dennis East, hired him and put him to work, on a part-time basis, directing the Natural Resources History Project (NRHP) as it was now named. By September, 1963, the NRHP was a reality.

Actually, even before this time, both the Society, through the efforts of its Field Services Supervisor, William K. Alderfer, and the Department through Walter E. Scott, had been actively gathering names and interviewing "old-timers." As Dennis East began to familiarize himself with the history of conservation in Wisconsin, he had some first-hand records to which he could go for information. His charge was, and is: increase the collection extent and depth.

The charge needs an explanation, since the word "collecting" has to have a reference point. The Society and the Department, in an informal agreement dated April 26, 1960, established some preliminary guidelines, four of which are worth repeating:

— To provide historical information to aid conservation research.
— To develop information about Wisconsin's conservation program which will be of some help to other states.
— To secure recognition for Wisconsin's pioneers of conservation, since the state was one of the first in the field.
— To add to the available resources of the history of the state the rich material relating to conservation history.

This is a big program, what an earlier memorandum called "a broad historical record." But it is important that these four statements are understood for the guidelines they are.

The NRHP is concerned with all natural resources in a state that has been wonderfully blessed with them. The project will ask questions about human activity in fish and forest conservation, in lakes and land conservation, in wildlife and water conservation. The project will delve into early fire prevention methods, law enforcement, and research. No area which has attracted dedicated conservationists in this state will escape the project's eyes, ears, and arms.

The NRHP is really a voracious monster, hungry for information about the history of the conservation of natural resources in Wisconsin, but it is a monster with a sense of humor. It is anxious to collect the human side of this human history—the anecdote, the practical joke, the lighter side which makes it human. And it is a monster with plaudits to bestow. The project wants to recognize the unsung heroes whose lives were and are monuments to the cause of conservation. The research men in the field, the wardens, the administrators, the planners, the lobbyists, the legislators—among these and other groups of men and women are the few who literally shaped the course of conservation in Wisconsin. This is what NRHP is all about.

The project has gone about its job with care. It uses a tape recorder to interview men and women whose recollections enliven and expand our knowledge of conservation history. It collects photographs, letters, memoranda, diaries, reports and other documents, printed, typed or scribbled, which relate to some part of this story. The end result will be as fine a collection of data about the history and the influence of the conservation of natural resources as exists anywhere in this country. Then will come the most important and continuing consequence—the use of this material for contemporary purposes, as history, as precedent, as example, as inspiration.

In the background lies an even larger objective, more subtle and less susceptible of ready accomplishment. The men and women who initiated, shaped, and implemented conservation policy have created and preserved Wisconsin's natural resources in challenging new ways over the last fifty years. The continuing result has been a changing landscape and an increasing popular and commercial use of these resources. The impact which conservation has had on Wisconsin and out-of-state citizens who benefit from these changes deserves serious study, since this is a wide and significant influence. It has brought about almost revolutionary changes in the way people live, what they do, what they wear, use and eat. Here is a Cinerama-sized screen of activities which the NRHP collections and studies will eventually help to illuminate.

Perhaps these wide-angle lens objectives are too grandiose for a project which has just begun on something less than a multimillion dollar budget, but we do not think so. The early efforts of the project have already brought in fruitful results. For example, most people who remember back to the 1920's think of flappers, Scott Fitzgerald and speakeasies, but historians are beginning to take that decade apart and discover that beneath the popular frills were some important, even world-shaking events. The NRHP materials already collected bear this out.

Wisconsin in this crazy decade was worried about its conservation program. In 1928, the then chairman of the Conservation Commission, William Mauthe, told a group at the Lake States Forest Experimental Station, that "Almost everyone from ploughboy to philosopher is quite certain that he alone possesses an exact knowledge of what is wrong with our conservation program." Mauthe was concerned about attacks that conservation policies were too political and set about to defend the commission as "a part of a political institution created through political effort," adding that "I prefer to hold to the better and finer interpretation of the word, 'politics'." Here is an indication that conservation has a very human history and that the development and implementation of our conservation policies have important consequences in other areas of life.

The recorded reminiscences of W. J. P. "Bill" Aberg, a former officer in the Izaak Walton State League reflect this, too. He remembered that giant among men, Aldo Leopold, whose activities extended the areas and influence of conservation. Leopold, Aberg said, brought game management into the U. S. Forest Service; and the pioneering study he did on the subject (beginning in this same flapper decade) was sponsored by the Sporting Arms and Ammunition Manufacturers Institute, a healthy marriage of self-interest and public welfare. When Leopold, Aberg and others began to work on what was to become the state Conservation Act of 1927, they enlisted the help of *Field And Stream* magazine and obtained reprints of an article on the conservation organization in the state of Pennsylvania, which were distributed widely in the legislature. The issue of conservation overflowed the narrow bed of natural resources and reached into areas of national and popular concern. The gubernatorial election of 1926 in Wisconsin, Aberg remembered, was largely determined by the conservation platform.

These brief samples from the 1920's, right out of the raw data which now make up the nucleus of the NRHP collections, suggest that the story of the conservation of natural resources in Wisconsin is an important and exciting human story which needs to be known. These samples suggest, too, that this story, like the conservation movement itself, is more than a narrative of what conservationists did or did not do. It is a story of how conservation has carved an important priority for itself in the range of all human activity. To gather material for research on these stories is the chief purpose of the Natural Resources History Project.

At this point in time, the NRHP is launched and sailing before a fair wind, but the voyage is a long one. The project will need the continuing support of conservationists and historians and their friends. It needs more funds to carry it into the second year. It needs more names and addresses of "old-timers" who can contribute their recorded memories and written materials. It needs and will receive the sustained backing of the two state agencies which initiated the project, the State Historical Society and the Conservation Department.

In 1950, the NRHP files reveal, Virgil J. Muench, President of the Wisconsin Division of the Izaak Walton League, told the story of the old man who always seemed cheerful in spite of his many troubles. When asked how he managed to do this, the old man replied that he had "learned to cooperate with the inevitable." His secret was probably a little deeper than that. He knew his history and how to live with it. This is the potential the Natural Resources History Project has for the conservation movement.

Materials on Deposit at the State Historical Society of Wisconsin Which Relate to the Natural Resources History Project— May 1964

Papers (already collected)

John Sweet Donald, (1869–1934). Farmer, politician, and prominent conservationist. Former President of the Sons of the Native Landscape, 1919–1920.

Speeches of William Mauthe. Chairman of the Wisconsin Conservation Commission, 1927–1933.

Papers of Arthur Kaftan. Concerned with the State Izaak Walton League, 1949–1954.

Papers of Virgil Muench. Concerned with the Izaak Walton League, 1948–1955.

Papers of Frank M. Graass, Conservation Commissioner.

Papers of Louis McClane Hobbins, Conservation Commissioner, 1929–1937.

Papers of the Wisconsin Federation of Conservation Clubs.

Papers of the State Izaak Walton League, 1938–1945.

Oral History (tape recordings already made.)

W. D. Barnard. Planter, forester, park superintendent. Tape concerned with forestry practices and conservation in Wisconsin from 1911 to 1916.

Mildred Castle. Chief Clerk for the Wisconsin State Board of Forestry, 1905–1915 (?). Tape concerned with operations of the Board and conservation practices in Wisconsin.

Henry Freund. First forest ranger in the Rhinelander District. Tape concerned with forest management.

C. L. Harrington. Superintendent of Forests and Parks. Tape concerned with forest conservation, tax laws, lumber company reforestation, establishment of the Forest Protection Districts, state regulation of lumbering, the Civilian Conservation Corps, and the Works Progress Administration.

George F. Kilp. First industrial forester. Tape concerned with reforestation movement after 1915.

Wilhelmine D. LaBudde. Milwaukee clubwoman and noted conservationist.

John Landon. Wisconsin lumber company manager. Tape concerned with lumbering and logging operations.

Nelson J. LeClair. Wisconsin fisherman and member of Wisconsin Conservation Commission. Concerned with commercial fishing on the Great Lakes.

Philip A. McDonald. Forest ranger. Tape concerned with experiences of forest station at Trout Lake.

Marvin Schweers. Tape concerned with history of soil erosion control in Wisconsin with emphasis on development of Coon Valley project and watershed management.

Charles Scoville. Tape concerned with fish and wildlife on the Wolf River.

Fred B. Trenk. Extension forester of the University of Wisconsin. Tape concerned with shelterbelt in Wisconsin and mechanization of tree planting.

B. O. Webster. Superintendent of Fisheries and Wisconsin Conservation Commissioner. Tape concerned with propagation and fish management.

W. J. P. Aberg. Lawyer and former officer in State Izaak Walton League. Tape concerned with early history and development of the Conservation Department, reminiscences of Aldo Leopold, the State Izaak Walton League, and related subjects.

Louis Blanchard. Tape concerned with early logging and log driving operations in northern Wisconsin.

The Wisconsin Conservation Department

The State Archives holds some early records of the State Board of Forestry and the State Parks Board (1904–1905) and other records of the Conservation Department from 1928 and later.

SPENT SULPHITE LIQUOR PROBLEM—PROGRESS REPORT FOR 1963

Averill J. Wiley, Technical Director
Sulphite Pulp Manufacturers Research League
Appleton, Wisconsin

We, who are actively engaged in research to find answers to the spent sulphite liquor problem of Wisconsin's sulphite pulping industry, are pleased to have this opportunity to report progress to the Wisconsin Academy. To find out exactly how many people are now at work on this problem in various research centers within the State, we made an industry count before preparing this paper.

We found that the Wisconsin pulp and paper industry employs in its own laboratories fifty-six full-time professional and technical research men and women specifically for research on the spent sulphite liquor problem. An additional ten to twenty engineers and chemists at the Forest Products Laboratory, on the University campus in Madison and at The Institute of Paper Chemistry, conduct fundamental and applied lignin and sugar research closely allied to the sulphite problem. These figures clearly indicate the responsibility which the pulp and paper industry accepts for finding solutions to this waste problem.

The Wisconsin Committee on Water Pollution makes another compilation which provides a further index of intensity of the industry's effort to find lasting solutions to this problem. The Committee reports that the pulp and paper industry in Wisconsin spent $336,897 in 1961 for pollution research, $772,392 in 1962, and $710,255 in 1963. The mills put these findings to practical use. The industry spent $2,059,560 in 1961 for new equipment and plants to reduce pollution, $3,036,430 in 1962, and $1,848,103 in 1963. Although this survey covers all types of pulp and paper mills in Wisconsin, the greater share of the expenditures tabulated were made by and in behalf of the sulphite pulp mills in their program to abate stream problems caused by spent sulphite liquor. It should be pointed out that these plant and equipment figures show sharp fluctuations as between years when major plants were being built and years when no new large-scale projects were in process.

The assigned topic of this paper is exclusively concerned with the research and development of practical processes for control of water pollution. It must, however, be pointed out that this same program is a true research for conserving the natural resources of Wisconsin. Water is one of our more important natural resources, and prevention of water pollution is now universally recognized as a major field of conservation. When we are making the best use of our water resources, we are genuinely forwarding the best interest of all of the people who live here and of the thousands from elsewhere who visit our State for reasons primarily connected with use of our surface waters.

In still another way our research and development of new processes for treating spent sulphite liquor is important to conservation. Much of the information set forth here should make it clear that this research program conserves Wisconsin's forest resources. A major fraction of the industry's research is directed toward finding effective new and better ways to use that half of the wood which is boiled out of the chips in the pulping process and constitutes the dissolved solids in spent sulphite liquor. These organic materials were formerly wasted but now are being utilized in an increasing number of products marketed all over the United States.

Our work takes this direction because keeping these organic materials from ever reaching the river has proved to be the best way to improve downstream conditions below sulphite mills. The only practical way to keep them out of the river is to transform them into commodities that customers will transport away from the mills while paying part or all of the processing cost incurred by the mills. It is a pleasing side effect that these new products or byproducts contribute significantly to better standards of living for all of our fellow Americans.

Some thirty-eight years ago the Marathon Corporation—now Marathon, Division of American Can Company—pioneered the development of the first processes that utilized the values contained in spent sulphite liquor. Marathon conducted a persistent and expensive research effort in developing its new materials. Nearly twenty years of hard work and more than a million dollars went into developing that company's method of processing spent sulphite liquor to the stage where they were manufacturing products and selling them for enough to meet the cost of operation. Today Marathon operates a major byproduct industry employing 135 people for processing spent sulphite liquor and for marketing the products which are sold worldwide.

Marathon's success encouraged other Wisconsin pulp and paper companies to proceed with research and development programs that led to other new and salable products made from spent sulphite liquor. Each of these companies lost money in its early years of operation, and some of them have not yet turned the corner where the new products are self-supporting. Not only is it expensive to perform the research and development of a new commercial product, but also a plant to process the spent sulphite liquor produced by a 100-ton mill usually costs $1 million or more. It takes years of expensive market development and sweat-stained selling to find enough people who want to use these new products and who can purchase in quantities that can make a dent in an output of 100 tons per day.

Today four major Wisconsin pulp and paper corporations operate five spent sulphite liquor utilization plants. A sixth major installation will be completed during 1964. At least one, probably two, other pulp mills will be engaged during this year in the final design work for new processing facilities to be built. At this moment, more than 100,000 tons per year of Wisconsin spent sulphite liquor solids are being manufactured into marketable products, with an estimated value approaching $10 million. This new sulphite products industry directly employs more than 300 persons in Wisconsin. A good many more jobs could be traced back to sulphite products by tallying up the full-time and fractional jobs created here in transporting these commodities as well as their raw materials and end products in the form in which they eventually reach market.

These are impressive figures for a brand-new industry based on what formerly was wasted. They are all the more impressive when considered in perspective. After all, these jobs and these values have been created only because the sulphite pulping industry is so firmly determined to solve the problem that its spent liquor creates in this state's streams.

Those of us who spend our working lives on this problem are looking forward to new developments, new processes, and new products to come from research now underway in our industry laboratories. Many of today's products from spent sulphite liquor are relatively crude. They are mixtures of organics directly proportional to the occurrence of various materials in the original pulpwood chips. But research today is finding ways to separate and modify purified lignin compounds, pure wood sugars, a number of sugar derivatives, and also the organic acids. As these are perfected to commercial usefulness, they should lead to major increases in the jobs and values as these more refined products find their place in new and profitable markets.

Processes and products such as these do not pop up overnight from simple efforts in the laboratory. Time is required to develop a good, new idea into a commodity for commercial production. As an example, for the past fifteen years we have been attempting to create from the crude lignin in spent sulphite liquor a particular kind of binder which could improve upon the mining industry's processes for recovering high-grade iron ore pellets from the low grade ore deposits of Northern Wisconsin, Michigan, and Minnesota. This is a market that could take vast tonnages of sulphite liquor solids—when and if we can attain its specifications of quality and meet its limitations of cost.

Each year our research has improved the binder products we could produce. Each year's binder comes closer than last year's to meeting the rigid requirements of the iron ore industry. But thus far all of our binders have fallen short. They have not been quite good enough either in quality or cost. We are continuing this development work on iron ore binders, and we feel confident that eventually we shall hit our target.

For another example, the lumber industry in Wisconsin and Minnesota, in the South and on the West Coast, uses tremendous tonnages of adhesives in making weather-proof plywoods. But they need still better adhesives than we have, and we are hard at work to meet their needs with a plywood adhesive derived from spent sulphite liquor. A display of these iron ore and plywood binder products in various stages of research and development has been brought to this meeting for those who would like to examine these products more closely.

You may ask how our industry research laboratories go about the task of finding these new processes and new products to be developed from spent sulphite liquor. This type of research requires a diligent and organized program that studies the properties of spent sulphite liquor as it comes from each of the various sulphite pulping processes used in our Wisconsin pulp mills. No two mills produce identical liquor, nor are their other conditions identical, which are the reasons why, when our research and development yields a new process or product, this can be put to practical use only by those mills whose situation it fits.

Only through fundamental research can the industry's scientists know the chemical structure and reaction characteristics of each of the lignin, wood sugar, and other organic components present in spent sulphite liquor. The Sulphite Pulp Manufacturers' Research League conducts fundamental research within its own laboratories, and additionally has supported a research grant at an average cost of $25,000 annually for the past twent-five years for fundamental research by staff members of the Organic Chemistry and Physical Chemistry Departments of The Institute of Paper Chemistry. Numerous other laboratories conduct their own independent fundamental research on lignin and wood sugars at the University and at the Forest Products Laboratory in Madison, and at similar research centers elsewhere in the U.S.A.

One-half of the total research budget of the League is directed to this systematic search for new knowledge about the organic compounds in spent sulphite liquor. This is not science in an ivory tower, for it is from this fundamental research that the new ideas come for new processes and new products. From that point on, our research effort systematically searches for ways to apply the new ideas. The League laboratories are equipped especially to follow through with practical developments. We have extensive laboratory equipment for carrying on our experimental work in test tube and flask, and we have the finest scientific instruments for careful analytical control.

When work in the laboratory yields results that are sufficiently promising, the League has pilot plants that can carry this work along to a scale for developing practical methods of processing. Where our pilot plants are inadequate for the particular program, we equip a new pilot plant. Our present pilot plants enable us to make large-scale studies requiring that products be centrifuged, filtered, ion exchanged, solvent extracted, evaporated, spray dried, polymerized, oxidized, and fermented. These pilot plants on occasion are also used to produce samples of our new materials in quantities sufficient for prospective industrial users to make trial production runs with our products in their own laboratories and plants.

In the course of the twenty-five years since the League was founded, our laboratories have tried out hundreds of new ideas for processes and products. Laboratory trials screen out most of the impractical and uneconomical projects. Those that pass this first screening move ahead to pilot plant testing. The eventual survivors are the more promising methods which merit further study.

Since we are working with a waste product from a large industry, we can expect that many of the proposals for new processes and products will not survive critical examination in the laboratory. We consider ourselves fortunate when 10 out of 100 proposed new ideas survive critical evaluations on paper and the blackboard, and move along to laboratory testing. Not more than one out of 100 gets as far as pilot-plant testing.

The League has constructed just eight major pilot plant installations in a quarter century. One of these yielded the process for growing food and feed yeasts on the carbohydrates in spent sulphite liquor, originally developed during the war years of 1943 to 1946. Two plants are now in full commercial operation, producing up to twenty tons of dry yeast daily at Rhinelander and Green Bay. Five plants at mills in Appleton, Green Bay, Rhinelander, and Rothschild are operating evaporation processes based on pilot plant studies in the League's laboratories and pilot plants.

But a somewhat larger contingent of other processes failed to survive pilot plant testing and were shelved. The trickling filter method for disposal type processing of liquid wastes, which is widely used for municipal sewage plants, was tested extensively in the League's first pilot plant; the process proved technically possible, but only at a capital cost and operating expense that no mill could support and remain competitive. A process for extracting pure wood sugars from spent sulphite liquor was also developed and pilot-tested, but it too fell afoul of the strict laws of economics. We still believe that the sugar products may some day be recovered feasibly from spent liquor, but it will have to be as part of an overall process which derives other values from the raw material.

The League's most recent pilot plant project is studying the electrodialysis process. We began working on electrodialysis research first in the laboratory, then went on to a small-scale pilot plant and finally to a commercial-scale pilot plant. The research is now in its sixth year and its total cost has reached $400,000. League member mills have financed the entire project.

Electrodialysis as a commercially feasible process has been the dream and the frustration of many competent electro-chemical engineers since before the turn of the century. Most of the early research scientists and engineers were handicapped by lack of proper equipment and materials; particularly, they did not have ion-selective membranes. Membrane improvements since 1950 have made electrodialysis practical for processing salt water into potable water, and electrodialysis desalting plants now are operating commercially in many arid regions of the world.

The success of these salt water treatment developments opened new vistas and brought forth new ideas. We have learned how to treat spent sulphite liquor for recovery of the pulping chemicals so that they can be reused in the pulp mill, and also we now can fractionate the valuable organics contained in spent sulphite liquor. We had all manner of difficulties in the early stages of this project, but we have overcome them one by one. Eventually we modified the conventional membrane arrangement by a simple method, and our laboratory staff was off to a running start.

Results were exciting from the very first use of this modified equipment—exciting enough to keep some research men coming back voluntarily for an extra evening of experience, and to keep technical experts of member mills dropping in day after day to watch. This project holds great promise for new and better methods of processing spent sulphite liquor to eliminate stream pollution, while at the same time recovering pulping chemicals and a variety of new organic materials which we believe will open new markets for the sulphite products industry.

A pilot plant costing more than $100,000 was eventually designed and constructed, and it has now been in successful operation for some 18 months. We are still busy with pilot plant studies, but gradually the findings are being developed into practical design data which can be used as the basis for sound decisions by industry executives on whether to build their own commercial plants to apply this process. A display showing phases of this electrodialysis research and the materials it produces is also available for your examination at this meeting.

Development of a feasible commercial process is really only half of the story. Once someone builds a plant processing 100 tons per day of electrodialyzed spent sulphite liquor solids, he will have an immediate need for markets for the products he is producing. It is no real long-term answer that some of the products might be burned to reduce stream pollution. The process of electrodialysis is costly to operate, and so we are looking for ways to use these wood chemicals profitably. We shall burn only those for which no known use exists.

We need large new markets for these new products which will be produced in large volumes, and finding such markets requires another type of research which we have carried out concurrently with the process development. Product development and market studies were begun very early in the laboratory phase of the 6-year research program. Once the pilot plant was operating, it yielded the new products in quantities sufficient for testing in our laboratory and also for sending out to prospective customers for their own practical testing of new uses for these materials.

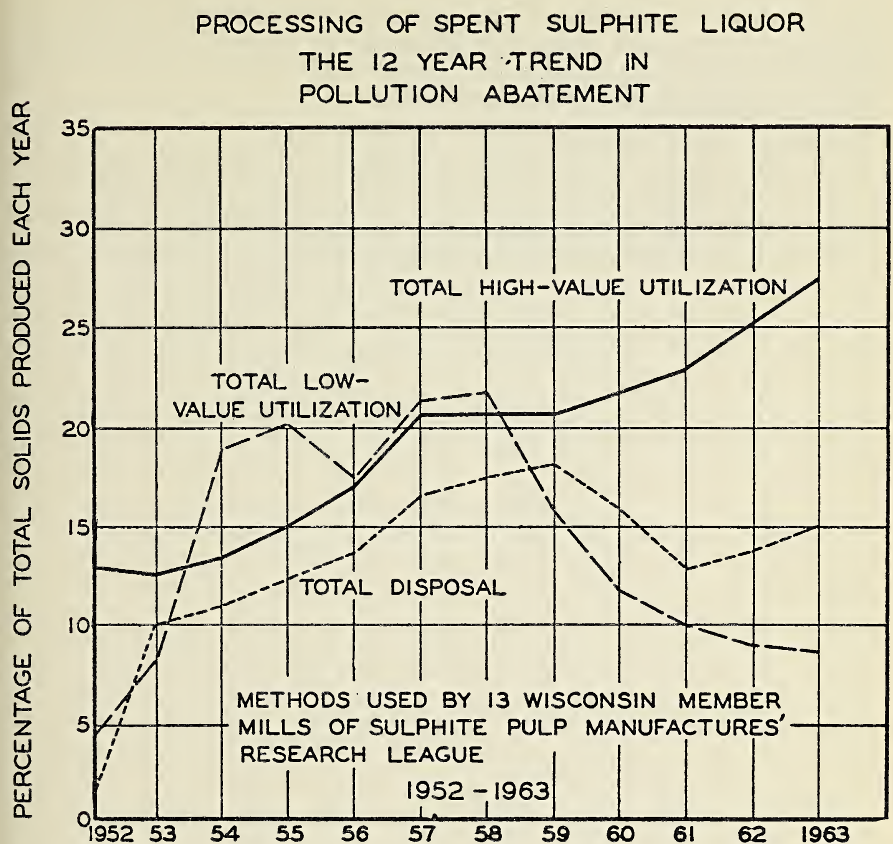
One such product being developed for the plywood adhesive market has already been mentioned in this paper. The lignosulfonate salts contained in the spent liquors as they come from the pulp mill are not suitably adhesive for plywood, and also they are water-soluble. The electrodialysis operation modifies these organics to yield free lignosulfonic acids, which in turn are easily polymerized to yield strong, water-insoluble adhesive resins. Some further research is required to obtain proper formulation of the final product, but we now have a plywood adhesive approaching final stages of development for practical use on a large scale.

The League laboratories are not the only research units at work on new processes and on the new products from such processes. Such activities are proceeding in other laboratories which are studying spent sulphite liquor. The League laboratories expect to move on to explore other new and promising processes when our electrodialysis research progresses to a stage that leaves us the opportunity for such work.

So what is the net effect of all this research and development program in terms of solving the spent sulphite liquor problem? The slide we are showing on the screen shows the twelve year trend in pollution abatement by methods used by thirteen Wisconsin member mills of the Sulphite Pulp Manufacturers' Research League in the period 1952 to 1963. In 1952 some 13% of the total spent sulphite liquor produced by the member mills was being processed in three evaporation plants, one yeast plant, and a large plant using a lignin precipitation process. Almost all of the spent sulphite liquor evaporated at that time was burned to recover heat values. No market existed for much of this evaporated syrup. A small amount of liquor was being processed by mere disposal methods in soil filtration ponds and soil irrigation areas.

All of these processing plants still are operating, and new plants have been added. The curve showing the trend in total high-value utilization of spent liquor has risen rather steadily and importantly over the years since 1952. In 1958 much less of spent liquor went to low-value utilization because greater quantities of the concentrate were finding markets at values greater than heat recovery.

With all this progress through the years, a number of the League's Wisconsin member mills have not yet been able to find ways of processing their spent liquor by economical means. They need still other routes for processing their spent liquor, and these member mills have been working in their own laboratories to develop new methods as well as supporting the League research program. To reduce their discharge of spent liquor substantially until appropriate utilization processes become available, these mills have used and con-



tinue to use short-term disposal methods that fit their interim needs. Total disposal held steady until 1959, then turned downward as more permanent methods of processing were applied. We look forward to substantial increases of utilization in future to provide more of the desirable permanent answers. Disposal operations will decrease as each new utilization plant goes into production.

The Wisconsin pulping industry is understandably proud of its record. The pulp manufacturers of this state have developed and installed more sulphite processing plants and are non-pollutionally handling a greater proportion of their spent sulphite liquor than those in any other state. These facilities serve the combined purpose of eliminating stream pollution and conserving both the water resources and the forest resources of Wisconsin.

Wisconsin has the finest, most effective state water pollution control authority existing anywhere. Public officials of this state have worked closely with water-using industries without even momentarily relaxing the official pressure for stream improvement. This attitude has gained for Wisconsin universal recognition as leading all other states in cooperative State-Industry development of permanent and complete answers to industrial waste problems. This is true not only for the pulp and paper industry, but also for the canning industry, the dairy industry, and many others.

Because of the vigorous research program of the mills and competent administration by the public control authorities, we who work full-time at the science of sulphite pollution abatement look forward with confidence to a future of continuing technical progress in a favoring atmosphere of continuing prosperity of the Wisconsin pulp and paper industry.

COMPETITIVE USES OF PUBLIC WATERS

L. A. Posekany, In Charge
Rivers Survey Section
Wisconsin Conservation Department

As one of the State's team responsible for the protection of our public waters, I daily see numerous proposals competing with or for public and riparian rights in our northern public waters.

It is my considered opinion that while efforts are constantly being made which could jeopardize public interests, the existing laws, statutory case, and common, generally have afforded a reasonable degree of protection to these interests. There is, however, a constant war of attrition going on requiring vigilance and determination on the part of protective authorities, complemented by understanding and active support by the public. There is also a real need for reasonableness and a determined effort at understanding both public and private needs in our waters and the adjoining lands.

The irrigator with a pump capable of removing 2 c.f.s. of water who wants to divert from a trout stream with a low flow of 2 or 3 c.f.s. must recognize that such a removal at times of low flow, when he needs the waters most, can result in the obliteration of the stream and its inhabitants. As long as public rights in our waters are paramount, such an unreasonable proposal cannot expect to receive approval. On the other hand, it would be equally unreasonable to oppose the diversion of the same 2 c.f.s. from a trout stream with a flow of 200 c.f.s. While both actions compete with fish and fish foods for the available water one can be found to be materially harmful and not in the public interest while the other cannot. In a third water also having a 2 to 3 c.f.s. low flow, the same 2 c.f.s. might be removed without materially harming fish life. Here the stream is so shallow, warm and silted that only a rare stickleback or darter can survive. Is the reduction of this stream to a thread of its former self of material harm? In itself, probably not. But if this stream serves as a source of water for a downstream farmer's cattle, then the harm from this water loss is at or approaching materiality. Here are two private "rights" in conflict. In Wisconsin the domestic rights of the downstream farmer will prevail if he makes an issue of the matter, objects, and his objections have substance.

Only in irrigation and mining operations does the competitive use of public water reach the extreme of using up the water. But extremes in pollution where the water is still physically present but rendered unsuitable for other uses might be considered equally consumptive. The tube and penstock type of power dam by-passing all of the flow at low stages uses all of the water in the by-passed segment of the river. In some peak and recharge power dam ponds, lessened downstream flow for portions of a day or week diminishes flow for periods sufficient to simulate consumptive use. Here the statutes require a minimum of 25% of ordinary low flow be passed at all times. The unnatural variation in water stage below this type of use has been found on occasion to materially adversely affect downstream animal and plant life and unnaturally erode adjacent banks.

The invasion of the bed of a public water could also be considered to consume or remove from use that portion of the bottom it occupies. Such occupations of the bottom of our navigable inland waters is not permissible except by legislative grant for public purposes because the state holds title to such lands in trust. Yet such invasions are not uncommon. In fact, this northern lake land finds the landowner competing with the state and the animals and plants that once lived in and used these areas of unauthorized fills.

One competitor here is the landowner who introduces material into the lake to make his lot larger. This is generally done with deliberate intent, sometimes to conveniently and economically get rid of excavation materials. There are, however, numerous cases where title description extends apparent ownership into and under the water. The landowner believes he has the right to occupy all of the lands described. Generally such fills, in addition to usurping the lake bed and competing with the public bed, uses and interferes with the normal flow pattern in the water invaded. They tend to collect debris and foster plant and algae mats in quiet areas. Usually these undesirable actions take place in front of adjacent lands, thus competing with the normal reasonable use of adjacent land.

Another invader of the lake bed is the usually uninformed landowner who, when the lake level recedes at times of low water, extends the land to the current lake edge. His counter-part is the landowner who attempts to firm up the floating bog—wetland shore. Generally, this type of fill competes with wildlife, plant communities, and eliminates areas for fish as well as taking an area of lake surface out of public use.

A less extensive but similar invader is the sea wall—shoreline straightener. Peculiarly enough sea walls are prone to being built in the water at or beyond the land water interface sometimes at the expense of bass, walleye or Esocid spawning sites and usually at the expense of the adjacent landowner who finds it necessary to extend the wall in self protection.

The lake riparian regularly competes with fish and wildlife along his segment of the lake. Just occupying the land and living near the lake lowers the inclination of wildlife to use available habitat. But mankind is always improving something. The whole matter of beach improvements competes adversely with fish and wildlife. The sand blanket to cover weeds or stones removes cover for fish and game and would, if permitted, occasionally cover bass or walleye spawning grounds. In mucky areas over-enthusiastic sand blankets, if permitted, could squeeze out less dense lake bottom muck onto adjacent property. Dredging eliminates the shallows, the feeding and living areas of the very young fish and could eliminate or diminish spawning grounds for muskellunge, northern pike, walleye and bass if it were not for a permit system and surveillance for unauthorized actions.

The boat house out over the lake eliminates a portion of the lake's surface area, prevents or obstructs in-shore use of the lake (particularly for the wading fisherman) and competes with the neighboring scenic use. The Florida-like lagoon dug in the upland may compete with the animal use of the "most economic to develop" wetland northern pike-muskellunge spawning ground, duck, muskrat and woodcock habitat. If improperly dug or designed, the completed unit may be a fish trap in the winter or, through primitive or inadequate sewage disposal and intensive development (including minimal lot size), contribute significant quantities of nutrients to the lagoon and parent water body. As competitive as the lagoons are to fish and wildlife, the numbers of users it adds to a given lake puts it more in competition with all of the existing riparian properties. The extreme here could change a small, uncrowded two-family lake with 10 to 20 water acres per family to a crowded lake with less than 1 acre available per family. In the original state the chances of most water uses becoming antagonistic competitors are low. Adding a 20–40 family lagoon makes almost all uses antagonistically competitive. In the later case even the fisherman will compete with other fishermen over the use of optimum habitat. The boat fisherman, pleasure boater and water skier are likely to be violently competitive.

The lagoon on a stream is already not uncommon in Wisconsin, in spite of the fact that it usually has available less parent water acreage than lakes. In both lakes and streams this type of project does make available land with water access above the flood level. As such, the land use competes with ordinary upland land use. Often in reaching the high land the lagoon removes wetland habitat for ducks, furbearers, song birds, or winter cover for upland birds by the area it occupies.

Stream-side lagoons are presently constructed only on our larger waters. Our smaller streams have fewer competing uses. Here individuals tend to feel so antagonistic toward their competitors that litigation is not uncommon. Though Wisconsin's courts have long held that fishing is an incident of navigation, individuals often compete with each other here for an exclusive use. "No trespass" signs and trespass charges limit the public's right to use an available fish population and the relaxation and enjoyment that sometimes goes with fishing. The fisherman in turn attempts to limit the stream riparian's use of adjacent upland by declaring cattle fences navigational obstruction. The increasing use of canoes, leisure and access add to the navigation for pleasure use on small streams to aggravate the fence-upland cattle competition. Most streams below medium river size are too shallow to offer convenient swimming areas. The increasing numbers of summer weekend and permanent homes on streams put the swimmer in competition with smallmouth bass and trout fishermen. The wading fisherman swims or drowns in the swimming hole dug in a trout stream. Understanding and reasonableness on the part of the landowner to mark such an area and permit skirting trespass has kept these uses from becoming materially antagonistic. Lagoons and boat slips offer similar problems in lakes. A burgeoning use of navigable streams involves what amounts to nonuse. This is the move to relocate streams to eliminate meanders and oxbows or to reroute the course onto least usable land and to define and limit the flood plain. Such acts remove a material segment of stream from fish and fish food production and adversely silt up downstream sectors. Fish spawning areas may be eliminated or rendered unusable. Like the sea wall this action tends to also increase the burden of the adjacent (downstream) landowner by shunting more water onto him more rapidly.

The ultimate in stream relocation is the action to divert surplus water temporarily or permanently out of the watershed, either to restore landlocked or small drainage area lakes at times of low water table or to obtain relief from high water. Since the statutes permitting these actions require a finding that the waters involved are surplus, they should not be a competitive use. Yet the introduction of water into one northern lake to restore lake levels also introduced northern pike into muskellunge water to compete adversely with the muskellunge.

A major competitive use of stream water involves physical and attendant biological changes to the stream by obstructing the flow with a dam. Involved here are competitive land and water uses. The stream is changed to a lake. Its character within the influence of the obstruction is changed from fast flowing and shallow to a relatively still deep water. Its summer temperatures may change from cool to warm. These physical changes, to use extreme examples, may completely change the biota from brook trout habitat to bass, perch, panfish. In the course of creating the lake, upland wildlife can be eliminated or reduced. A common example in this north land is the inundated eliminated winter deer yard and attendant increased aggravated pressure put upon neighboring yards. Species and habitat changes or loss, fast water canoe ways, relatively inaccessible wild areas and scenic rapids or waterfalls compete here with the serene pond, abundant, prolific lake fishery and engineering work.

In addition to river impoundment competition, the impoundment itself has various competing water users.

There is some site competition between the hydro-power interests and the land developer. A more striking competition exists between the impoundment for storage and discharge at times of low flow interests and the resort-recreation industry demand for stable full pond levels. The fish and wildlife interests find themselves in the middle in this competition.

Not all habitat changes caused by dams result in a loss of scarce habitat; in fact some can create such habitat. Nor do all dams create material wildlife habitat changes. There are innumerable small structures built in the outlets of our northern lakes to prevent throat erosion of their outlets. These devices maintain existing levels to benefit all of the water uses on these lakes, including fish and game habitat.

In the time allotted for this talk, I could not hope to cover, even by a simple list, all of the various competing uses for our public waters. I have, therefore, deliberately limited this paper to what I feel are most of the more important uses involving fish and wildlife interests.

In my opinion, as long as a test of reasonableness and materiality is applied when any use of public water is being considered, conflicts will be at a minimum, and public rights will be protected. This should also permit an orderly and reasonable development of private land uses in our northern lake land.

WILDLIFE HABITAT AND THE MANAGED FOREST

Forest W. Stearns, Research Forester
Lake States Forest Experiment Station
William A. Creed, Biologist
Wisconsin Conservation Department

Introduction

The future prosperity of northern Wisconsin is based on water, wood, wildlife, and people. Several papers at this conference have discussed water resources from the viewpoints of people, power, recreation, fish, and waterfowl. This paper will consider some of the relationships between wildlife and modern forestry and explore these questions:

1. What is the present relationship between the managed forest and wildlife?
2. How may intensive forest management change in northern Wisconsin in the next thirty to forty years?
3. How may more intensive forest management influence the wildlife population; and, in turn, how may wildlife influence forest management?

The title of this paper is particularly appropriate since the trend in the Lake States is toward more intensive forest management—a trend that must continue if the wood producers of the area are to remain competitive. We wish to discuss here what lies in the future for wildlife habitat and forest management. This will necessitate some educated guesses as to both the needs of wildlife and the supply and demand for forest products, coupled with the role of forest engineering. We have drawn freely on published sources and informal talks for our look into the future.

Our major hypothesis is not new. It is this: With planning, a forest in full production can provide adequate habitat of good quality for most forms of wildlife.

Any land management plan to benefit wildlife must provide for maximum diversity of forest types and adequate harvest of game populations. Many excellent studies of Wisconsin vegetation indicate that nature once provided this diversity through wind storms, catastrophic fires, or insect and disease epidemics. Now the forest manager must do for wildlife what catastrophe once did—and still maintain a healthy, growing forest.

Past History

In brief, the history of northern Wisconsin forests has been one of cut, burn, and burn again, then improved fire protection, regrowth, improved management, and a gradual trend toward a stable cut. Logging began in the 1850's and increased rapidly until the turn of the century. As cutting for lumber diminished, logging of the second growth began for pulpwood. Fires accompanied the early cuttings, and wildlife habitat expanded along with much brush land and open space. With the increase in suitable habitat, the snowshoe hare, ruffed grouse, and white-tailed deer populations all exploded. Market hunting toward the turn of the century reduced the deer herd until protection seemed the only answer. However, with continued cutting and fire into the 30's, the Wisconsin deer herd again increased until overbrowsing became the rule rather than the exception, and starvation was a frequent occurrence in severe winters. Not only did the winter habitat deteriorate, but in the last twenty years regrowth of timber stands has gradually eliminated much of the summer range.

During the years of high animal populations, conflicts between wildlife and forest management became severe. Excessive deer and snowshoe hare populations frequently consumed all the reproduction of commercial forest trees. Several preferred browse species were almost completely eliminated.

Present Habitat in Relationship to Forest Management Practice

Today the 19 more heavily forested counties of northern Wisconsin contain approximately 14,600 square miles of forest land, most of which is commercially operable. All of this area, plus about 2,000 square miles of adjacent farmland, is assumed to be deer range. Perhaps 10% can be considered winter range. Ruffed grouse range is roughly comparable to that for the white-tailed deer. Bear range is more limited, largely because the black bear gets into trouble easily when he associates closely with man. About 50% of the forest land is in public or industrial ownership, and hence susceptible to intensive management, while additional acres of private land are now or will be intensively managed.

Forest management today is much more sophisticated than it was 20 or 30 years ago. Some techniques are in wide use, for example clearcutting of aspen which results in sprout reproduction; selective cutting in northern hardwoods to improve quality and to encourage reproduction; planting, used at first to revegetate abandoned farms, burns, and poorly stocked lands and now to convert low-grade and inferior hardwoods to conifers; and finally, removal of unwanted species by mechanical or chemical means.

Detailed management plans are now in use, developed on the basis of forest inventory samples, aerial photographs, soil surveys, and ground examination. In some forest types, cutting cycles are being shortened, improvement and thinning cuts are made, and crop trees are selected for future harvest. Tractor and truck logging have replaced four-legged animals and railroad logging almost completely. All of this implies an increased investment in forest production.

The continued growth of the forest, improved fire control, and gradual replacement of pioneer species by natural succession have each drastically influenced forest habitat conditions. The acreage cut is now less than the acreage growing from seedlings and saplings into poletimber. In other words, large areas of brush and open land are disappearing and are being replaced by closed, pole-size stands of either natural or plantation origin.

Present forest management is doing much for wildlife habitat. Scheduling of logging operations in the winter months provides large quantities of deer browse. Sale of timber in sequential arrangements around winter deer concentrations, so that all is not cut within one or two years, is highly beneficial. In some public forests, openings are being left unplanted, and new openings are being created to the benefit of many wildlife species. However, much more can be done if the forest manager is convinced of the need.

The current situation is evident and reasonably well known; what then are the future prospects in forest management, and how will they influence habitat? We must look ahead and forestall, if possible, adverse situations which may reach a peak thirty to fifty years from now.

Future Trends in Forest Management

In discussing the future, we will first consider silvicultural methods and their influence on habitat without particular regard to economics. This will be followed by a consideration of possible changes in logging techniques and the overwhelming influence of supply and demand.

Silvicultural Techniques

Intensive forestry implies greater money input into each unit of land; and for this reason, intensive forestry will be concentrated on the more productive and accessible sites. Thus, part of the plan for the future will include detailed classification of sites for quality and quantity production.

Aspen. Management of aspen generally involves clearcutting. This frequently means that only the merchantable stems are clearcut, leaving a residual tree cover of poor-quality stems and of other species. Future management of aspen may involve a two-step clearcut to improve the quality of the clones left to sprout. A thorough job of clearcutting is essential for regeneration and is favorable for wildlife since the profuse sprout growth of the clearcut stand will furnish browse for several years and will provide early cover and later ample buds for ruffed grouse.

Planting and conversion. Planting has been an important management activity since 1913 when the first Star Lake Plantations were established. Over one million acres have been planted in Wisconsin. Much of the planting in the future will probably be on poorly stocked lands or those in need of conversion rather than on open lands, now in short supply. Conversion of aspen to conifers is increasing, and this trend may be expected to continue wherever the site has a higher growth potential for conifers than for aspen. Conversion usually involves planting conifers (white spruce, red pine, etc.) after a partial cut or other site preparation; this is followed in a few years by a release cutting or by killing the overstory of low-quality aspen and other species with herbicides. If large blocks are converted, increased uniformity may result. However, if accomplished in relatively small blocks in an otherwise uniform aspen area, conversion can increase diversity and provide needed cover both for deer and ruffed grouse.

Conversion is a variation on natural succession with the emphasis on pine or spruce rather than on a mixture of pine or balsam fir and tolerant hardwoods. Young plantations may function in effect as refuges in heavily hunted areas, since visibility for the hunter is very poor. There is a good possibility that increased conifer cover will serve to extend the winter range, now a major limiting factor for the white-tailed deer. With proper manipulation of vegetation around plantation boundaries, perhaps plantations can be substituted for browsed-out yards. Future plantations may be expected to carry fewer trees to the acre and will often be planted on a rectangular rather than on a square pattern. Frequent and wide firebreaks will increase the amount of edge.

Fire as a tool. The use of fire in preparing planting sites and in maintaining older stands is gradually increasing as techniques are developed. Fire has silvicultural advantages. It removes the old stems of hazel and other shrubs, reducing competition; it bares the soil, permitting the regeneration of trees from seed; and it releases minerals for rapid assimilation. Controlled fire may be beneficial in habitat management; it may result in vigorous and succulent sprouts, in the growth of weedy forbs, and in establishment of pioneer species. The type of fire and the burning conditions are of vital importance. A fire which runs slowly may burn deeply and kill most of the shrubs rather than merely eliminating the old tops. Wisconsin has had some success with fire as an inexpensive tool for sharptail grouse management; undoubtedly fire can be used more extensively.

Hardwood silviculture. Although not as evident, changes may also be expected in northern hardwood silviculture. Cutting in the past has varied from high-grading to selection silviculture in uneven-aged stands. For quality timber the trend is toward a shorter cutting cycle, with cuts at 10-year intervals, removal of stems of little merchantable value, and retention of crop trees, i.e. stems with desirable characteristics. This procedure is not necessarily beneficial to wildlife; it results in little major disturbance, removes den trees, and retains ground cover with little change. Future intensive management for high-quality sawtimber will probably follow this pattern, save where special steps are taken for yellow birch regeneration. Future management of such desirable species as yellow birch may even involve planting of selected high-quality stock derived from the forest genetics programs. In high-quality stands, management should be designed to protect regeneration from heavy animal populations; a combination of wise location and silvicultural manipulation will be needed. Other possibilities are evident, among them management of lower quality northern hardwood for hardwood pulp. This would shorten the rotation and be highly desirable for wildlife if cuts were made in small blocks. As another speaker pointed out, market conditions may shift as new processes evolve; for example, the demand for a particular spent-sulphite liquor product may even dictate the species chosen for pulping.

Trends in Forest Engineering

Equally important to silvicultural techniques are the methods used by the logger in removing timber. Most of us have seen the change from the use of ax and crosscut saw in felling and of horses or oxen for skidding to the chain saw and the caterpillar tractor. Raw-material extraction is still the most expensive operation in wood production, and methods are being devised to increase efficiency and, at the same time, reduce the waste left in the woods.

One possibility involves the use of trees to a smaller top diameter. In principle, utilization to a smaller diameter than four inches would not be detrimental to wildlife. In fact, if it involved tree-length logging, in which the tree is removed from the woods intact, there may be more disturbance of the soil surface and a resulting increase in reproduction both of trees and of herbs.

Development of an integrated harvest system may have considerable importance. In this system a tree snipper, capable of handling trees at least 12 inches in diameter, is mounted on a caterpillar tractor. When the tree is snipped off at the base it is lowered into place, limbed, cut up, barked, and chipped. Handling of the smaller limbs will be very important in regulating the supply of winter browse and of cover. The use of integrated logging equipment, particularly if wood is field chipped, might shift the cutting from winter to a year-round operation. This may cause more surface ground disturbance, but would seriously reduce winter food. At present a considerable portion of the winter diet of deer consists of fresh logging slash. Tops cut in the summer are of little value. The integrated logging machine may have habitat advantages in that, if reasonably mobile, it would permit sales in smaller units than at present. Larger equipment may mean more roads. Roads provide edge and roadside cover. Likewise, if roads are to be used at frequent intervals, they may be kept in shape by seeding and mowing, a practice now used primarily for ruffed grouse habitat improvement.

Today one of the major deterrents in the conversion of aspen to conifers is cost. Since a crop of conifer timber is more valuable than an aspen crop, work is beginning on improved equipment for site preparation and planting.

Some of the equipment being developed for site conversion may be useful in direct habitat improvement. Michigan has already made extensive use of the tree cutter, a sharp blade mounted on a heavy bulldozer. This machine is used to eliminate the overstory of unmerchantable aspen and produce browse; the sprouting that follows may also result in a merchantable stand of aspen in the second rotation. Improved equipment will accelerate some of the changes which influence habitat such as conversion to pine. But it will also permit more extensive manipulation of the forest with accompanying disturbance and the possibility that, with lower costs, both direct and indirect habitat improvement may be accelerated.

Supply and Demand

When everything is considered, the most important factors influencing habitat changes are economic. To a large extent, economic considerations control both the type of woods operation and the intensity of management. Management today has the problem of planning for the quality and type of product desired thirty to 100 years hence. To some extent, the supply available will condition the development. Presumably this is the case with hardwood pulp, now in more than ample supply. If the demand for hardwood pulp continues to increase, there will be benefits both to hardwood silviculture and to habitat. A larger pulpwood market will permit thinning of young poletimber and sawtimber hardwood stands. Likewise, it will permit more frequent pulpwood rotations in poorer stands and on sites where wildlife pressures make sawtimber management difficult, specifically along the edges of wintering areas.

What of the management and use of pine plantations and of stands which have been converted and are being converted to pine? A projection for Wisconsin indicates a continued increase in demand for wood. The trend, however, is toward use for pulp rather than for lumber, with possibly a drop in the market for pole and posts. Presumably this will result in shorter rotations or cutting cycles in most forest types including the plantations and converted areas. The increased frequency of disturbance resulting from shorter rotations usually should be beneficial to wildlife. However, young plantations are not highly desirable for wildlife; their greatest effectiveness as winter cover does not come until they have reached pole size.

We may assume that annual cutting will continue on an area at least equal to the current acreage cut. If the cut should decline, habitat will suffer. As with most generalities, this statement needs qualification. Hemlock in mixed hardwood stands provides winter cover for both grouse and deer and increases the diversity of an otherwise rather uniform forest type. Thus decline in the value and, hence-cut of hemlock is beneficial.

A major influence on habitat quality will be the size and scheduling of the timber sales. Present sales administration and increased equipment costs are gradually eliminating the small operators—sales are getting larger. Increased use of expensive harvesting equipment will probably encourage this trend. If harvesting equipment can be made sufficiently versatile so that small areas can be cut in any one location, the trend will not be unfavorable. This may be possible since a mobile and integrated unit should not require a local center of operations. Actually, the size of the sale is not important but rather how the sale is scheduled. If a large area of poletimber is to be cut in the space of two or three years, no variety in habitat is achieved. But a maximum variety can be provided with small sales or with larger sales to be cut over a long period. Larger operators generally build more roads, and the shortening of the cutting cycle to 10 years in many areas also requires better and more roads. Road building will go part way toward balancing the loss in diversity caused by cutting large areas. Once again the condition of the future habitat revolves around planning.

Much progress has been made in cooperative planning. In fact, adjustments in timber sale schedules have been one of the most significant contributions towards integrated forest-wildlife management to date.

Another area where planning and coordination is beginning to pay off is in the provisions being made for openings in the forest. With reduced need for maximum timber production (save on favorable sites) it would appear that more land will be available for the openings essential to most wildlife species.

Economic factors control the overall trend in land use. Forest growth is keeping ahead of demand in Wisconsin, though not far ahead. On this basis, it appears that only the more suitable sites (either from the point of view of tree growth, ease of management, or location close to the mill) will be managed intensively. In many areas it may be possible to release land from maximum timber production to allow management for wildlife.

To sum up the economic factors, it appears that forest management will become more intensive on selected sites within both public and privately held lands. In many of these areas, habitat requirements can be achieved with little impact on timber production; and, in fact, intensive management may be beneficial. In other areas, primarily in northern hardwoods, it will be desirable to reduce certain animal populations. Most other forest lands, not economically susceptible to intensive management, will be managed chiefly for pulpwood production at levels not much higher than those used today. On these large acreages the land manager should give considerable thought to coordination of uses. On public lands, at least, he can afford to sacrifice timber values if this will bring him a wildlife return. With the great interspersion of soils and forest types in northern Wisconsin, the areas of intensive management will frequently be located where they may serve as the nucleus of a habitat unit.

From the wildlife standpoint, the capability of deer production exceeds the foreseeable demand, and effort must continue to sell the product. Habitat management will not be justifiable unless adequate harvests, of big game in particular, are maintained and regulated by objective evaluation. Habitat for ruffed grouse and similar species needs to be managed in a concentrated fashion to improve utilization of the resource; here, classification of favorable areas and the dedication of those areas primarily to grouse management is necessary.

Conclusion

Can intensive forestry and game management succeed together? We conclude that they can, provided that those responsible for land management plan together. The outlook for the wildlife resource is far brighter with intensively managed forests than without.

LAND FOR LEARNING: A PROPOSAL FOR A STATE-WIDE OUTDOOR INTERPRETATION PROGRAM

James H. Zimmerman, School Forest Naturalist
Madison Public Schools

Since we have too few kinds of competitive land use, I propose another! Seriously, what I have in mind could be called "green spaces plus," or "land for learning," but the program, not the land, is the key feature.

It is only the availability of Wisconsin's natural resources that makes existence bearable for many Chicagoans; we have an obligation to society here. The rapid degrading of these resources will soon make vacationing a mockery —a waste of commuting time to and from a resort or cottage whose environment is exactly like that of Chicago. Permanent Wisconsin residents are equally, if not more, to blame, likewise failing to analyze what is valuable about their resources and joining the out-of-state visitor in this massive rape of the north which involves waterfront development, drainage, damming, filling, pollution, vandalism, pesticides, littering, noise, and picnic-table conservation. As local communities strive to broaden their tax base, their uniqueness disappears, usually irrevocably.

In seeking corrective action, I make an assumption based on my own limited experience: That it is only because of lack of opportunity to learn about the land and waters, their plant and animal life, and their human and geological history, that their values are unappreciated, and the cost and know-how of their maintenance unknown. Where good interpretation is offered, adults and children alike respond with great enthusiasm and respect for resource and knowledge. Not only Madison's School Forest but also our State Parks, where a serious interpretation program was recently begun, witness unmanageable crowds when tours and lectures are offered. The University must hide its information resources under a bushel, for it has no full time public service employees to handle the flood of inquiries that would result if it advertised its specialty personnel. Background information and interesting aspects of each field are available only to the graduate student. Integration of specialized fields is non-existent.

This proposal is simply that Wisconsin strike out boldly and vastly extend the National Park Service's policy of providing well-trained, skilled interpreters for public education-recreation, so that, no matter where a resident or visitor went outdoors, he would meet not just the resource but also a flesh-and-blood person to tell him about it. On public and private lands alike, the user and visitor would have available interesting and basic information, and be able to have his questions answered on the spot. The interpreter must be interested in the subject, able to apply basic understandings to specific instances encountered, and explain principles and processes in simple terms. True stories about plants and animals, including the interpreter's own experiences; separating fact from fancy; tips on how to look for and detect living things and deduce history; areas where knowledge is lacking and amateur detectives needed; these are some of the interpreter's stock in trade. He must walk the narrow line between the "big show" P. T. Barnum and the "big word" professional show-off; he must take the audience into his confidence and above all get them interested in pursuing the matter of learning further on their own. Special attention should be paid to adults, to encourage family-unit learning. There must be enough interpreters so they will not be overworked nor the audiences too large.

The three requirements of this program, needing simultaneous development, are training, employment, and coordination: (1) Undergraduate and graduate majors in land-heritage interpretation in our state college system, with stiff requirements in breadth and depth, accelerated through in-service research-teaching jobs, supported in part by user fees that will insure quality and interest by trainee and audience alike, operated on both public lands and private, wherever natural resources and considerable public use coincide.

(2) Good-paying permanent full-time employment in state, county, and municipal parks, resorts, campgrounds, youth camps, school districts, and so forth, to attract the most capable people away from indoor jobs. In winter, the senior interpreters and naturalists would be kept busy training other naturalists and school teachers at workshops, while the rest went back to school or held other jobs. Summer work for all must include time for rest and pure research, as well as technique improvement and contact with other interpreters. Locally-initiated "heritage centers", financed jointly by private and public funds, would be a good way to start. While professional interpreters are being trained, many persons with good backgrounds of knowledge and communication experience should be enlisted now so that no public education opportunities will be lost. Conservation Department men, school teachers, and retired people with long field experience or hobbies should be enlisted or given more time off from other duties in their present work.

(3) State-wide coordination to integrate training facilities, maintain high quality and uniform user fees, advertise opportunities for interpretive services to the traveling public, place qualified personnel, direct attention to unfilled needs, and pool information sources for both the working interpreters and the interested public. People should be encouraged to ask questions about any subject relating to the land, its life and history, and be given good answers by the appropriate specialist so that the interest is built upon rather than discouraged. In time, a series of informative publications would grow out of this; the most-asked questions would be answered by these pamphlets. Newsletters, both for the public and for the working interpreters, would be very useful. A coordinating committee might well be begun by the Wisconsin Academy, with Conservation Department and Resort Owners Association and other agencies represented too.

What do I mean by interpretation? Here are a few examples, drawing on plant material mainly; the same can be done with zoological and geological subjects, and, most important, relating all the pertinent fields into a unified story. Interpretation falls into three general categories: (a) *Introduction* (perception and identification), which must include the "why". This is a black oak tree *because* the black-red oak group differs from the white-bur oak group in having sharpt-tipped lobes on its leaves and because the black oak differs from the red oak in having fuzzy, later very shiny, leaves, with "pinched-in" lobes. The importance of identifying oaks is that each has different tolerances and requirements and behavior. Basic structure indicates long-term evolution from certain common ancestry; thus the main lines of descent are indicated by the oaks, the violets, the canine mammals, the squirrels, the ladybird beetles, or the cob-weaving spiders. But in each geological period, including the present one, short-term rapid diversifying evolution of each group, under natural selection tending to reduce competition, results in different species exploiting different ecological situations and becoming recognizable by small structural differences which accompany the behavioral ones. Thus both structure and site aid in identification, and both mean something.

(b) *Relationships,* which include three types of ecology—life history, natural communities, and changes in time. Structure and function of a tree trunk's parts are revealed by the location of the first fungi that attack a felled oak log—eating the easily-digested sugar that was stored in the sapwood and soft bark layers. Oaks form natural communities (assemblages of plants and animals that coexist without a caretaker) in which specific (indicator) trees, herbs and animals are mutually tolerant and often interdependent. The older open-growth oaks indicate the youth and short life history of many present oak stands. Multiple-trunked oaks indicate the origin of many Southern Wisconsin oak stands from fires set by Indians and stopped by white settlers. Old (light-loving) pines overtopping shade-tolerant hemlock-yellow birch-sugar maple forests in Northern Wisconsin likewise reveal behavioral differences that cause plant succession and show the relation of fires and availability of seed trees to the course and cause of succession. Forest composition also relates to the occurrence of tip-ups, good seed years, and the intensity of deer browze. Boy Scout "survival" plants like Solomon's seal has an astonishingly slow growth rate as compared to corn; the difference, explainable by examining the types of natural communities in which each evolved, in turn explains why modern civilizations, by exploiting the "ecological weeds", enjoy high population densities and suffer from high soil erosion rates as compared with primitive peoples that did not have the tools to work the land. Crab spiders on flowers illustrate not only protective coloration for successful ambush of prey, but also show how "eating" (re-use and cycling of space, materials and energy) permitted life to diversify further without increasing the carrying capacity of the land.

(c) *Management* of land resources, which involves understanding the economics of productivity and renewal. Woodpecker holes in dead trees illustrate the fact that, due to energy leakage, there is a limit to the length of food chains and food webs and hence to the mass of life supportable by even the richest land; and that management of land (defined as attempting to obtain maximum production of a single land product) must be at the expense of other products and hence requires zoning. You can no more manage a forest simultaneously for wood production and for woodpeckers and other wildlife dependent on dead wood for food and dens than a farmer can manage land for corn and alfalfa simultaneously in the same field. Examples of successful zoning involving more than one landowner and the cooperation of many persons is the fencing of Mt. Vernon Creek by Paul Olson's four-week summer work-learn program for high school boys. The boys obtain experience and course credit in return for contributing the labor. The farmer is spared bank erosion of his pasture land and the need to wash his cows of mud, in return for applying for federal funds to buy the fence materials. The angler can use a land product whose space requirement is too negligible to compete with farm food production. (Incidentally, the uncatchability of the trout that hatched after stream improvement here was an unexpected bonus in the way of "multiple" land use; many anglers were able to "enjoy" each trout!) Many other situations of land waste and conflict of land use cry for ingenuity in working out zoning to the benefit of all. One of the toughest and most crucial is watershed and waterfront planning to maintain unspoiled, diverse and semi-wild environments for people, at negligible cost in terms of land space, but very high cost in terms of cooperation of many interests. But let's have faith in people's good sense and ability. Show them the results of attempts at management—the failures as well as the successes—and give them the knowledge they need to work out the proper solutions that are in accord with the long-term natural processes and laws that run the world of life. Lands suitable for learning must include wilderness and scientific areas—each protected by a resident custodian-interpreter—but they must include all types of managed lands and waters too, with people with broad backgrounds available to interpret them.

The three aims of this proposed outdoor interpretation program, all urgent in point of time, are: (a) To raise, in 15 years (when perhaps half of the present natural resources will be gone) to a hopefully adequate 2%, the percentage of landowners, developers and users who take an active interest in their natural heritage and its maintenance cost. By an active 2%, I mean someone in every four city blocks who is qualified to answer questions intelligently, who works at cooperative land management and teaches others, who leads the community in the combined intellectual and emotional approach to land stewardship.

(b) To bring a new kind of tourist money into the areas having the most abundant natural resources and yet often the poorest economies, while using these resources in non-depleting ways, namely those related to education. This could easily become the most popular form of recreation yet devised.

(c) To provide food for thought and new horizons for starved lives and minds in this new age of freedom from the slavery of labor, and help raise scholarship and knowledge to the deserved rank of status symbol as the distinctive quality of man.

We have the intense interest in nature which people are born with. We still have the resources that could inspire people. On-the-spot interpretation, available to all, is the vital link that can bring need and opportunity together, if done soon enough, and well enough, and on a large enough scale.

THE NORTHERN WISCONSIN SETTLER RELOCATION PROJECT, 1934–1940

L. G. Sorden, Assistant to the Director
Agricultural Extension
University of Wisconsin–Madison

The era from timber to tinder to trees brought overwhelming problems and difficult adjustments in Northern Wisconsin. The important adjustment took place in the minds of men. But that was slow in coming.

Let's go back to the end of the logging period—that was in time of destruction by fire of the cut-over. We the people let fires destroy more of our timber resources than loggers ever destroyed. This era was black on the landscape and black in spirit. It was complicated by depression and drouth.

The first signs of change in the minds of men came with the acceptance of an educational program carried on under the leadership of the Agricultural Extension Service and other public and private agencies.

Then came in increasing tempo the development of National, State, County, School, Community, industrial, and private forest—the CCC Camps—providing equipment and manpower to stop forest fires—the taking of tax deed by the counties to stablize ownership—the tree planting program—the enactment of county zoning ordinances which classified land into its best use and kept man off non-productive agricultural land—and the removal of some of the non-conforming users, isolated settlers living on submarginal land under the county zoning ordinance.

By 1940, twenty-four Northern Wisconsin counties had restricted five million acres of land against future agricultural settlement.

This paper concerns itself with the first 299 cases of 416 isolated settlers whose holdings were purchased and the families relocated under the Resettlement Administration Program called the Northern Wisconsin Settler Relocation Project. This project was carried on from 1934 to 1940. These 299 families all lived in the seven counties of Bayfield, Florence, Forest, Langlade, Oconto, Sawyer, and Vilas. The total program was carried on in twenty northern and central Wisconsin counties. Individual counties removed about 200 isolated settlers through purchase or trade in addition to this Federal program.

Here are some of the conditions under which these families existed. One family lived eighteen miles from a school, a market, or a road that was snow plowed during the entire winter period. Their two sons were boarded out at public expense to attend school. In three different families, mothers taught the children at home as there was no school in the vicinity. One mother of two bright boys did not see another woman for a four month period. In several cases the schools operated for only one or two families. One widely published incident related the death of a woman in an isolated area during a severe snowstorm. A trapper reported the death and a county employee on snowshoes hauled out the body on a toboggan twelve miles for burial. One community of about ten families cost the county $35 each time a doctor was called. They lived thirty-five miles from the nearest doctor and it cost $1 per mile for the doctor to call.

While these and many other similar cases were some of the worst, all the settlers whose farms were purchased were living on submarginal land which was either too light and sandy, too stony and rough, or so isolated from markets that they were definitely uneconomic farm units. In some of the counties, as many as 80% of the families whose farms were purchased received public aid.

In Forest County, 124 tracts were purchased for $99,268. In the five-year period prior to May 1, 1937, this group of people received, in direct relief, $52,000 plus $25,000 from the WPA for a tota lof $77,000. Adding commodities and other emergency relief costs would more than equal the purchase cost of the land of the isolated families.

Not all of the people whose holdings were purchased became self-supporting. From the information available, however, it is estimated that at least one-half of those originally on relief become self-supporting.

In addition to the purchase of the submarginal farms, a resettlement program was carried on to assist these families in relocating to better farm land in established communities. The Land Buying Program preceded the Resettlement Project. About 45% of the settlers moved from their farms before the resettlement work was started. Prior to that time, however, considerable help was given their families to help them find new locations. Somewhat less than one-half of the families whose farms were purchased were actual farmers or had a background of farming experience. Only 38% relocated on farms to make their living from the soil. Fully one-third of the families were too old for farming, or for industrial occupations. A few returned to industrial centers and obtained work similar to that which they were doing before moving to northern Wisconsin.

The following is a tabulation of the occupations in 1938 of the relocated families:

114—Farming
20—Woodworking
67—General Labor
47—Retired
7—Resort Work
23—Business—largely mercantile, but includes 2 school teachers
4—Conservation work
6—Deceased
11—Not yet moved from the land

299

Of the 299 families living on the land at the time it was optioned, forty-three moved to other states, and the remainder relocated in Wisconsin. The number going to other states was as follows: Indiana, eleven; Oregon, eight; Michigan, five; Washington, four; Minnesota, three; Ohio, three; Alaska, two (Matanuska Colony); Illinois, two; California, two; Iowa, Kentucky and South Dakota, one.

A surprisingly small number returned to the locality in which they originally lived before moving to their submarginal farm. On one project, almost one-half of the lands purchased were owned by people originally from Kentucky who had come here to work in the woods. At the time the land was optioned, most of them indicated that they planned to return to their native state, but when they finally relocated only one family returned to Kentucky.

Definite assistance was given in relocating 123 of these families. Resettlement farms were provided for twenty-five, and eighteen were provided temporary loans from the Wisconsin Rural Rehabilitation Corporation to purchase farms or homes until they received the money from their submarginal farms.

The resettlement farms were located and appraised by the project staff. The prospective resettlement family was shown a number of these farms and chose the one most to their liking. Money for the purchase of the farm was loaned by the Farm Security Administration, rather than the Government taking title to the farm. All of the twenty-five resettlement farms were purchased from families who wished to retire because of age or disability, or where farms of estates were being closed. In no case was the family on the farm inconvenienced by the purchase.

In addition to the real estate loans, funds were also loaned to make minor repairs on buildings and to purchase livestock and machinery, to establish an economical income-producing farm. Most of the families had some livestock and machinery and some had a small amount of money from the sale of their submarginal farm, which was used as part repayment on the real estate or chattels. The average price of the resettlement farm was slightly under $3,000, and the average chattel loan about $1,000, making the total debt about $4,000. With the supervision given in their farming operations, most of these people succeeded on their new farms.

In order to take care of those people who were too old or were physically handicapped and therefore incapable of caring for themselves, nine "Retirement Homesteads" were constructed. All of these houses were occupied by people who presented serious medical and relief costs in their former locations. Three of the houses, located at Antigo, were completely modern and built at a cost, including land, of less than $2,400 each. Six of the houses, in Crandon, were less modern and were built at a cost of less than $2,000, including land. All were well constructed and had three or four rooms.

Funds for the construction of these "Retirement Homes" were furnished by the Wisconsin Rural Rehabilitation Corporation, a predecessor of the Farm Security Administration. An annual rent contract was signed by the counties affected whereby they agreed to pay 3% of the construction cost per annum, plus necessary repairs. This provided a good comfortable home at a cost of less than $7 per month for the county. At the Crandon unit, a small barn was constructed to house milk cows owned by the families. Sufficient land was furnished to provide a large garden for each occupant. The people occupying these houses took excellent care of them and at that time they all indicated contentment in their new homes.

In addition to those given financial assistance, eighty submarginal land families were assisted in finding new locations. Farms were found for many of them, on which they used the proceeds from the sale of their submarginal land to make a down payment. In a few cases, credit was arranged for them to make the purchase of either a farm or a home in town. Most of this credit was in loans from local banks, until such a time as they received their submarginal land purchase money. More than one-half of the families had plans of their own and made re-adjustments, although most of these counseled with the project staff.

In all areas of purchase the local county and town officials cooperated in making most of the decisions as to which settlers should be relocated.

Since these submarginal farms had little production value, arbitrary values for appraisal purposes had to be established. Buildings were appraised on a square foot basis depending on the type of construction—cleared land so much per acre depending on quality. United States Forest Service values were used for cut-over land. Timber was appraised separately. No land was optioned in excess of the appraised value.

On the average, $1,000 was paid per farm. These "farms" ranged from a tar paper shack in the woods to a few quite well developed farms. The land purchased by this project was later transferred to the Federal, State or County, depending on its location and is being used for productive forestry.

The question most often asked about this project was—were the people willing to sell? When the project was explained and when the families were given time to think it over and talk it over with other people in whom they had confidence, 98% of these isolated sellers were willing to sell and relocate.

The results of this Isolated Settler Relocation Project made possible immediately a saving in school costs of more than $15,000 per annum by closing twelve rural schools. In addition, several thousand dollars worth of school transportation cost was eliminated. Road costs were reduced by the elimination of maintenance and snow plowing. Relief costs were cut materially by placing many of these families in a position to make their own living.

More important, however, than these financial savings to local and state government, was the renewed hope given to these people by their removal from isolated areas to established communities where they and their families had a chance to start over again with a more secure financial and social future.

DETERGENTS IN WISCONSIN SURFACE WATERS

Gerald W. Lawton, Professor of Preventive Medicine
State Laboratory of Hygiene
Theodore F. Wisniewski, Director
Richard Zimmerman, Chemist
State Committee on Water Pollution

Detergents are defined as substances that aid in the removal of dirt[1]. Until recent years, soaps were the universally used detergents for most cleaning purposes. Synthetic detergents have now displaced soap as the common cleaner and represent over seventy-five per cent of detergent sales[2].

Synthetic detergents were produced experimentally in France before the middle of the 19th century and were further developed in Germany during the first World War[1]. Not until the 1930's were chemical processes developed which made production in quantity feasible in any country. A variety of these surface active agents, often called surfactants, are now produced. They are classified as non-ionic, cationic, and anionic detergents. The latter are most widely used as laundry detergents, and are mainly sodium salts of alkyl benzene sulfonate (ABS). They may be represented by a typical formula such as $C_{12}H_{25}—C_6H_4SO_3Na$. The alkyl group varies but usually consists of a branched chain of 10–15 carbon atoms. The type of carbon chain is the important factor which determines whether the compound may be degraded or broken down biologically. In general, a non-branched chain is readily biodegradable, a branched chain is less degradable, and if a tertiary carbon exists at the end of the carbon chain the detergent is practically non-degradable[3], $(CH_3)_3C(CH_2)_8—C_6H_4SO_3Na$. The finished detergent as marketed, also contains "builders" such as polyphosphates which aid in soil suspension and hardness sequestering.

During the past year there has been considerable agitation to ban the sale and use of the "so-called" non-degradable detergents. The 1963 Wisconsin Legislature enacted into law a bill prohibiting the sale and use of non-degradable detergents containing alkyl benzene sulfonate on and after December 31, 1965[4]. A similar bill was introduced in the last session of the United States Congress, but no final disposition of it has been made. Dade County, Florida, has banned the sale and use of these detergents. Several states have considered similar action.

The Soap and Detergent Association has promoted several study groups to determine the effects of detergents in water. One such study is being carried out at the University of Wisconsin, College of Engineering. The data presented in this paper were obtained at the State Laboratory of Hygiene in close cooperation with the above study. Detergent manufacturers have developed linear alkylate sulfonate (LAS) detergents that are appreciably more degradable than the ABS type. They are presently becoming available in limited quantities. It is expected that by December, 1965, essentially all of the detergents on the market will be of the more readily degradable type.

ABS type detergents have produced a number of problems as their production and use increased. The major problem is associated with the foaming caused by the surfactant in water supplies, in rivers, and in sewage as it is being treated. It is not unusual in activated sludge sewage treatment plants to have huge banks of foam develop along the aeration tank. On windy days, the foam frequently blows about the area, leaving a grease coating wherever it lands. Some rivers which have an appreciable detergent content develop considerable foam at falls or rapids areas. For example, along the Rock River at Beloit in 1963, masses of foam were observed blowing about at a distance several hundred yards from the river. Water from many private wells will foam profusely when shaken or when discharged from the tap, mainly due to the presence of detergents.

The United States Public Health Service[5] recommends a maximum of 0.5 mg/l of ABS in drinking water. At that concentration no appreciable foam will develop; and no taste or odor is detectable. Walton[6] notes that the odor of ABS is seldom detectable at concentrations less than 1000 mg/l and that only very sensitive individuals can taste it in water at concentrations of 16 mg/l. Fifty per cent of a panel were able to detect the presence of ABS in water at 60 mg/l[7]. Studies on man and animals have shown that they can tolerate relatively high concentrations of ABS in their drinking water without ill effect[8].

Nichols and Koepp[9] found that in Wisconsin private shallow well, 32.1 per cent showed the presence of detergent. They noted a high correlation between unsafe waters and detergent content, and suggested that the presence of detergent in a well's water might be a possible indicator of the presence of virus in that water. The finding of detergent in a ground water supply is evidence that waste water or sewage is entering the well, and warns the user that a problem exists or is developing.

The State of Wisconsin Committee on Water Pollution and the State Laboratory of Hygiene have been carrying out a monthly monitoring program of Wisconsin surface waters at 37 locations for several years. In January, 1963, the determination of detergents (ABS) was included in this program. The data presented here cover the period through March, 1964. The stations selected for this program generally are near the mouth of the stream or near the border of the state, as shown in Figure 1. One station is located on Lake Michigan near Carrolville. A list of the stations and their locations are given in Table 1.

The analytical procedure for detergents in this study is a modification of the methylene blue method given in "Standard Methods for the Examination of Water and Waste Water"[10]. This method is based on the formation of a blue salt when methylene blue reacts with anionic surfactants. The salt is soluble in chloroform, and the intensity of the blue color is proportioned to the concentration of the surfactant. The color intensity was measured spectrophotometrically. Various substances that occur in water may interfere in the test. Most interfering substances produce positive errors; thus results are in all probability greater than the true value[11]. For that reason ABS data are here expressed as apparent ABS. The minimum concentration detectable by the procedure as used is about 0.03 mg/l.

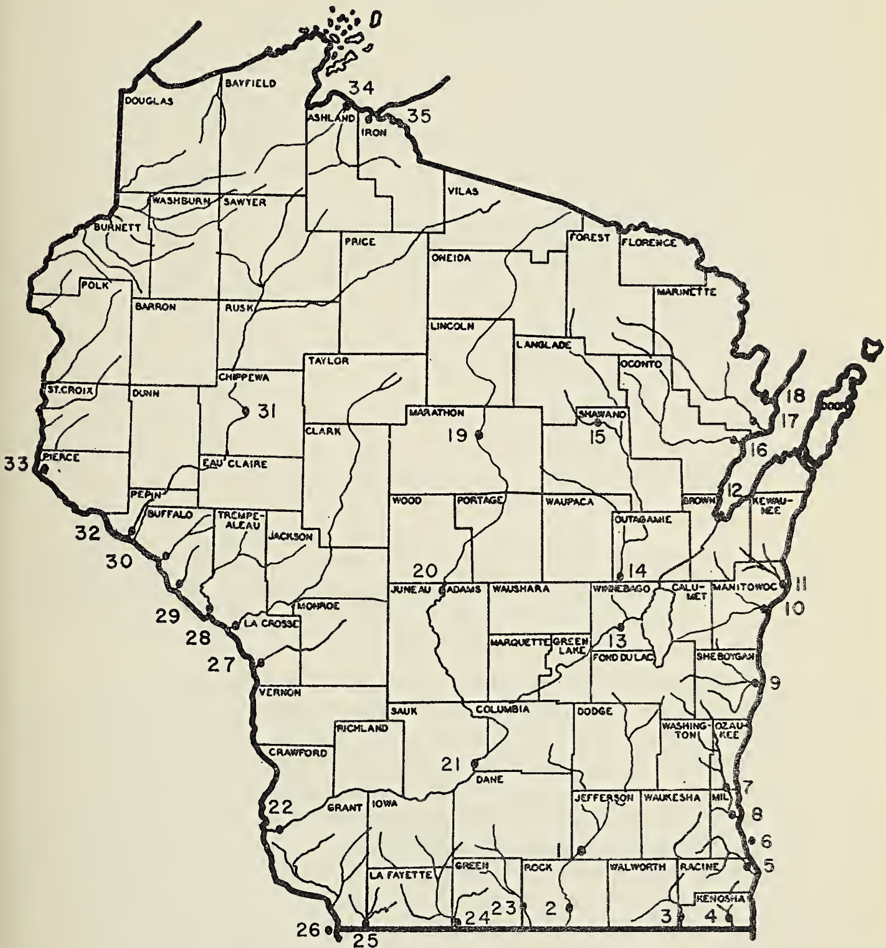


FIGURE I-MONITORING STATIONS

Table 1. Monitoring Stations

1. Rock River, west side about 1 mile above Lake Koshkonong.
2. Rock River, town bridge at Afton.
3. Fox River, C.T.H. "C" bridge at Wilmot.
4. Des Plaines River, C.T.H. "C" near Pleasant Prairie.
5. Root River, State Street bridge at Racine.
6. Lake Michigan, Carrollville water intake.
7. Milwaukee River, Brown Deer Road North of Milwaukee.
8. Milwaukee River at Milwaukee near mouth and junction with Kinnickinnic River. Composite sample.
9. Sheboygan River, 8th Street bridge at Sheboygan.
10. Manitowoc River, U. S. Highway 10 at Manitowoc.
11. East Twin River, Highway 42 at Two Rivers.
12. Fox River, Highway 54 at Green Bay.
13. Fox River, Highway 21 at Omro.
14. Wolf River, Highway 10 at Fremont.
15. Wolf River, town road at Neopit.
16. Oconto River, Highway 41 at Oconto.
17. Peshtigo River, Highway 41 at Peshtigo.
18. Menomonee River, upper dam at Marinette.
19. Wisconsin River, Highway 51 bridge or dam at Wausau.
20. Wisconsin River, Petenwell Dam near Necedah.
21. Wisconsin River, Prairie du Sac Dam.
22. Wisconsin River, Highway 35 bridge at Bridgeport.
23. Sugar River, C.T.H. "T" near Brodhead and Illinois border.
24. Pecatonica River, C.T.H. "M" near Browntown and Illinois border.
25. Galena River, C.T.H. "W" between Benton and Illinois border.
26. Mississippi River, Lock and Dam #11.
    a. Gate 1—Iowa side Dubuque.
    b. Gate 7—At center of river.
    c. Gate 15—Wisconsin side of river.
27. La Crosse River, Highway 35 at La Crosse.
28. Black River, Highway 35 near Galesville.
29. Trempealeau River, Highway 35 near Centerville.
30. Buffalo River, Highway 35 near Alma.
31. Chippewa River, dam at Chippewa Falls.
32. Chippewa River, Highway 35 near Pepin.
33. St. Croix River, Highway 10 at Prescott.
34. Bad River, Highway 2 at Odanah.
35. Montreal River, Highway 122 near Saxon on Wisconsin–Michigan border.

ABS concentrations were obtained each month at each station with a few exceptions. A summary of the results are shown in Table 2. The mean value, the range, and the frequency that the USPHS standard was exceeded are shown for each station for the fifteen month period.

Of 502 samples examined, only 17 showed concentrations above the USPHS drinking water standards. This number represents only about three per cent of all samples. The Root River, which flows from near Hales Corners to Lake Michigan at Racine, showed consistently high concentrations of ABS, with values ranging up to 3.1 mg/l. This stream receives considerable treated and untreated sewage, which readily explains the high detergent concentrations. Omitting the Root River from consideration, only six samples have ABS concentrations above 0.50 mg/1, or slightly over one per cent. Seventy-eight per cent of the stations showed ABS concentrations of less than 0.3 mg/1 at every sampling, while 83 per cent had average concentrations below 0.2 mg/1.

The Milwaukee River, which flows through a heavily populated area, shows an ABS concentration at Brown Deer which exceeds drinking water standards only two times during the sampling period. At the sampling station in Milwaukee, the concentration did not exceed 0.5 mg/1 in any sample.

The small streams in lightly populated areas generally contained very low concentrations of ABS, as expected. The Mississippi River which highly dilutes the entering wastes showed relatively low detergent concentrations, with maximum values of only 0.26 mg/l.

TABLE 2. APPARENT ABS CONTENT OF WISCONSIN SURFACE WATERS

	Range mg/l	Ave. mg/l	Per Cent of Samples Exceeding USPHS Standard
1. Rock R. above L. Koshkonong	0.14–0.56	0.26	7
2. Rock R.—Afton	0.14–0.87	0.36	7
3. Fox R.—Wilmot (Ill.)	0.12–0.40	0.22	0
4. Des Plaines R. near Pleasant Prairie	0.03–0.32	0.07	0
5. Root R.—Racine	0.32–3.1	1.14	73
6. L. Michigan—Carrollville	0.03–0.08	0.04	0
7. Milwaukee R.—Brown Deer	0.03–0.68	0.28	14
8. Milwaukee R.—Milwaukee	0.03–0.48	0.27	0
9. Sheboygan R.—Sheboygan	0.03–0.26	0.12	0
10. Manitowoc R.—Manitowoc	0.03–0.12	0.06	0
11. East Twin R.—Two Rivers	0.03–0.18	0.10	0
12. Fox R.—Green Bay	0.08–0.20	0.14	0
13. Fox R.—Omro	0.03–0.12	0.06	0
14. Wolf R.—Fremont	0.03–0.12	0.05	0
15. Wolf R.—Neopit	0.03–0.06	0.03	0
16. Oconto R.—Oconto	0.03–0.26	0.13	0
17. Peshtigo R.—Peshtigo	0.03–0.08	0.04	0
18. Menomonee R.—Marinette	0.03–0.12	0.04	0
19. Wisconsin R.—Wausau	0.04–0.19	0.11	0
20. Wisconsin R.—Necedah	0.03–0.55	0.15	7
21. Wisconsin R.—Prairie du Sac	0.03–0.48	0.12	0
22. Wisconsin R.—Bridgeport	0.03–0.18	0.07	0
23. Sugar R.—near Ill. border	0.03–0.14	0.06	0
24. Pecatonica R.—near Ill. border	0.03–0.08	0.04	0
25. Galena R.—near Ill. border	0.03–0.26	0.06	0
26a. Mississippi R.—Iowa side	0.03–0.18	0.07	0
26b. Mississippi R.—center	0.03–0.16	0.07	0
26c. Mississippi R.—Wis. side	0.03–0.26	0.08	0
27. La Crosse R.—La Crosse	0.03–0.18	0.06	0
28. Black R.—Galesville	0.03–0.08	0.05	0
29. Trempealeau R.—near Centerville	0.03–0.08	0.04	0
30. Buffalo R.—near Alma	0.03–0.10	0.04	0
31. Chippewa R.—Chippewa Falls	0.03–0.10	0.05	0
32. Chippewa R.—Pepin	0.03–0.10	0.06	0
33. St. Croix R.—Prescott	0.03–0.10	0.05	0
34. Bad River—Odanah	0.03–0.06	0.04	0
35. Montreal R.—near Saxon	0.06–0.14	0.10	0

A typical example of the gradual decrease in the ABS content of a stream due to dilution, degradation, absorption, and other causes is found in the Badfish, Yahara and Rock Rivers. The Badfish River receives the sewage plant effluent from the Madison metropolitan area. This waste is pumped to an open ditch and permitted to flow into the Badfish River. Various small streams enter the Badfish before it empties into the Yahara River. The Yahara, in turn, empties into the Rock River. The detergent contents in these streams are indicated in Figure 2. The value at each station represents the mean ABS content in mg/l during the study period.

For a short distance below its junction with the Badfish River, the Yahara has a relatively high average detergent content, 1.18 mg/l. As the Yahara empties into the Rock River, the value drops to an average of 0.36 mg/l and gradually decreases as the water moves downstream.

It is interesting to note that the ABS content in the Madison Metropolitan Treatment Plant effluent decreased appreciably following the completion of additional aeration facilities about midyear, 1963. Prior to that time, the mean ABS content over a five month period was 5.1 mg/l, and following the expanded operation it dropped to 3.3 mg/l. The stream waters generally reflected the reduced detergent load at the various sampling stations.

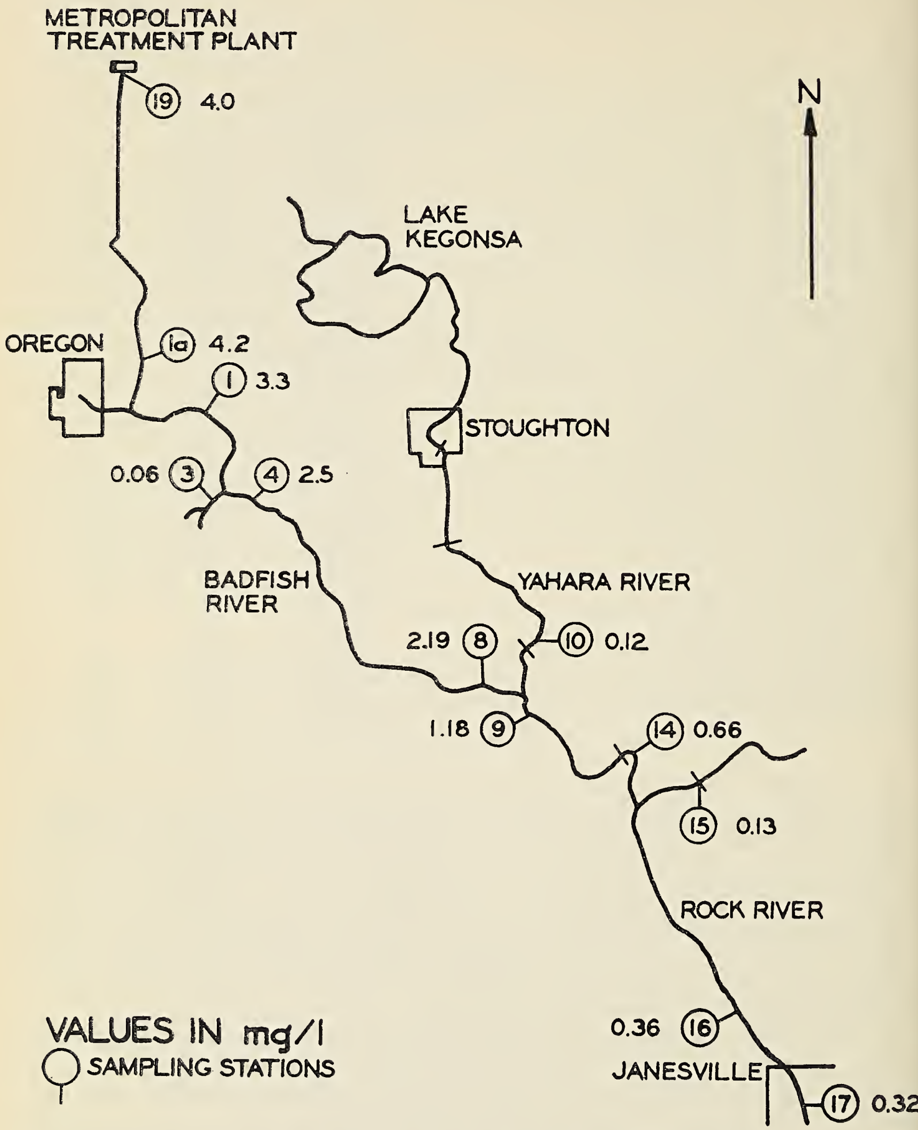


FIGURE 2– ABS CONTENT IN BADFISH, YAHARA AND ROCK RIVERS

Responsible representatives of the Soap and Detergent Association have given assurance that the detergents being marketed by the end of 1965 will be bio-degradable, mainly of the LAS type[12]. As the percentage of bio-degradable detergent increases during the next twenty months, the detergent content of our streams should materially decrease. The LAS detergents are not expected to be completely degraded before they reach our streams, but their breakdown will proceed as they move downstream; thus no appreciable build-up should occur.

The detergent problem is but one of many pollution problems. Concerted effort to reduce these problems are a necessity if we are to maintain our streams and other water supplies in a satisfactory condition.

Summary

1. Only the Root River in the monitoring program shows an ABS content that is consistently above the accepted drinking water standards of 0.50 mg/l.

2. The mean detergent contents of 97 per cent of the streams in this program are below 0.4 mg/l.

3. The ABS content of our streams will decrease as the biodegradable detergents replace the present type.

4. No health hazard has been found in Wisconsin surface waters due to the presence of detergents.

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FORTY YEARS AMONG THE TREES

Edward W. Blackford
Wisconsin Tree Expert Company
Wausau, Wisconsin

It is with some reluctance that I present this paper because of the personal references. However, after more than forty years of work with shade trees, it is hoped that some of these observations and experiences may be of interest to persons who make a living from trees, pursue a hobby or scientific study of trees, or merely appreciate their aesthetic value.

Within the span of more than forty years of shade tree work, a considerable evolution has taken place. In 1923, shade tree crews traveled largely by Model T touring car, with pole saws tied on the side and tool box strapped on the running board, often traveling a hundred miles or more between jobs. Ladders were not used by tree men of the old school, not until about 1930. Every day and every tree was part of a physical fitness program. A rope was tossed over the first limb on the tree and the rope was climbed, sixty feet being not uncommon. I surmise that some tree owners had their trees cared for in order to witness the agility of the workmen. It is feared that now there may be some evolution in reverse.

Early shade tree workers were usually referred to as tree surgeons and their work as tree surgery. These terms still follow us to this day. Much tree work then consisted of cutting out decayed areas and filling the cavities with concrete. Chiselling may be a more accurate term, in that it was too often done to the tree owners as well as to the trees. The additional bolting and cabling made necessary by extensive excavation often brought the total cost per tree up to hundreds and even thousands of dollars, and that in pre-inflationary days. Shade tree crews seemed to vie with one another for the dubious honor of putting the most concrete in one tree. The writer recalls working on one large oak on an estate in Washington, D.C., now known as Dumbarton Oaks. This particular oak had a filling of concrete made up of 102 sacks of Portland cement, a little over two parts of sand, and a large number of boulders. Approximately 500 feet of rod and 2000 feet of cable had previously been applied. The present condition or existence of the tree is unknown.

Much of this extreme, so called tree surgery, brought discredit to the work. The writer and his colleagues eventually found that in reaching a larger clientele of middle class people, and overcoming an economic condition of the nineteen thirties, preventive care made the average tree last longer than it would have with extensive surgery, and also at much less cost. They were protected from insects and disease. When they were structurally weak, they were bolted or cabled to protect them from being destroyed in a storm. They were kept healthy. This is the basic principle of good tree service today, although diagnosis and treatment have technically advanced.

After training and apprenticeship in most of the states from Texas to New England, it was the writer's good fortune to gravitate to Wisconsin in the spring of 1930, and the privilege of working on the trees in Capitol Park and at the Governor's Residence in Madison. In the course of this work, which consisted largely of pruning, it was noted that several Pin Oaks on the north side of the Capitol Building were suffering from iron deficiency chlorosis. The leaves were a pale yellowish green, with darker green along the veins. A test of the soil around the trees showed an alkaline condition. Upon inquiry into the history of these trees, we found that when they were planted some years before, horse manure had been placed in the bottom of the planting holes. This had aggravated an already alkaline soil. Iron in the soil had been tied up in an insoluble ferric form and unavailable to the trees. We decided to inject a ferrous sulfate solution directly into the trunks of the trees. A solution of one ounce of ferrous sulfate in one pint of distilled water was injected into four ⅜″ holes near the base of these 6″ to 8″ Pin Oaks. Within ten days the leaves had a much darker green between the veins.

This was not a permanent thing because it did not change the condition of the soil, and it has not much present day application except to prove the need for an acid soil and available iron, as in soils where pin oaks are growing in their native habitat. A better long time approach would be to change the soil condition. It has been said that one gram of chelated iron around a tree provides as much usable iron as a pound of iron sulfate. Incidentally, iron chlorosis deficiency is not found to be a problem in Marathon County.

After several weeks in Madison, I received word from my firm to go to Wausau. Neither I nor my assistant knew of this place. After consulting a map and making inquiries, we found that Wausau was a good town. Among other things, it was reported to have thirty-four millionaires, all of whom in one way or another had made their fortunes from the products of the forest. However, I don't have any documentary evidence to support this statement. The large trees were gone and the whistles had blown for the last time on the big sawmills in Wausau.

We were intrigued by the remnants of a once mighty forest. Large logs lay where they had fallen, knots along the length of them, reminding one of stories of the bones of bison on the plains where wanton hunters had left them. My assistant wrote to his father who lived on the Rio Grande in Texas, and told him we were in Wausau, Wisconsin. His father wrote back that he had logged in the Wausau area when he was a young man of twenty-one, back in the eighteen eighties, mostly near Ringle. We went out there to see where his father might have helped cut the big pines fifty years before. One section particularly attracted our attention and speculation. The stumps were all about four feet high. Had these been cut during a winter of deep snow? Had they been cut by long legged lumberjacks? Had fire gone through many years before they were cut, leaving injuries and decay near the base? Or had this at one time been a swampy area producing trees with an irregular butt cut like the "knees" of the southern swamp cypress?

In this summer of 1930, we learned of the discovery of Dutch Elm Disease in this country. I have here a letter from the Davey Tree Expert Company, Kent, Ohio, for whom I worked, dated August 27, 1930, describing the disease, and asking us to send in any specimens showing symptoms. Also enclosed was a copy of a release by the Office of Forestry Pathology, Bureau of Plant Industry, United States Department of Agriculture entitled, "Dutch Elm Disease Found in America". Quote in part: "The Dutch Elm Disease was never found in this country until this summer when Mr. Curtis May, of the Department of Botany & Plant Pathology of the Ohio Agricultural Experiment Station at Wooster, Ohio, isolated Graphium ulmi from four wilting American Elm trees at Cleveland and from one at Cincinnati. So far, no common center has been found from which the disease has spread in this country. Scouting for the Dutch Elm Disease presents many difficulties because of the wilting of elms from other causes."

Since no mention is made of the scolytus beetle, it probably was not known then just how the disease was spread. Had everyone been diligent, this scourge might have been wiped out completely and millions of elm trees would be alive today. It is certainly one of the greatest natural tragedies since the passing of the passenger pigeon and the American Chestnut.

By learning from the mistakes and apathy of other states, and by the diligence and research of the University of Wisconsin and the Wisconsin Department of Agriculture, the State of Wisconsin has a good chance of saving most of its elms.

It is interesting to note that trees go through crises and times of stress. The drought years of the nineteen thirties were difficult years for trees. By 1935, tops and large branches were dying in hardwoods and hemlocks, nature's way of balancing the top or leaf area with the supply of moisture from the roots. While all of Wisconsin suffered from the drought, some areas appeared to be harder hit. In Barron County, along Highway 53, large groves of hardwoods had more dead wood than live. It may be well to also note here that when trees are weakened by drought, they are more susceptible to insect attack, both by leaf feeding and wood boring insects, and also by disease. In Barron County, in 1932, 1933, and 1934, canker worms denuded trees of their foliage in June as though it were late autumn. The attack seemed worse along the Red Cedar River and particularly bad on islands in Red Cedar Lake. In Marathon County, thousands of large hemlocks died. We may assume the drought to be the primary cause, and the subsequent ravishing by insects the secondary cause. Many trees of both hardwood and softwood species, dead and stag-topped, stood out as a stark reminder of the drought well into the forties.

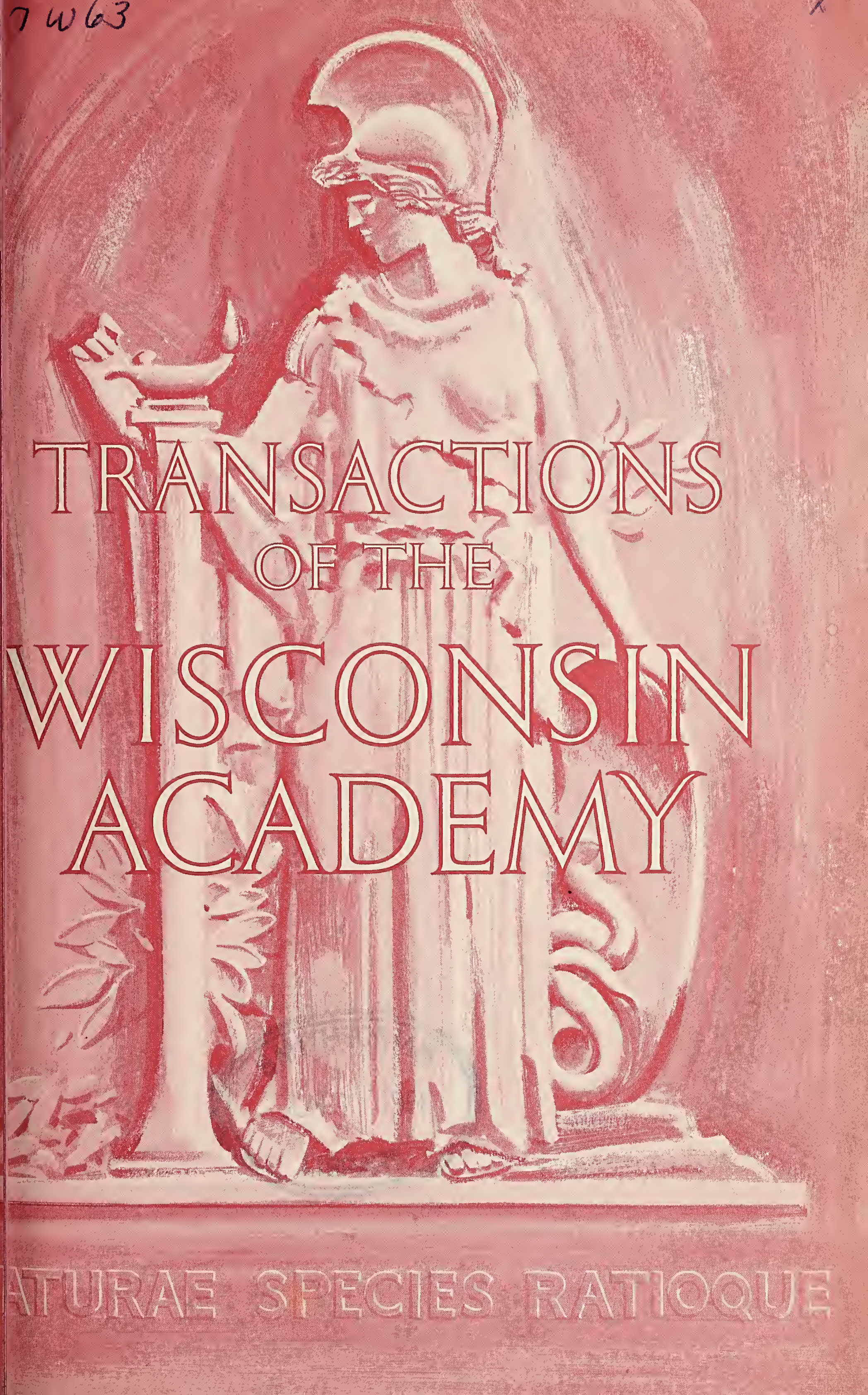
On September 8, 1939, Mr. C. C. Yawkey, famous Wisconsin lumberman, took me to one of his forest holdings about three miles south of Minocqua to show me the results of an unusual lightning strike. At that time, the National Shade Tree Conference was making a survey of lightning damage to trees. These notes are from that report:

> One Norway Pine and a small maple were somewhat shattered in the center of a circle of 110 feet diameter. Fifty-three pines in this circle were completely dead. At least a dozen more on the outer fringe of the circle were almost dead. None of these dead or dying trees showed any dying sign of physical injury. A number of small maples and birch within the circle were healthy. The dead trees had been healthy, as indicated by surrounding trees. They were about evenly mixed white and Norway evenly Pine, 12″ to 14″ D.B.H., 85 feet and up in height, and with a 10′ crown spread. The struck trees were small. The area was flat but slightly lower than the surrounding rolling area. The top soil was sandy loam,

with a gravel subsoil. It was 80 rods from the lake and any house. The caretaker of this pine forest first observed this in the spring of 1939 and presumed it had happened in the fall of 1938. He cut the dead trees in the winter of 1939–1940 and reported the number of 65, and all sound trees, except that they were dead.

It is interesting to note that some trees are seemingly immune to insect, disease, and man made forces. Such a tree, an elm, stands on the northeast corner of Third and McClellan Streets in Wausau. It is virtually surrounded by concrete and blacktop. In about 1940, a storm sewer was dug in the street and the roots were cut close to the tree on the curb side. It was predicted that this was the end of one of the most beautiful and healthy trees in town. However, it has remained vigorous throughout the years, probably due to some unknown source of food, water, and air supply to its roots. It leafed out late in the spring of 1963, but was one of the very last to lose its leaves in autumn. In this connection, reference should be made to the observation that all elms leafed out late in the spring of 1963. Although this was an early spring, judging from the above normal temperatures in April, most of the elms did not leaf out in the Wausau area until late May. I have only one explanation to offer for this. The winter of 1963, January and February, was one of the coldest of record, little snow and frost, very deep. The natural elm range does not normally extend much beyond northern Wisconsin. When our weather is as severe as Winnipeg weather, the elm is out of its natural weather zone. This dormancy until near Memorial Day may have been due to low soil temperature, extreme cold on bud cells, or a combination of these factors. At any rate, it did not seem common to other species.

In closing I would like to pay tribute to the scientific effort of so many persons in the field of entomology, soils, plant physiology, and pathology. These men and women by avocation or assigned research, in universities and industry, on shade tree problems and their active membership and papers for the International Shade Tree Conference and related organizations have made the field of arboriculture so useful and interesting.



TRANSACTIONS OF THE WISCONSIN ACADEMY

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TRANSACTIONS OF THE WISCONSIN ACADEMY OF SCIENCES, ARTS AND LETTERS

LIV — 1965

Editor

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Volume LIV

WISCONSIN TORNADOES

*M. W. Burley and P. J. Waite**

Introduction

Tornadoes are one of nature's more spectacular storms. The American Meteorological Society's 1959 Glossary of Meteorology defines tornadoes as "A violent rotating column of air, pendent from a cumulo-nimbus cloud, and nearly always observable as a "funnel cloud" or tuba. On a local scale, it is the most destructive of all atmospheric phenomena. Its vortex, commonly several hundreds of yards in diameter, whirls usually cyclonically with wind speed estimated at 100 to more than 300 miles per hour." Later information indicates that wind speeds within the tornado vortex may possibly exceed 500 miles per hour. Most people will live their lives without seeing a tornado, but that does not mean that tornadoes are not a real threat in Wisconsin. With increasing population in the state, the number of people and amount of property within the paths of tornadoes will also increase. Timely forecasts and public cautionary measures are becoming more important.

Tornadoes have captured public attention at irregular intervals. Since the Civil War, outstanding damage or loss of life in Wisconsin from these storms has occurred over four dozen times and have been at times as devastating as anywhere in the world. The "Circus Day" tornado in New Richmond on June 12, 1899 killed 117 persons and destroyed much of the town as it swept down the main street that evening. Damages estimated at seven million dollars were reported in a single tornado of a complex of five on the evening of June 4, 1958 at Colfax in Dunn County. This exceeded, only in inflated dollar value, the four million dollar loss sustained on September 9, 1884 in a tornado that moved east-northeastward out of Minnesota, across St. Croix County to finally end in Price County in the north central portion of the state.

Known tornadoes and some of the more severe windstorms from 1843 through 1964 are tabulated for the first time in a chronological sequence to meet public requests, particularly those originating from news media. The statistics of Wisconsin tornadoes are derived

*Marvin W. Burley is Supervisor of the Climatography Section, National Weather Records Center, Asheville, North Carolina. He was the U. S. Weather Bureau State Climatologist for Wisconsin from 1959 to 1965. Paul J. Waite is the U. S. Weather Bureau State Climatologist for the state of Iowa. He was State Climatologist of Wisconsin from 1956 to 1959.

from the 1916–64 period, except the tabulation and map of outstanding Wisconsin tornadoes, which spans the century from 1865 to the present. The data in this paper provide seasonal, diurnal and areal probabilities for a variety of applications and research. Following the seven million dollar loss suffered on June 4, 1958, insurance companies exhibited considerable interest in Wisconsin tornado statistics. The State Department of Public Instruction investigated the feasibility of including tornado safety features in planning school construction. South Carolina also investigated this possibility in 1959.[1] The need for adequate preparation in the event of a tornado strike has been demonstrated. The climatological information on tornadoes now available permits intelligent planning for such contingencies.

Obviously some bias exists in tornado records because of the methods of gathering information, the variable density of population, the location of the collection centers, and variable public and professional interests. Classifying these data by categories has not wholly eliminated bias, but it is believed that the longest and most damaging tornadoes are most likely to have been reported. There is evidence that a storm reported as one tornado may have been a complex of two or more tornadoes or have been subject to other human error, thereby producing some variation in tornado statistics.

Sources and Reliability of Data

Wisconsin windfall and tornado tabulations from the beginning of record-keeping in the early 1800's through 1964 were obtained from a number of sources.[2] Windfall record was derived from original public land survey maps and from the notes of the surveyors by Increase A. Lapham.[3] U. S. Signal Corps records were used for the portion of the record from 1840 to 1891.[4] Since 1891 official publications of the Weather Bureau have provided most of the data.[5] Newspaper accounts on file at the Wisconsin Historical Society Library provided supplemental information, particularly about earlier tornadoes.

The tornadoes reported during the early history of the state were mostly the spectacular ones—those with great loss of life and property. Examination of the written record of what has been called the earliest recorded tornado in Wisconsin, August 20, 1843, clearly describes a water spout. This phenomenon occurred 12 miles south of Kenosha over Lake Michigan; its formation and dissipation were witnessed by scores of people and vividly described by Lapham.

The range of detail used to describe earlier tornadoes appears in the following two examples:

> May 31, 1851. "Near the second of the Four Lakes in Dane County, six miles from Madison, the Capitol of the State of Wisconsin, was seen a dark column of leaves and branches whirling around with great rapidity, extending far above the forest trees, which bent and swayed before it like reeds. The noise and confusion defied all description; a tract of more than 100 acres was stripped bare of trees, all blown down, torn up by their roots, or twisted into fragments; the ground looking as if it had been harrowed. It took a direction nearly from the west, destroying everything in its way.
>
> Another tornado passed on the same day, from near the farm of Abel Nutting in Farmington, Jefferson County, where two clouds came in contact, through portions of the towns of Concord, Ixonia and Oconomowoc, where it swept over LaBelle Lake assuming many of the characteristics of a water spout. Houses were unroofed and trees blown down for many miles in extent, and over a breadth of from 80 to 100 rods. Among the incidents that happened, was that a girl 13 years of age was lifted up, clinging to a feather bed, over the top of the trees and landed without injury—thus, literally riding upon the whirlwind."[6]

The opposite to this is contained in a comment. "October 15, 1870. A tornado occurring in the city of Milwaukee was not considered enough of a news event to make the local paper."[7]

The increase in the number of reported tornadoes in the 1870's was due to the efforts of the Signal Corps; increases are also noted in 1916 when the Weather Bureau strengthened their tornado observing network and in the early 1950's when the public became concerned with tornado forecasting. We can assume we have record for only a small percentage of the state's tornadoes prior to 1870, all notable tornadoes from 1870 to 1916, probably most of the tornadoes from 1916 to 1953, and nearly all tornadoes from 1952 to date.

There is no question that some tornadoes have been omitted or improperly classified. Tornadoes with long paths or with skipping paths suggest a complex of tornadoes generated at intervals by a parent storm. However, original records were not revised unless evidence strongly indicated that a change was in order.

The large increase in the number of tornadoes reported in recent years can be attributed primarily to the expansion of the Weather Bureau's storm reporting networks, the increase in the number of storm detection and radar tracking stations, and the new public awareness of possible danger through the issuance of tornado forecasts for specific areas and particular time periods. Wider distribution of public information materials on tornado warning procedures have also contributed to the recent increase in the detection and reporting of tornadoes. One of the recent problems is the tendency to call all severe storms tornadoes. Investigations of damage sometimes show that reported tornadoes were locally severe thunderstorms with straight line winds.

The dollar value of storm damage can be useful in computing insurance rates, but was not used in this paper to obtain totals over a period of time as it is considered to be a misleading statistic. Estimates on actual loss have often been found erroneous, and changing property values and inflation casts doubt on computed dollar values.

Although there are shortcomings and omissions in the data presented, these records are the best presently available and have been carefully evaluated by meteorologists throughout the years.

Windfalls

The earliest comprehensive study on Wisconsin tornadoes was made by Increase A. Lapham in the 1850's and 1860's. He summarized his findings in a letter written to General A. J. Myer, Chief Signal Officer in May 1872. In addition to data on observed tornadoes, Lapham went to public surveys for information. The maps he examined were original surveys made between 1834 and 1865.

Early public land surveyors were required to record all windfalls crossing township and section lines. Windfalls were defined as "the tracks of tornadoes through forests as shown by the prostrated and confused masses of timber." Undoubtedly some of the entries were the result of straight line winds and not tornadoes, although examination of the maps indicate that many of the windfalls could only have been caused by tornadoes. In either case, winds were strong enough to blow down strips of virgin timber. These old surveys give us a record of severe wind storms that passed over the forested areas of the state within the time it took blown down trees to decay; few traces were left on open or prairie country in their natural condition.

Lapham prepared eighty pages of diagrams giving the exact location, length and width of each of the 360 windfalls recorded. Many of the storm tracks were so short that their direction cannot be accurately determined, although fifty-three paths were long enough to indicate the movement of the storm. The average direction from which these destructive winds blew was 254°, or about west–southwest. Lapham found that two tracks traveled directly from the south, seven from between south and southwest, twenty-nine from between southwest and west, thirteen between west and northwest, one from north–northwest and one from north. Approximately two-thirds of the windfalls were less than one mile long with only a few exceeding two to three miles. The width of the tracks ranged from a few rods to a mile or more, and averaged less than a quarter mile. Several severe storms, apparently not tornadoes, covered many square miles.

A windfall in the northeastern part of the state was over twenty-two miles long, occurring between the time the township lines were surveyed in 1857 and the section lines in 1865. Another windfall extended from township 32N, range 6W to 38N, range 2W, touching down six times and devastating thirty-three miles of timber over a distance of fifty-five miles; parallel to this track and at a distance of eight miles away a second tornado of apparently even greater force touched down four or possibly five times.

Several of Lapham's interesting interpretations of the data are:

> "That two or more tornadoes may be united with one,[8] and pursue a course in a direction intermediate between that of each, is well established by these surveys . . . . . a case in township 35N, range 14E, where four tornadoes are united, each apparently modifying the general direction of the track and increasing in breadth. There are perhaps 20 other cases where tracks are thus united."
>
> "There are also a few cases where tracks became divided, and two tornadoes continue their separate mark of destruction; and some, after thus separating, became united leaving a kind of island of standing timber amidst an expanse of prostrate trunks."
>
> "We may suppose that the tornadoes causing the windfalls represented on the map occurred within a period of about ten years; and that therefore, there are about thirty-six cases annually when the wind blows in some part of the state with sufficient force to prostrate trees. Of these, perhaps not more than twenty are of sufficient magnitude and extent to cause considerable damage. Now, if these are compared with the 200,000 quarter sections in the state, it will be seen that there is about one chance in probability in 10,000 that any particular farm of 160 acres (in any year) will be visited by such a calamity."

Tornado Characteristics and Statistics in Wisconsin

The causes for the formation of tornadoes is only generally understood. They often develop southeast of a deep low centered in the central or north central states; they may appear in any section of the low and be associated with fronts, instability lines, troughs and have even formed within high pressure ridges. Their highly localized nature and random distribution make it impossible to forecast the spot they will strike with our present knowledge. The best meteorologists are able to do is to forecast an area in which they are likely to develop.

Wisconsin lies to the northeast of the principal tornado belt in this country. In comparison with other states it ranks seventeenth in number of days with tornadoes and eighteenth in number of tornadoes. Table 1 lists 102 tornadoes from the beginning of record

TABLE 1. LIST OF REPORTED TORNADOES FROM BEGINNING OF RECORD THROUGH 1964

Place		Date	Time	Direction of Advance	Length of Path, Miles	Width of Path, Yards	Number of Persons		Estimated Damage	
County	Town						Killed	Injured	Property (exclusive of Crops)*	Crops*
Fond du Lac		1844 28 Aug.	3 PM	NNE		330				
Milwaukee		1848 4 June	4 PM							
Ozaukee	Saukville	1850 30 July								
Waukesha, Jefferson	Through portions of Concord, Ixonia, Oconomowoc	1851 31 May		NE		500				
Dane	South of Madison	1851 31 May		E						
Monroe		1852 16 Aug.								
Waukesha		1853 3 July	3 PM	NE		550				
Monroe		1853 23 July								
Columbia, Sauk		1857 21 Aug.	6 PM	ESE						
Dodge		1860 22 Aug.		E						
Winnebago	Oshkosh	1861 8 July	2 AM							
Juneau	New Lisbon	1863 11 Aug.	Early morning	NE						
Portage		1863 21 Aug.	9 PM	SE						
Vernon		1864 17 June	Afternoon	NE						
Vernon	West of Viroqua to Hillsboro	1865 28 June	4 PM	NE	40	160	24	100	200, 000	
, Milwaukee	Milwaukee	1870 15 Oct.	3:30 PM							
Crawford		1872 Oct.				220				
Vernon		1875								
La Crosse		1875	7:40 PM	SE		200				
Grant	Hazel Green	1876 10 Mar.	4:30 PM	E	5	170–220	9	15	46, 000	
Waushara	Wautoma	1877 5 July								

TABLE 1. LIST OF REPORTED TORNADOES FROM BEGINNING OF RECORD THROUGH 1964—Continued

Place		Date	Time	Direction of Advance	Length of Path, Miles	Width of Path, Yards	Number of Persons		Estimated Damage	
County	Town						Killed	Injured	Property (exclusive of Crops)*	Crops*
Oconto	Pensaukee	1877 7 July	6–7 PM	SE	6	330	8	30	300,000	
Iowa, Dane, Waukesha, Jefferson, Milwaukee	10 miles west of Mineral Point to Milwaukee	1878 23 May	3:00 PM	NE	150	220–330	At least 19	45 or more	130,980	
Rock	Beloit	1880 18 April	5 PM	NE		160–2300	several		75,000	
Monroe		1880 11 June	Afternoon	NE						
Wood		1880 20 Sep.	9:30 PM	NE						
Waushara	Wautoma	1881 29 Sep.	5 PM	NE		400–660				
Buffalo	Mondovi	1881 29 Sep.	Afternoon	NE			12			
Waupaca		1881 29 Sep.	2 PM	NE						
Sauk		1882 June	Afternoon	NE						
Rock		1883 9 May	4 PM	NE		220				
Rock		1883 18 May	4:15 PM	E		110				
Racine		1883 18 May	7 PM	NE	3	220	25	100	200,000	
Waukesha		1883 25 May	Afternoon							
Rock		1883 11 June	5:50 PM	SE						
Green Lake		1883 11 June	4:45 PM	NE						
Sauk, Columbia		1883 10 July	Noon	S						
Jefferson, Waukesha		1883 16 July	1:20 PM	N		220				
Clark, Wood		1883 21 Aug.	Noon	E						
Wood		1883 21 Aug.	1:30 PM	NE		10–120				
Trempealeau		1883 8 Oct.	Noon	NE		660				
Crawford		1883 25 Nov.	9 PM	NE						

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Place		Date	Time	Direction of Advance	Length of Path, Miles	Width of Path, Yards	Number of Persons		Estimated Damage	
County	Town						Killed	Injured	Property (exclusive of Crops)*	Crops*
Trempealeau		1884 22 July	12:30 PM	ENE						
Ashland		1884 22 July	1 PM	NE						
Dunn		1884 25 July	2:40 PM	ESE						
Shawano		1884 29 July	4 PM	ENE						
Richland, Sauk, Columbia		1884 2 Aug.	5 PM	N		110–440		2	150, 000	
Buffalo		1884 22 Aug.	4:30 PM	N		75				
Crawford, Grant		1884 22 Aug.	6:20 PM	SE		55–440		Several		
St. Croix, Barron, Chippewa, Price, Polk		1884 9 Sep.	5 PM	NNE	120	880	6	75	4, 000, 000	
Vernon		1885 7 June	1 PM	NNE						
Waupaca		1885 8 July	8 PM	NE						
Winnebago		1885 8 July	8 PM	NE						
Dane	Madison	1885 8 July	9 PM	SE		880				
Fond du Lac		1885 3 Aug.	3:35 PM	ENE		70				
Marathon		1886 21 June	Afternoon	NE		Narrow				
Rock		1886 6 Aug.	Afternoon							
Polk		1887 1 May	6 PM	NE		Narrow				
Clark		1887 1 May	9 PM	NE		Narrow				
Dunn		1887 6 July	5 PM	NE		330–1300				
Clark		1887 16 July	2 PM	NE		1000				
Waupaca		1887 16 July	5 PM	NE		Narrow				
Walworth		1887 10 Aug.	Afternoon	E		Narrow				

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County	Town						Killed	Injured	Property (exclusive of Crops)*	Crops*
Richland		1887	4 PM	NE						
Green		11 Aug. 1888	4 PM	NE						
Crawford		4 May 1888	5 PM	SE						
Eau Claire		12 May 1888	3:30 PM	NE		440				
Winnebago		11 June 1888	11 PM	E						
Walworth		18 June 1888	3:30 PM	NE		Narrow				
Green		19 June 1888	7 PM	NE		220				
Washington		3 July 1888	4 PM	NE		270				
Kewaunee		4 July 1888	4 PM	NE		880				
Trempealeau		1 July 1888	6 PM	E		Narrow				
Dunn		28 July 1888	10:20 AM	NE		100				
Trempealeau		30 July 1888	11 PM	E						
Trempealeau		1 Aug. 1888	9:40 PM	E						
Dunn		4 Aug. 1888	6 PM	E		Narrow				
Waukesha	Ottawa	16 Sep. 1890	3 PM							
Milwaukee	Milwaukee	30 May 1891	2:51 PM						4, 000	
Grant	Near Livingston	14 June 1892	2:50 PM						Light	
Lafayette	Darlington	4 April 1893	5 PM	NE			2			
Iowa	Moscow	22 May 1893	5:03 PM				3		3, 500	
Clark	Humbird	22 May 1895						3	300	
Winnebago	Near Oshkosh	2 May 1896							One barn	
		8 June								

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Place: County	Place: Town	Date	Time	Direction of Advance	Length of Path, Miles	Width of Path, Yards	Number of Persons: Killed	Number of Persons: Injured	Estimated Damage: Property (exclusive of Crops)*	Estimated Damage: Crops*
Polk	Clayton	1896 24 June	6:30 PM					2	6 houses, a few barns	
Eau Claire, Clark, Marathon, Lincoln, Langlade	Abbotsford, Antigo	1898 18 May	4 PM-6:40 PM	NE	110		17	100	710, 000	
Dane	Began SW of Madison	1898 18 May	6 PM	NE					10, 000	
Price, Oneida		1898 18 May	6:30 PM	NE	50	100	7	15	200, 000	
St. Croix, Polk, Barron	"New Richmond Tornado"	1899 12 June	6:30 PM	NE	45	100	117	125	600, 000	
Sheboygan		1900 20 Aug.	12:45 PM						25, 000	
Portage	Almond	1903 3 Oct.		NE		80	Several			
Vernon, La Crosse		1906 6 June		NE	20	400	4	18	70, 000	
Clark, Jackson, Juneau		1907 3 July	4:45-6:30 PM	SE	95	80	26		100, 000	
Green Lake, Winnebago		1907 3 July	6:30 PM	E	8		2			
Vernon to Juneau		1908 7 June	3:30 PM	NE	17	35	2			
Portage	"Stevens Point Tornado"	1908 25 Nov.	7 PM	NE	12	10–100	1	2	100, 000	
Wood	Rudolph	1908 25 Nov.	6:30 PM	NNE	7		1	6		
Rock		1911 11 Nov.	2 PM	NE	30		9	10	500, 000	
Vernon, Crawford, Juneau	"Soldiers Grove Tornado"	1913 10 Oct.	1:30 PM				4	27	250, 000	
Rock		1913 10 Oct.	4:20 PM					6		
Crawford	"Lansing–Ferryville Tornado"	1915 12 June	5:30 PM	NE	20	120–400	7	25	100, 000	
Sauk		1915 12 June	6:30 PM	NE	10	60	1	15	50, 000	
Dane	Near Mazomanie	1916 1 June	9 PM	NE	5–6	440			20, 000	
(None Reported)		1917								
Rusk, Price	Ladysmith to near Phillips	1918 19 May	1–4 AM	NE	40	67–100	1	2	50, 000	

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County	Town						Killed	Injured	Property (exclusive of Crops)*	Crops*
Grant, Iowa, Richland, Sauk	1 mi. S of Glenhaven to 6 mi. N of Lancaster to Lone Rock to Baraboo	21 May	6:30 PM to later than 8 PM	NE	85	67–433	8	100	650,000	
Wood, Portage	NE Wood County, NW Portage County	26 June	8–8:30 PM	E	few miles	50–67	0	1	15,000	
		1919								
Sauk	2 mi. NE of Ableman	20 Aug.		NE	Short	200			500	
		1920								
Walworth	Eastern Walworth County	28 Mar.	12:30	N			1		25,000	
		1921								
Outagamie, Shawano	SE Shawano	20 June		NNE					60,000 (incl. crops)	
Dane	Near Madison	19 Aug.	4:15 PM				2		620,000	
		1922								
Pierce	Trim Belle	3 May	Night	NE					10,000	
St. Croix	From Roberts to intersection of Polk, Dunn, Barron, St. Croix cos. to near Chetek	15 June	7–9 PM	ENE	50	Few rods to 2 mi.	8	More than 100	500,000	
Langlade	W of Antigo	16 June	2:30 PM	NE	2	50–100	0		50,000	
		1923								
(None reported)										
		1924								
Racine	Center of Racine Co.	20 June	7:30 AM	ENE	30	300–3520	0	12	500,000	
Trempealeau, Jackson	Osseo to Black River Falls	7 Aug.	6:30 PM	SE	27	334–1760	4	100	200,000	
Barron, Chippewa	Dovre Township thru Chippewa Co.	7 Aug.	7 PM	SE	15	330	3		100,000	
Barron, Rusk, Sawyer, Bayfield, Ashland	Chetek, Barron Co. to Marengo, Ashland Co.	21 Sept.	2–5:30 PM	NNE	90	67–880	10	50	250,000	
Oneida	Minocqua	21 Sept.	4 PM						None reported	
Eau Claire, Clark, Marathon, Taylor, Lincoln, Oneida	Augusta, Eau Claire to near Three Lakes, Oneida Co.	21 Sept.	2:20-4:30 PM	ENE	120	67–880	26	114	564,000	
Langlade	Antigo	21 Sept.	Afternoon		Short				4,000	
		1925								
Calumet	Near center of county	11 April	12:30 AM	SW	Short	Up to 880	0	0	4,000	
Clark	SW corner of Clark Co.	2 June	10:30 PM	NE	20	100	0	0	30,000	
Florence	Brule	3 June	1 AM				2		2,500	
Juneau	SW Juneau County	13 June	5:45 PM		Short	20–25			30,000	
		1926								
Bayfield, Ashland, Iron, Vilas	20 mi. NW of Ashland Jct. to 4 mi. S of Winchester	16 July	6:15-7:45 PM	ESE	85	100–440	3	16	90,000	
Sauk	3 mi. S of Wonewoc	20 Aug.	12 PM	NE	½	167	0	1	1,000	
		1927								

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County	Town						Killed	Injured	Property (exclusive of Crops)*	Crops*
St. Croix, Pierce, Dunn	N Pierce to W Dunn	12 July	Evening						20, 000	
Ashland	N of Morse	30 Oct.	4:30 PM		Short	880	0	0	1, 200	
		1928								
Pierce	W and N central Pierce Co.	20 June	1:30-2:00 PM	NE	4	110	0	0	35, 000	
Polk	Dresser Jct.	2 July	12:30 AM	ENE	6		0	0	60, 000	
Barron	Prairie Farm	2 July	1:30 AM				0	0	50, 000	
Trempealeau	Blair	2 July	2:00 AM				0	0	25, 000	
La Crosse	New Amsterdam to near West Salem	20 Aug.	6:00 PM	SE	20	100–1760	0	Few	60, 000	
Rock	Magnolia	14 Sept.	3 PM		1	440	0		30, 000	
Dane	Riley, Verona	14 Sept.	3 PM		15	Few rods–880	0	13+	100, 000	
Waupaca	Scandinavia to Marion	14 Sept.	3:30 PM	NE	20	55–110	0		27, 500	
		1929								
Polk	10 mi. SW of Balsam Lake to 5 mi. N of Balsam Lake	5 April	6-6:30 PM	NE	15	440	0	0	10, 000	
Pierce to Iron	SW River Falls to Van Buskirk	5 Apr.	5:45-8:30 PM	NE	170	30–400	12	100	725, 000	
Grant to Green	Cuba City to N of Monticello	6 April	4:30-6:30	ENE	45	30–330	0	25	250, 000	
Rusk	Ladysmith	10 June	7:15 PM	SE	11	150	0	5	150, 000	
Oneida	Minocqua	10 June	7:30 PM	SE		35–200			100, 000	
Sawyer	8 mi. NW Stone Lake, Washburn Co.	29 June	8 PM	SSE	14	Few rods	0	1	12, 000	
		1930								
Vernon	N Vernon Co.	1 May	7:30 PM	E	5	70	1		100,000	
Trempealeau, Monroe, La Crosse	S. Trempealeau, across N La Crosse Co.	1 May	7:30-8 PM	E	33	500	1		202, 000	
Kewaunee		1 May	10:30 PM	NE	5	440	0		60, 000	
Walworth, Racine, Milwaukee	Angled across Racine, Milwaukee Co. line	1 May	11:00 PM	NE	40	500	0		30, 000	
Lincoln	N Lincoln Co.	3 June	2:15 PM	NE	3	Narrow	0	0	900	
Price	N Central Price Co.	12 June	6:45 PM	NE	2	20	0	0	5, 000	
Trempealeau, Jackson, Clark, Marathon, Lincoln	W Trempealeau, N Jackson, E Clark, NW Marathon	13 June	5:30-7:30 PM	NE	80	1, 300	0	0	600, 000	
Pierce, Dunn, Eau Claire, Chippewa, Clark	Cent. Pierce, S Dunn, NW Eau Claire, S Chippewa	13 June	5:30-8:00 PM	E	125	1, 000	6	80	1, 000, 000	
Dunn	Parallel to above tornado on left	13 June	6:30 PM	E		90	0	0	125, 000	
Eau Claire	Parallel to above tornado on right	13 June	7 PM	E	16		0	0	25, 000	
Portage	Near Darcy	20 July	4:30 PM	E	10	880	0	0	15, 500	

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Portage	Coddington	27 July	1:30 AM	SE	3	880	0	0	10,000	
		1931								
Dane	Madison NE	6 May	5 PM		<1	50	0	0	100	
Rusk	Near Tony	1 July	Afternoon		<1	Narrow	0	0	8,000	
Lafayette	Darling and vicinity	1 July	5:30 PM	NE	7	880	0	0	25,000	
Rock, Jefferson, Waukesha	Near Oxfordville to Oconomowoc	21 Sept.	7:30-9:00 PM	NE	50	200	1	9	300,000	
		1932								
Manitowoc	Kiel	19 Sept.	7 PM	NE		440	0	0	2,000	
		1933								
Pepin	Durand	30 April	3 PM	S	2	100	0	0	5,000	
Wood	10 mi. SW Wis. Rapids to Rudolph	23 May	3:30 PM	NNE	15	100	0	1	75,000	
Green Lake	N of Marquette to Kingston then SE of Manchester	5 June	5:15 PM	SSE	10	150	1	4	100,000	5,000
Sauk	Reedsburg	1 July	7:30 PM	SE		250	0	0	5,000	
Polk	Clear Lake	10 Aug.	4:45 PM	ENE	12	50	0	0		
Polk	Clear Lake	10 Aug.	4:45 PM	ENE	20		1	4	25,000	
Dane	3½ mi. W of Cambridge	26 Sept.	Midnight		1	Narrow	0	0	5,000	
		1934								
Dane	Cottage Grove	17 Mar.	2:45 AM	S	Short	60	0	0	1,300	
Walworth	East Troy	21 May	3 PM		1½		0	0	10,000	
Dodge	Reeseville	8 June	2:30		2	220	0	0	4,000	
Green	Brodhead	20 June	5:45 PM		3	330	0	0	10,000	
Adams	Briggsville	25 June	11:30 PM		1½	880	0	0	3,000	
Waupaca	Manawa	30 June	3 PM				0	0	7,000	
Calumet, Manitowoc	NE Potter to SE Reedsville	12 July	8:00 PM	E			0	0	None	
Polk	E of Milltown	5 Oct.			5	35	0	3	10,000	
		1935								
Vernon	3 mi. W of Viroqua	26 April	Afternoon		Short	Narrow	0	0	300	
Eau Claire, Clark	Fairchild	5 July	5:45 PM	E	3	33–167	0	0	12,000	
Marathon	Wausau	5 July	7:15 PM	ENE	25	100–167	0	0	125,000	
Langlade	Phlox	11 July	5:30 PM	E		880	0	1	10,000	
Langlade	Near Neva	17 Sept.				33	0	0	1,000	
Polk	6 mi. NE of Amery	16 Oct.	5:30 PM		1/5	67	0	0	4,000	
Polk	3 mi. SE or Amery	16 Oct.			Short	Narrow	0	0	500	
		1936								
Trempealeau	N Trempealeau Co.	16 May	Mid-night	NE	6	275	0	0	30,000	
Lincoln	Tomahawk	11 July	4:30 PM	E	1	1,320	0	0	5,000	
Washington	West Bend	22 Aug.	12:20 AM	NE	3	140	0	0	300	
		1937								
Lafayette	S Cent. Lafayette Co.	25 June	3:30 PM	SSE	8	100	0	0	10,000	

TABLE 1. LIST OF REPORTED TORNADOES FROM BEGINNING OF RECORD THROUGH 1964—Continued

PLACE		DATE	TIME	DIRECTION OF ADVANCE	LENGTH OF PATH, MILES	WIDTH OF PATH, YARDS	NUMBER OF PERSONS		ESTIMATED DAMAGE	
County	Town						Killed	Injured	Property (exclusive of Crops)*	Crops*
		1938								
Langlade	W of Antigo	3 May	3:30 PM	E	2	35	0	2	10,000	
Juneau	6 mi. NW of Wis. Dells	23 Aug.	1:00 PM	NE	3	100	0	0	5,000	
(None reported)		1939								
		1940								
Vilas	Land O'Lakes	17 June	4:15 PM	E	5½	100	1	4	2,500	
Oneida	Lake Tomahawk	17 June	4:30 PM	E	2	125	1	3	5,000	
		1941								
Langlade	Deerbrook	13 April	4:00 PM	E	6	160	0	0	12,000	
Portage	Plover	14 April	2:00 PM	NE	2		0	0	4,000	
Rock	S Footville to Leyden	19 April	8:30 PM	NE	6	100	0	0	10,000	
Grant	Cassville	3 Sept.	6:00 PM	NE		100	0	2	1,000	
		1942								
Chippewa	Edson to SE of Thorp	4 April	5:00 PM	E	18	70	0	0	60,000	
Polk	10–12 mi. SWbf Deronda to Deronda	13 May	3:00 PM	NE	12	30	0	2	50,000	
Jackson, Clark	Black River Falls to Loyal, Clark Co.	13 May	3:00 PM	NW	35	100	1	1	100,000	
Langlade	Antigo	13 May	3:45 PM	NE	10		0	0	15,000	
Douglas	Hawthorne	11 June	Afternoon				0	0	500	
Winnebago	Waukau	28 July	4:00 PM	E	1½		0	1	10,000	
Waushara	Hancock	28 July	4:00 PM	NE		30	0	0	3,000	200
Chippewa	Stanley	16 Sept.	6:00 PM	NE	1½	50	0	0	Minor	
Chippewa	SE Chippewa Co.	17 Sept.	11:30 PM	E	1½	100	0	0	20,000	
(None reported)		1943								
		1944								
Manitowoc	Two Rivers	4 June	4 PM	NE		67	0	0	600	
Portage		18 June	3:50 PM	ESE	12	55–1,320	0	3	100,000	5,000
Lafayette	Belmont—crossed to Illinois	22 June	6:30-8:00 PM	SE	36	200–1,760	7	65	1,000,000	25,000
Wood	SE Wood Co.	22 June	9:30 PM	E	20	880	0	0	15,000	25,000
Dane	7 mi. NNE of Madison	23 July	5-5:15 PM	E	1½	67	0	1	15,000	5,000
		1945								
Taylor	S Taylor Co.	27 Mar.	7:30 PM	E	1		0	1	6,000	
Langlade		11 April	3:20 PM	ENE	10	1,760	1	0	100,000	1,000
Waushara	NW Waushara Co.	21 May	7:00 PM	NE	6	220	0	0	7,000	
Wood, Portage	Sigel to southern Stevens Point	19 Sept.	3-3:45 PM	E	25	200	0	2	25,000	
		1946								
Sauk	Lake Delton and vicinity	22 Sept.	5:55-6:10 PM	NE	Short	27	0	0	10,000	
(None reported)		1947								

TABLE 1. LIST OF REPORTED TORNADOES FROM BEGINNING OF RECORD THROUGH 1964—Continued

Place		Date	Time	Direction of Advance	Length of Path, Miles	Width of Path, Yards	Number of Persons		Estimated Damage	
County	Town						Killed	Injured	Property (exclusive of Crops)*	Crops*
		1948								
Grant	Near Lancaster	29 July	5:15 PM	NE		Narrow	1	1	25, 400	
Iowa	Near Linden	29 July	5:25 PM	NE	1	333	0	0	10, 000	1, 100
Dane	Near Springfield Corner	29 July	6:00 PM	NE	2	133	1	11	20, 850	650
La Crosse		29 July	6:30 PM	NE		5	0	0	500	
		1949								
Polk	Near Amery	17 May	2:30 PM	NE	8	50	0	0	Minor	
Winnebago	Near Omro	19 May	4:03 PM	NE	Short	70	0	0	5, 000	
Lincoln	N of Tomahawk	18 July	Afternoon	ENE	15	300	0	0	No estimate	
Oneida	Clearwater	27 July	Afternoon	NE	Short	Narrow	0	0	Minor	
		1950								
Rusk	Ladysmith	25 June	7:20 PM	ENE	Short	Narrow	0	0	50, 000	
Price	Near Prentice	25 June	8:20 PM	ENE	1	Narrow	0	0	54, 000	
Oneida	SW Rhinelander	25 June	9:00 PM	NE	12	500	2	50	500, 000	
Clark	Near Unity	25 June	Night	NE	Short	Narrow	1	0	25, 000	
Green Lake	Berlin	25 June	11:30 PM	E	1	300	0	0	100, 000	
		1951								
Dodge	Near Brownsville	19 June	8:30 PM	NE	1	500	0	0	25, 000	Minor
Richland	Near Cazenovia	3 July	8:00 PM	NE	½	50	0	0	10, 000	
Pepin, Dunn	Greatest destruction 6 mi. E of Menomonie	12 Sept.	11:30 AM	NE	30	200	0	2	127, 000	Minor
Waupaca	Most destruction 3 mi. N of Waupaca	26 Sept.	3:50 AM	NE	20	100	6	3	250, 000	Minor
Columbia	Near Cambria	26 Sept.	4:30 PM	NE	10	100	1	10	225, 000	Minor
		1952								
Polk	Centuria	23 June	9:15 PM	NE	15	100	2	6	250, 000	
		1953								
Pierce, St. Croix, Polk, Burnett, Washburn, Douglas	First observed at River Falls, Pierce Co.	10 May	6:30-8 PM	NNE	100	100	4	27	1, 000, 000	Minor
Buffalo, Trempealeau, Eau Claire, Chippewa, Taylor, Price	Crossed River from Minn. into Buffalo Co.	10 May	6:30-8 PM	NE	100	100	0	10	1, 000, 000	
Oneida	Near Three Lakes	20 June	PM		Short		0	0	30, 000	
		1954								
Iowa	6 mi. N of Highland to 3 mi. SE of Avoca	7 April	5:45 PM	NE	6–8	400	0	4	60, 000	300
Waukesha	Oconomowoc	7 April	1:15 PM	NE			0	0	50, 000	
Fond du Lac	Mt. Calvary	7 April	Late AM-PM	E			0	0	30, 000	
Waushara	Neshkoro, Lohrville, Redgranite	15 April	3 PM	NE			0	0	10, 000	

TABLE 1. LIST OF REPORTED TORNADOES FROM BEGINNING OF RECORD THROUGH 1964—Continued

Place		Date	Time	Direction of Advance	Length of Path, Miles	Width of Path, Yards	Number of Persons		Estimated Damage	
County	Town						Killed	Injured	Property (exclusive of Crops)*	Crops*
La Crosse, Trempealeau	At Camp Dekorah between Holman and Galesville	26 April	3:35 PM	N			0	0	600	
Grant	N of Andover	26 April	4 PM				0	0	Losses not reported	
Jackson	Hixton	18 June	6:30 PM	ESE	10	900	0	0	100, 000 Includes Crops	
Marathon	Near Mosinee	20 June	2:40 AM	E			0	0	Losses not reported	
Calumet	Near Brothertown	20 June	AM				0	0	Losses not reported	
Pierce	Herbert (8 mi. SE Ellsworth)	29 June	3:30 PM	NE	6	....	0	0	5, 000 Includes Crops	
Columbia	Lodi and Vicinity	30 July	7 PM	ESE	8	200	0	0	80, 000 Includes Crops	
St. Croix	New Richmond and Vicinity	15 Aug.	6 PM	E	6		0	0	70, 000 Includes Crops	
		1955								
Crawford	Near Prairie du Chien to near Lynxville	18 April	1 AM	NNE			0	0	25, 000	
Iowa	Dodgeville, Ridgeway, Barneveld	18 April	4 PM	E	13		0	0	Losses not reported	
Dane	Belleville and Vicinity	18 April	5 PM	ESE			0	0	250, 000	
Walworth	Heart Prairie and Vicinity	18 April	7 PM	E	4		0	1	Losses not reported	
Lincoln	Irma	3 May	6 PM	ENE	8		0	2	20, 000	
Rock	7 mi. NW of Janesville	28 May	1:15 PM	E	4	100	0	0	20, 000	Losses not reported
Waupaca	3 mi. W of Clintonville	28 May	3 PM	N	3	75	0	4	20, 000	Losses not reported
Pierce	Elmwood	22 July	2 PM	NE	2	220	0	0	1, 000	Minor
Manitowoc	Newton	31 July	5:10 PM	SSE			0	0	50, 000	25, 000
		1956								
Iowa	5 mi. NE of Highland	3 April	11:00 AM	NE	4	200	0	0	100, 000	
Portage	From Bancroft to near Amherst	3 April	12:50 PM	NE	18	100	2	7	180, 000	
Green Lake, Winnebago	Berlin and Northeastward	3 April	2:05 PM	NE	12	400	7	50	1, 000, 000	
Door	Brussels	1 July	12:00 PM	NE			0	0	100, 000	10, 000

TABLE 1. LIST OF REPORTED TORNADOES FROM BEGINNING OF RECORD THROUGH 1964—Continued

Place		Date	Time	Direction of Advance	Length of Path, Miles	Width of Path, Yards	Number of Persons		Estimated Damage	
County	Town						Killed	Injured	Property (exclusive of Crops)*	Crops*
Waukesha	Big Bend and Muskego areas	16 July	12:30 PM	E	3	30	0	0		1, 000
Dodge	W of Beaver Dam	21 July	4 PM	E			0	0		
		1957								
La Crosse	Holmen	19 April	2:30 PM	NNW	2–3	150	0	0	18, 000	
Juneau	Near New Lisbon through Necedah to Refuge N of Necedah	19 April	4 PM	NNE	20	300	1	0	7, 500	
Walworth, Racine	Burlington area	19 April	4 PM	NE	6	200	0	2	75, 000	
Portage	Coddington and Bancroft	19 April	4:05 PM	NE	5	30	0	0	15, 000	
Waushara	Wautoma, Saxeville	19 April	4:15 PM	NE	12	150	0	1	50, 000	
Monroe	Kendall	19 April	8:30 PM	NE	8	400	0	0	60, 000	
Grant	Bloomington to Fennimore	25 May	4:30 PM	NW to NE	20	40	0	0	20, 000	
Florence	Florence	14 June	5:30 PM	NE	7	100	0	0	50, 000	
Barron	Brill	4 July	6:30 AM	NE	4	150	0	4	75, 000	
Brown	Denmark	11 July	1:30 PM	ENE			0	0	1, 000	
Manitowoc	Whitelaw	11 July	2 PM	NE			0	0	2, 000	
Vernon	Hillsboro	19 Sept.	12:30 AM	NE	10	165	0	0	50, 000	10, 000
		1958								
Marinette		17 May	2:20	NE	5	80	0	1	175, 000	
St. Croix, Pierce		24 May	2:45 PM	SE	50	50	0	5	385, 000	
Lafayette		31 May	2:30 PM	NE	3		0	0	75, 000	
St. Croix, Dunn		4 June	5:30 PM	ENE	32	880	19	110	7, 000, 000	10, 000
Chippewa		4 June	6:45 PM	ENE	12	600	4	56	1, 000, 000	
Rusk		4 June	7:00 PM	ENE	15	200	0	0	7, 500	
Chippewa		4 June	7:00 PM	ENE	5	300	0	3	75, 000	2, 000
Eau Claire, Clark, Marathon		4 June	7:30 PM	ENE	60	880	4	3	750, 000	50, 000
Chippewa		22 June	1:30 PM	E	440 yd.	25	0	0		1, 000
St. Croix		22 June	3:25 PM	E	440 yd.	50	0	0	500	
Lincoln		30 June	5:30 PM	E	2	50	0	0	1, 000	
Barron		14 July	1:00 PM	E	1	75	0	0	10, 000	
Iron		14 July	2:45 PM	SE	25	250	0	0	75, 000	
Milwaukee		7 Aug.	2:47 PM	SE	1	100	0	4	45, 000	
Marinette		30 Aug.	5:30 PM	E	1	100	0	0	6, 000	
St. Croix		9 Oct.	12:00 PM	NE	8	50	0	0	30, 000	1, 000
Dane		9 Oct.	4:45 PM	NE			0	0		

TABLE 1. LIST OF REPORTED TORNADOES FROM BEGINNING OF RECORD THROUGH 1964—Continued

Place		Date	Time	Direction of Advance	Length of Path, Miles	Width of Path, Yards	Number of Persons		Estimated Damage	
County	Town						Killed	Injured	Property (exclusive of Crops)*	Crops*
		1959								
Chippewa	10 NE Eau Claire	4 May	9:12 AM		¼		0	0		
Marathon	SW of Wausau	4 May	10:30 AM		1	200	0	0	2	1
Langlade	Deerbrook	4 May	11:05 AM		1	100	0	0	1	
Jackson	1 N Black River Falls	4 May	1:00 PM		1	150	0	0	4	1
Buffalo	Mondovi	5 May	7:00 PM		¼	150	0	0		
Waupaca	Symco to near Clintonville	6 May	3:20 AM		10	1,000	0	0	5	
Outagamie	3 NE Shiocton	6 May	1:30 PM		3	200	0	0	4	
Columbia	Portage	10 May	7:20 PM	NE	2	200	0	0	3	
Brown	Green Bay	10 May	8:50 PM		6	600	0	3	6	
Grant	SW Lancaster	19 May	5:20 PM	NE	5	200	0	0	4	
						Funnel later sighted near Mt. Horeb, Dane County.				
Trempealeau, Jackson Eau Claire	Trempealeau, Fairchild	26 May	3:45 PM				0	3	5	
Rusk	Ladysmith	26 May	3:45 PM				0	0	4	
Sauk	Prairie du Sac	28 May	2:02 PM				0	0	3	
Fond du Lac	5 N Ripon	28 May	3:05				0	0		
		A few small tornadoes touched the ground. Also funnels reported.								
Winnebago	N Oshkosh	28 May	3:15 PM				0	0	3	
Brown	7 S Green Bay	28 May	3:30 PM				0	0	3	
Brown	15 S Green Bay	28 May	3:38 PM				0	0		
Walworth	Whitewater	6 June	3:37 PM				0	0	0	
		Touched down once—no damage.								
Brown	4 E Green Bay	10 June	1:20 PM				0	0	0	
Waukesha	25 WSW Milwaukee	12 June	Mid-night to 1:45 AM		2	1,000	0	0	3	
Chippewa	12 N Chippewa Falls	26 June	1:20 PM							
Marquette	Harrisville	8 July	Mid-afternoon				0	0	4	
Marinette	Niagara	8 July	4:54 PM		Short		0	3	4	
Outagamie	26 SW Green Bay	28 Aug.	2:04 PM				0	0	2	
Burnett	Grantsburg	6 Sept.	6:24 PM		Short		0	0	0	
Clark	10 SE Stanley	22 Sept.	6:30 PM		½	30	0	0	2	
Milwaukee	Milwaukee	26 Sept.	6:28 PM		4	Narrow	0	3	5	
Racine, Kenosha	Kansasville to Racine	26 Sept.	6:30 PM		15	50	0	0	5	
Waukesha	2 NW Mapleton	8 Oct.	4:00 PM		1	Narrow	0	0	4	
Racine	Near Franksville	8 Oct.	4:48				0	2	4	
		1960								
Sawyer	27 SE Winter	23 April	7:00 PM				0	0	2	
Manitowoc	7 E Chilton	24 April	Late Afternoon		Short		0	0	2	
Sauk	40 NW Madison	21 May	5:10 PM				0	0		
Fond du Lac	20 W Fond du Lac	21 May	5:14 PM	NE			0	0		

TABLE 1. LIST OF REPORTED TORNADOES FROM BEGINNING OF RECORD THROUGH 1964—Continued

Place		Date	Time	Direction of Advance	Length of Path, Miles	Width of Path, Yards	Number of Persons		Estimated Damage	
County	Town						Killed	Injured	Property (exclusive of Crops)*	Crops*
Winnebago	5 W Oshkosh	21 May	5:30				0	0		
Trempealeau	Eleva	28 June	3:45		10	60	0	0	3	
Buffalo	Mondovi	28 June	Afternoon	SE	10					
Dodge	3 S Reeseville	8 Aug.	4:00 PM	S	Short	Narrow	0	0	2	
Iowa	15 SE Lone Rock	20 Aug.	4:05 PM				0	0		
		Two tornadoes, briefly touched ground.								
Taylor	3 N Medford	27 Aug.					0	0	Slight	
Monroe	8 N Sparta	28 Aug.	3:30 PM				0	0	4	
Rock	1½ N Union	15 Nov.	Late afternoon		2	Narrow	0	0	2	
Clark	2 NW Chili	15 Nov.	2:25		35	100	0	1	4	
		1961								
La Crosse	La Crosse	14 May	1:50 PM		1	35	0	0	4	
Burnett	Grantsburg	2 Aug.	7:00 PM	Touched momentarily						
Price	Park Falls	14 Aug.	7:50 PM	NE	5	400	0	0	5	4
St. Croix	Glenwood City	2 Sept.	9:30 PM				0	0		
Marathon	Fenwood	3 Sept.	12:10 AM				0	0		
Clark	5 W Thorp	3 Sept.	12:15 AM		3½	5	0	0	4	
Marathon	Athens	3 Sept.	1:00 AM				0	0		
Walworth	1 S Whitewater	22 Sept.	12:00 PM		5	Narrow	0	1	5	4
Fond du Lac	Campbellsport	22 Sept.	1:30 PM		4–5	300	0	0	3	4
		1962								
Fond du Lac	5 NE Ripon	17 June	6:00 PM	NE	1	75	0	0		
Clark	Thorp	23 June	4:40 PM				0	0	2	
Brown	Point Sauble, Green Bay	23 June	4:30 PM				0	0		
Portage	15 E Stevens Point	23 June		Briefly touched ground			0	0		
Milwaukee	West Allis	22 July	12:48 PM			25	0	0	3	
Lincoln	Merrill	24 July	5:00 PM				0	0	3	
Barron, Chippewa	Barron, Rice Lake, Bloomer, Cadott	15 Aug.	3:15 PM	SE		400	0	0	3	3
		Touched at Barron 8 NW at 3:15; at Rice Lake 12 SW at 3:30; Bloomer 14 NE at 5:00 PM; and Cadott shortly after 5:00 PM.								
Milwaukee	Greendale	4 Oct.	3:20 PM	NE			0	0	Minor	
Jackson	18 SE Neillsville	10 Oct.	8:30 AM		3	400	0	0	3	
		1963								
Dodge	Hustisford	8 June	7:15 PM	SE thne E	Short	30	0	0	5	
Dodge	Lomira	13 June	4:55	SE	Touched briefly.		0	0	2	
Kenosha	Near State Hwy 50 and County "B"	19 July	4-5 PM	S	8	30	0	0	4	4
Columbia	Prairie du Sac, Lodi	16 Aug.	7:15 PM	E	6	Narrow	0	13	5	4

TABLE 1. LIST OF REPORTED TORNADOES FROM BEGINNING OF RECORD THROUGH 1964—Continued

Place: County	Place: Town	Date	Time	Direction of Advance	Length of Path, Miles	Width of Path, Yards	Number of Persons: Killed	Number of Persons: Injured	Estimated Damage: Property (exclusive of Crops)*	Estimated Damage: Crops*
Lafayette and Green	Lamont to 3 E Argyle	2 Sept.	5-6 PM		10	Narrow	0	0	5	
Dane		2 Sept.	6:30 PM			Narrow	0	0		
		Touched down in rural Mazomanie: rural Waunakee and rural Sun Prairie.								
Marquette	Buffalo	2 Sept.	6:30 PM				0	0	3	
Forest	Laona	19 Sept.	6:00 PM		½	Narrow	0	0	4	
		1964								
Jackson	2 SE Melrose	4 May	5:00 PM	NE	9	200	0	1	5	
Crawford	Lynxville to Rising Sun	4 May	8:00-8:45 PM	NE	25	200	0	2	5	
Juneau	Fountain and Orange	4 May	8:00-8:20 PM	NE	6	100	0	0	4	
Oneida and Vilas	St. Germain	4 May	6:00 PM			125	0	0	4	
Juneau	3 W Necedah	4 May	8:30 PM			25	0	0	3	
Barron	7 W Cumberland	5 May	2:15 PM		¼	100	0	0	4	
Juneau	1 N Meadow Valley	7 May	2:30 PM	ENE	4	30	0	1	3	
Wood	Wisconsin Rapids	7 May	6:00 PM	E		100	0	14	5	
Vernon and Richland	Readstown to 3 SW Hillsboro	8 May	5:30 PM	NE	23	300	0	1	5	
Marathon	Bevent to Elderon	8 May	4:50 PM	NE	12		0	0	5	
Waupaca	1 W Clintonville	8 May	5:00 PM	NE	3	200	0	1	5	
Juneau–Adams		8 May	5:15 PM	NE	25	150	0	0	5	
Winnebago–Outagamie	Fox Cities area	8 May	6:30 PM	NE	35	25–100	0	5	6	
Buffalo	5 SW Gilmantown	23 May	7:30 PM	NE	2	100	0	0	4	
Trempealeau–Jackson	Pleasantville	23 May	7:30 PM	NE	10	100	0	0	5	
Brown	Bellevue	30 May	1:28 PM				0	0	0	
Shawano	Belle Plaine	9 June	2:30 PM				0	0	4	
Marinette	Pound	9 June	3:00 PM				0	0	4	
Barron	Cameron	18 June	6:00 PM	NE	7½	12	0	2	4	
Buffalo	Mondovi	20 June	8:10 PM				0	0		
		Touched ground briefly.								
Taylor	2½ W Medford	6 July	6:15 PM				0	2	3	
Washington	Jackson	6 July	9:30 PM				0	0		
St. Croix	Hamilton	28 July	7:15 PM				0	1	3	
Fond du Lac	8 E Fond du Lac	22 Aug.	1:55 PM	NE	Short	Narrow	0	0	3	
Fond du Lac	Fond du Lac	22 Aug.	3:15 PM	NE	1	500	0	2	5	
Portage	Grant	22 Aug.	Mid-afternoon	NE	7	Narrow	0	0	4	4
Dodge	Lowell	22 Aug	Mid-afternoon		Short	Narrow	0	0	3	3
Ozaukee	Port Washington	22 Aug.	3:55 PM	NE	1	50	0	30	6	
Milwaukee	Oak Creek	22 Aug.	4:00 PM	NE	2	400	0	0	5	
Barron–Burnett		28 Aug.	1:45-2 PM	NNW	4½	50	0	0	4	
Richland	Near Hwy. 60 and Co. "F"	3 Sept.	3:15-3:45 PM		15	850	0	4	5	4
Dodge	7 NW Hartford	3 Sept.	5:00 PM		Short	Narrow	0	0	3	3
Milwaukee	Milwaukee	3 Sept.	5:20 PM		1/8	100	0	0	5	

*After 1958, tornado damage is placed in the following categories:
1—Less than $50: 2—$50 to $500: 3—$500 to $5,000: 4—$5,000 to $50,000: 5—$50,000 to $500,000: 6—$500,000 to $5,000,000.

through 1915 and 293 tornadoes from 1916 through 1964. Unless otherwise specified, the data used in this paper are for the period 1916–1964.

Distribution of the number of tornadoes and number of tornado days by month is given in Figure 1. The number of tornadoes and tornado days reach the maximum in June, followed by May and July with a secondary peak in September. The two peaks occur at the approximate times of the beginning and ending of meteorological summer in Wisconsin, as well as the rainfall peaks of the year.

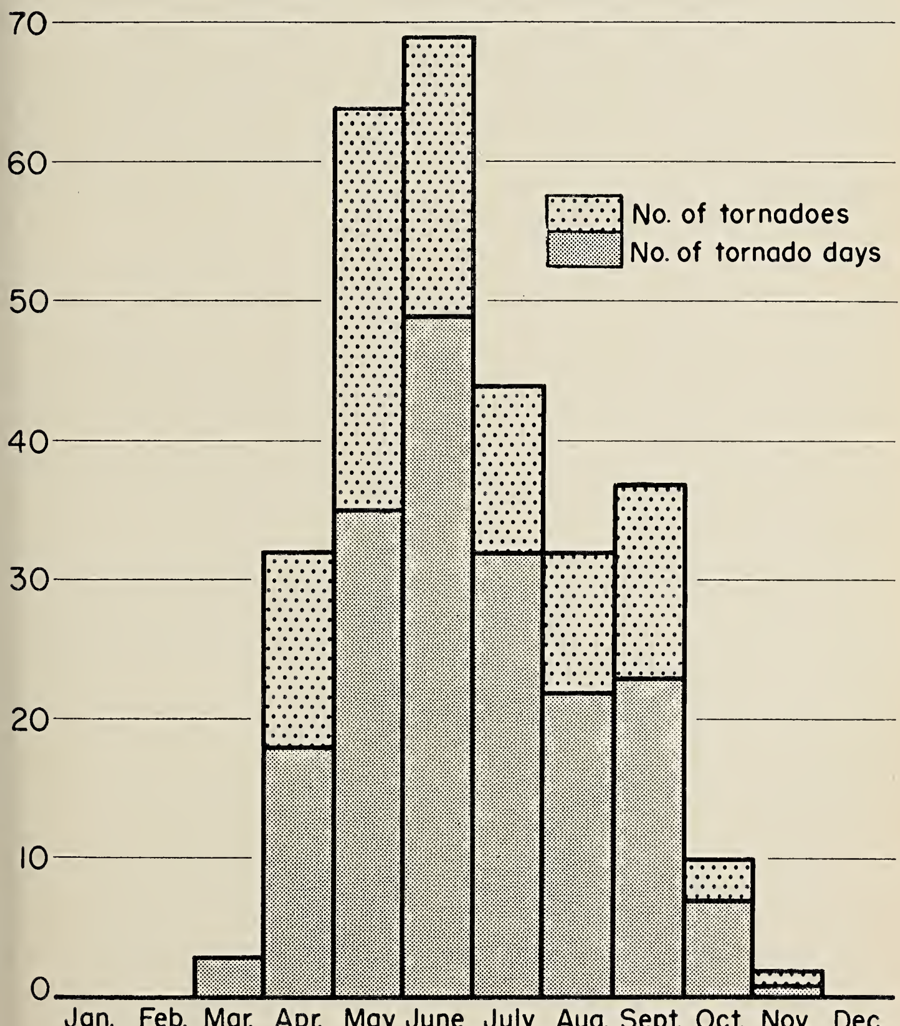

FIGURE 1. Number of tornadoes and tornado days, 1916–1964.

This timing is different from the national average, where the maximum number of tornadoes is reached in May with a secondary peak in November, and the number of days with tornadoes having one peak in June. Approximately 95% of the tornadoes and tornado days occur in the five-month period, April through September. No tornadoes have been reported in this state in December, January or February. The season's earliest recorded tornado occurred March 17, 1934, while the season's latest recorded tornado was November 15, 1960. Although tornado occurrences are generally distributed through the season, the highest probability is from June 20 to 25.

During the period 1916–1964, about 13% of the tornadoes were responsible for loss of human life, 28% were responsible for injury, and 32% were responsible for either death or injury. The fewer deaths and injuries in recent years are believed to reflect better forecasting, timely warning, and a better informed public knowing what safety precautions to take.

The number of tornadoes has averaged 6.0 per season, while the number of days with tornadoes has averaged 3.9 per season. (Table 2) No tornadoes were reported in 1917, 1923, 1939, 1943, and 1947. The thirty-three tornadoes reported and confirmed in 1964 makes it the highest season on record, followed closely by 1959 with thirty. There have been deaths in twenty-two of the forty-nine years in this study for an average of 3.2 deaths per year. Tornado related injuries occurred in thirty-three of these years for an average of 19.6 per year.

The most frequent time of day for tornadoes to occur is between 3 P.M. and 7 P.M., (Table 3) with 5 P.M. being the most probable hour. Three out of every four tornadoes have touched down between 1 P.M. and 8 P.M. The hours of least probability are between 2 A.M. and 11 A.M.

TABLE 2. NUMBER OF REPORTED TORNADOES, TORNADO DAYS, DEATHS, INJURED, PROPERTY LOSS BY YEAR, 1916–1964.

Year	Number	Days	Deaths	Injured	Property Loss
1916	1	1	0	0	$ 20,000
1917	0	0	0	0	0
1918	3	3	9	103	715,000
1919	1	1	——	——	500
1920	1	1	1	——	25,000
1921	2	2	——	2	620,000
1922	3	3	8	100+	560,000
1923	0	0	0	0	0
1924	7	3	43	276	1,618,000
1925	4	4	2	0	66,500
1926	2	2	3	17	91,000
1927	2	2	0	——	21,200
1928	8	4	0	13+	387,500
1929	6	4	12	131	1,247,000
1930	12	6	8	80	2,173,400
1931	4	3	1	9	333,100
1932	1	1	0	0	2,000
1933	7	6	2	9	220,000
1934	8	8	0	3	45,300
1935	7	5	0	1	152,800
1936	3	3	0	0	35,300
1937	1	1	0	0	10,000
1938	2	2	0	2	15,000
1939	0	0	0	0	0
1940	2	1	2	7	7,500
1941	4	4	0	2	27,000
1942	9	6	1	4	258,500
1943	0	0	0	0	0
1944	5	4	7	69	1,130,600
1945	4	4	1	3	138,000
1946	1	1	0	0	10,000
1947	0	0	0	0	0
1948	4	1	2	12	56,750
1949	4	4	0	0	5,000
1950	5	1	3	50	729,000
1951	5	4	7	15	637,000
1952	1	1	2	6	250,000
1953	3	2	4	37	2,030,000
1954	12	8	0	4	405,600
1955	9	5	0	7	386,000
1956	6	4	9	57	1,380,000
1957	12	6	1	7	423,500
1958	17	10	27	182	9,635,000
1959	30	17	0	14	*
1960	14	9	0	1	*
1961	9	6	0	1	*
1962	9	7	0	0	*
1963	10	6	0	13	*
1964	33	14	0	66	*
Total	293	190	155	1303	
Average	6.0	3.9	3.2	26.6	

*Losses categorized by classes after 1958.

TABLE 3. NUMBER OF TORNADOES BY HOUR AND MONTH, 1916–1964

Hour	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
00				1	1	1	1	1	3				8
01				1	1	1	2		1				6
02							1						1
03			1		1	1							3
04						1			1				2
05													0
06							2						2
07						1							1
08										1			1
09					1		1						2
10					1								1
11				1					1				2
12			1		1		2		2	1			7
13				2	4	4	3	1	1				15
14				3	6	4	2	3	2		1		21
15				4	11	6	1	4	5	1			32
16				8	7	4	6	6	2	2			35
17				2	9	9	7	4	3	3			37
18				3	7	7	5	3	10				35
19			1	2	7	11	4	5	2				32
20				2	3	5	2	1					13
21					1	4			1				6
22					1	1							2
23					1	2			1				4
Unknown				3	1	7	5	4	2	2	1		25
TOTAL			3	32	64	69	44	32	37	10	2		293

Surface winds in weather systems with devoloping tornadoes are usually from the southwest, and most tornadoes move from this direction. (Figure 2) However, tornadoes can come from any

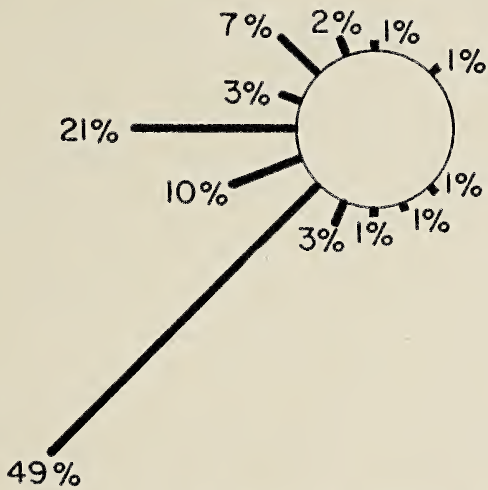

FIGURE 2. Tornado rose for Wisconsin showing percent of reported tornadoes moving from indicated directions, 1916–1964.

direction. Ninety fiive per cent of the tornadoes in Wisconsin have moved from a westerly direction with nearly fifty percent moving directly out of the southwest. National averages and Lapham's windfalls closely approximate these figures. The length of individual paths vary from brief touch downs to 170 miles. Although the average tornado path is 11.7 miles, the median of four miles is considered more representative since the average includes several extremely long paths. Tornado paths have been less than one mile in length 26% of the time, for one to five miles 32%, six to ten miles 15%, eleven to twenty miles 14%, twenty-one to fifty miles 9%, and over fifty miles 4% of the time. The average width of the path is 285 yards, while the median is 100 yards. Widths have been under 100 yards 35% of the time, from 100 to 200 yards 32%, from 300 to 500 yards 15%, from 600 to 1,000 yards 9%, and greater than 1,000 yards 5% of the time.

Tornadoes have been observed in nearly ever county in the state. (Figure 3) The area of greatest frequency is the west central section, while the area of least frequency is a band of counties along the northern border of the state and a band along Lake Michigan north of Milwaukee. A map of Lapham's windfalls, also by county,

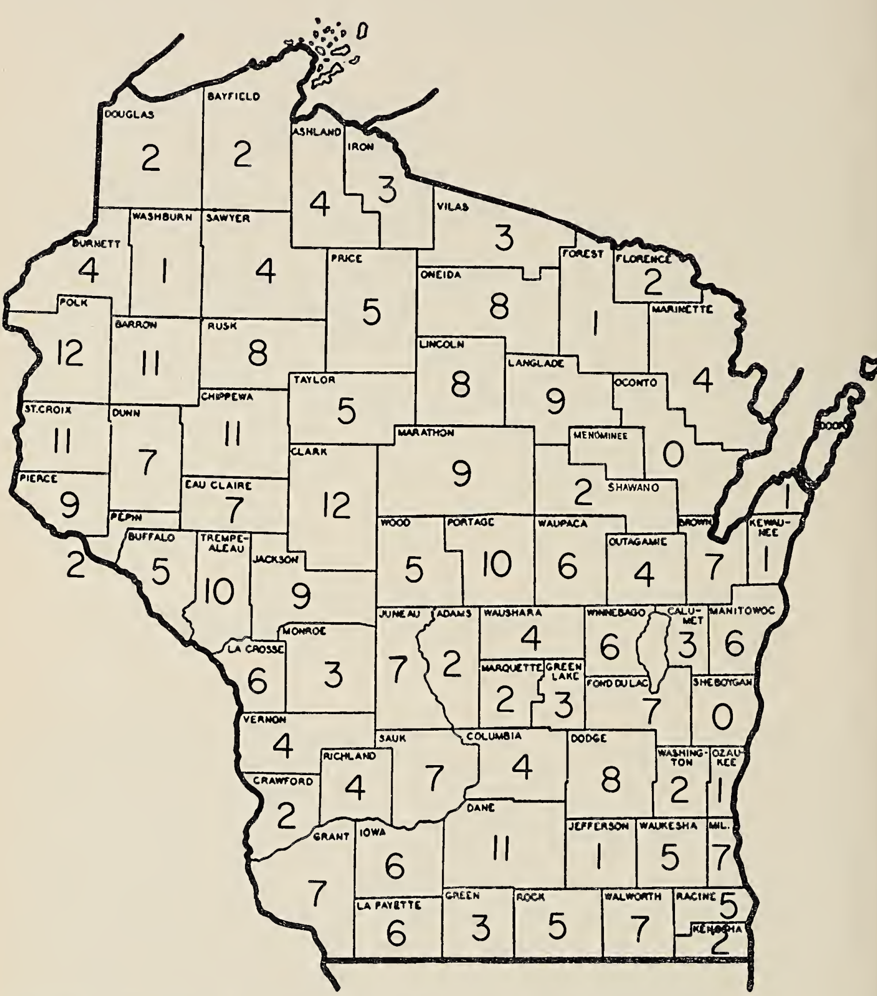

FIGURE 3. Number of reported tornadoes by county, 1916–1964.

makes an interesting comparison. (Figure 4) The highest frequency of windfalls is to the east and north of the highest frequency of tornadoes, suggesting that there were different wind flow patterns in the two periods. In the forty-nine year span, 1916–1964, no tornadoes were reported in Oconto County although early surveyors listed twenty-three windfalls in the county. Bryson's work with Wisconsin's earliest weather data indicates that wind

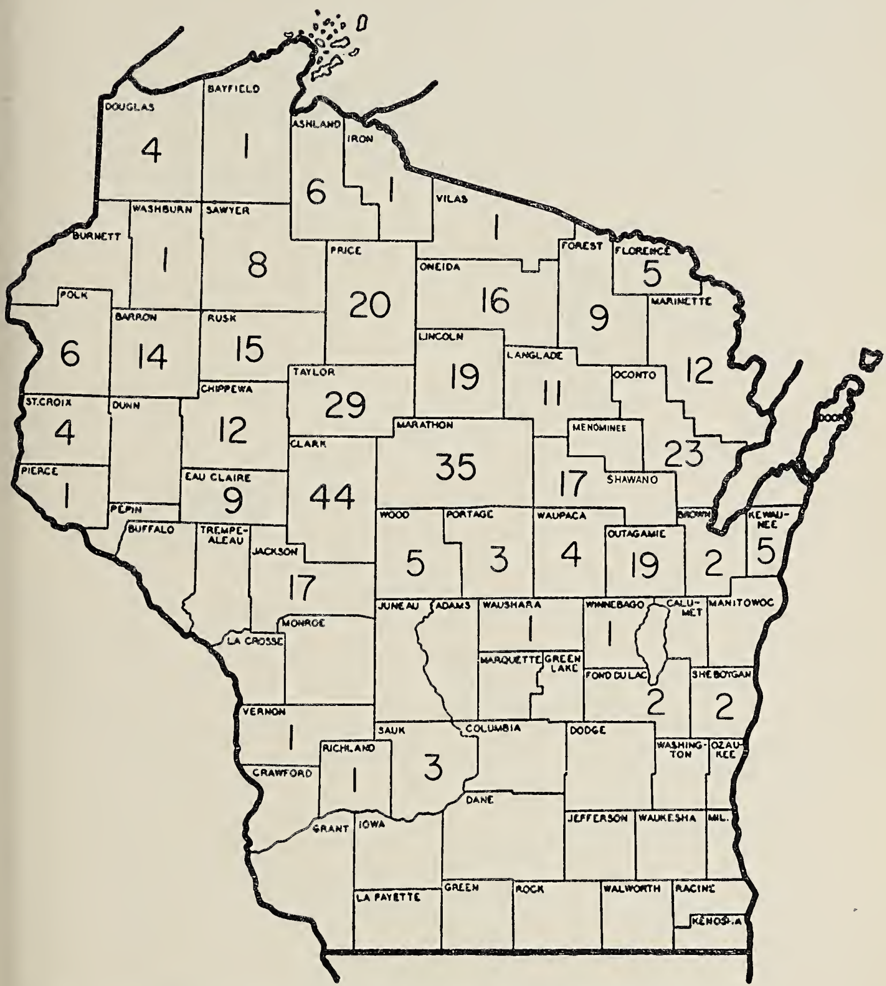

FIGURE 4. Number of windfalls by county. (before settlement)

flow patterns changed between the early 1800's and recent times, and that the changes took place between 1870 and 1880.[9] In making the comparison one must keep in mind that the windfalls are only for the part of the state unsettled and under virgin forest at the time of the survey, that a skipping tornado could leave a number of windfalls, and that some of the windfalls were probably the result of straight line winds.

Outstanding tornadoes are arbitrarily defined in this paper as meeting one or more of the following criteria: (1) loss of life to the extent of at least five, (2) property damage amounting to at least $500,000, (3) and path at least twenty-five miles in length. (Figure 5, Table 4) Wisconsin's "tornado alley" is clearly located in the west central counties, it appears to be approximately in line with the tornado gradient increasing southwest through Iowa into Kansas and Oklahoma. (See Figure 6). A large number of eastern

FIGURE 5. Outstanding tornadoes from beginning of record through 1964. Where loss of life was at least 5, or property damage was at least $500,000, or path was at least 25 miles long.

TABLE 4. OUTSTANDING TORNADOES FROM BEGINNING OF RECORD TO 1964. (WHERE LOSS OF LIFE WAS AT LEAST 5, PROPERTY DAMAGE WAS AT LEAST $500,000, OR PATH WAS AT LEAST 25 MILES LONG)

No.	Date	Counties	Time of Occurrence	Lives Lost	Injured	Estimated Property Damage	Length in Miles
1	1865, June 28	Vernon	4:00 PM	24	100	$ 200,000	40
2	1876, March 10	Grant	4:30 PM	9	15	46,000	5
3	1877, July 7	Oconto	6–7 PM	8	30	300,000	6
4	1878, May 23	Iowa to Dane	3:00 PM	19	45+	130,980	150
5	1881, Sept. 29	Buffalo	afternoon	12			
6	1883, May 18	Racine	7:00 PM	25	100	200,000	3
7	1884, Sept. 9	St. Croix to Price	5:00 PM	6	75	4,000,000	120
8	1898, May 18	Eau Claire to Clark, Langlade	4:00 PM	17	100	710,000	110
9	1898, May 18	Price, Oneida	6:30 PM	7	15	200,000	50
10	1899, June 12	St. Croix to Barron	6:30 PM	117	125	600,000	45
11	1907, July 3	Clark to Juneau	4:45-6:30 PM	26		100,000	95
12	1911, Nov. 11	Rock	2:00 PM	9	10	500,000	30
13	1915, June 12	Crawford	5:30 PM	7	25	100,000	20
14	1918, May 19	Rusk, Price	1:00 AM	1	2	50,000	40
15	1918, May 21	Grant, Iowa, Richland, Sauk	6:30 PM	8	100	650,000	85
16	1921, Aug. 19	Dane	4:15 PM	0	2	620,000	—
17	1922, June 15	St. Croix to Barron	7:00 PM	8	100+	500,000	50
18	1924, June 20	Racine	7:30 AM	0	12	500,000	30
19	1924, Aug. 7	Trempealeau, Jackson	6:30 PM	4	100	200,000	27
20	1924, Sept. 21	Barron to Ashland	2:00 PM	10	50	250,000	90
21	1924, Sept. 21	Eau Claire to Oneida	2:20 PM	26	150	564,000	120
22	1926, July 16	Bayfield to Vilas	6:15 PM	3	16	90,000	85
23	1929, April 5	Pierce to Iron	5:45 PM	12	100	725,000	170
24	1929, April 6	Grant to Green	4:30 PM	0	25	250,000	45
25	1930, May 1	Trempealeau to Monroe	7:30 PM	1		202,000	33
26	1930, May 1	Walworth to Milwaukee	11:00 PM	0		30,000	40
27	1930, June 13	Trempealeau to Marathon	5:30 PM	0	0	600,000	80
28	1930, June 13	Pierce to Chippewa	5:30 PM	6	80	1,000,000	125
29	1931, Sept. 21	Rock to Waukesha	7:30 PM	1	9	300,000	50
30	1935, July 5	Marathon	7:15 PM	0	0	125,000	25
31	1942, May 13	Jackson, Clark	3:00 PM	1	1	100,000	35

TABLE 4. OUTSTANDING TORNADOES FROM BEGINNING OF RECORD TO 1964. (WHERE LOSS OF LIFE WAS AT LEAST 5, OR PROPERTY DAMAGE WAS AT LEAST $500,000, OR PATH WAS AT LEAST 25 MILES LONG)—Continued

No.	Date	Counties	Time of Occurrence	Lives Lost	Injured	Estimated Property Damage	Length in Miles
32	1944, June 22	Lafayette	6:30 PM	7	65	1,000,000	36
33	1945, Sept. 19	Wood, Portage	3:00 PM	0	2	25,000	25
34	1950, June 25	Oneida	9:00 PM	2	50	500,000	12
35	1951, Sept. 12	Pepin, Dunn	11:30 AM	0	2	127,000	30
36	1951, Sept. 26	Waupaca	3:50 AM	6	3	250,000	20
37	1953, May 10	Pierce to Douglas	6:30 PM	4	27	1,000,000	100
38	1953, May 10	Buffalo to Price	6:30 PM	0	10	1,000,000	100
39	1956, April 3	Green Lake, Winnebago	2:05 PM	7	50	1,000,000	12
40	1958, May 24	St. Croix, Pierce	2:25 PM	0	5	385,000	50
41	1958, June 4	St. Croix–Dunn	5:30 PM	19	110	7,000,000	32
42	1958, June 4	Chippewa County	6:45 PM	4	56	1,000,000	12
43	1958, June 4	Eau Claire to Marathon	7:30 PM	4	3	750,000	60
44	1958, July 14	Iron	2:45 PM	0	0	75,000	25
45	1959, May 10	Brown	8:50 PM	0	3	500,000+	6
46	1960, Nov. 15	Clark to Marathon	2:25 PM	0	1	5,000+	35
47	1964, May 4	Crawford	8:00 PM	0	2	50,000+	25
48	1964, May 8	Juneau, Adams	5:15 PM	0	0	50,000+	25
49	1964, May 8	Winnebago, Outagamie	6:30 PM	0	5	500,000+	35
50	1964, Aug. 22	Ozaukee	3:55 PM	0	30	500,000+	1

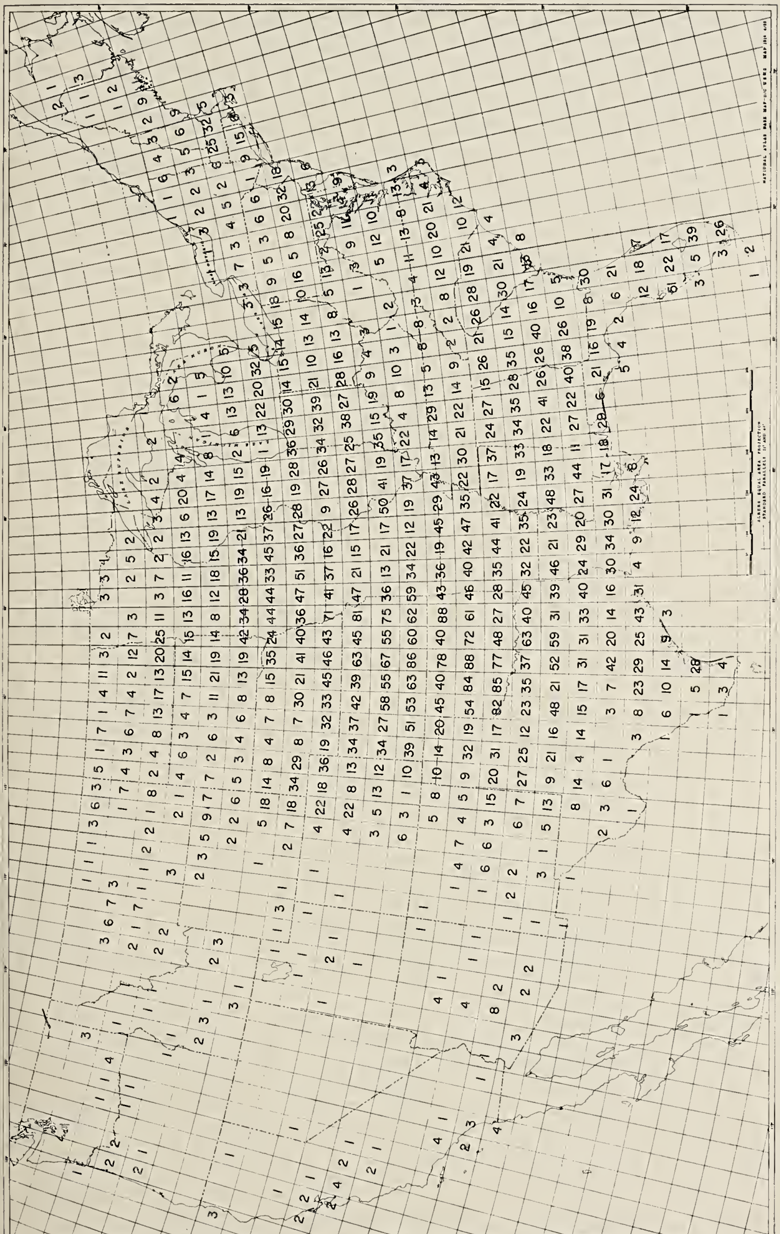

FIGURE 6. Number of reported tornadoes in the United States by 1° "squares", 1916–61. Based on the first point of contact with ground of 11,053 tornadoes.

counties have never been crossed by an outstanding tornado, as defined above. Fortunately, the heavier populated and industrialized part of the state has largely escaped the longer paths of whirling destruction. Figure 5 is in sharp contrast to Figure 3, number of tornadoes by county, where, although the greatest frequency is in west central counties, there is a general geographic distribution with gradual decreases outward from the maxima.

A waterspout is a tornado occurring over water. (Table 5) It is not unusual for a tornado to change to a waterspout or vice

TABLE 5. WATER SPOUTS, 1843–1964

PLACE	DATE	TIME	
Lake Michigan	August 20, 1843	Morning	Near Kenosha
Lac LaBelle	May 31, 1851		Near Oconomowoc
Lake Michigan	July 31, 1867	Dawn	Near Milwaukee
Lake Winnebago	July 22, 1938	12:30 PM	
Lake Koshkonong	July 6, 1954	PM	Near Madison
Sturgeon Bay	August 21, 1955	2:30 PM	Riley's Point near Little Sturgeon
Lake Winnebago	July 1, 1956	Noon	2 water spouts
Lake Winnebago	June 28, 1960	10:35 AM	
Green Bay	June 23, 1962	4:30 PM	Near Point Sauble
Big St. Germain	May 4, 1964	6:00 PM	Crossed over Vilas County lake drawing water to an estimated 200 feet
Lake Michigan	May 8, 1964	8:37 PM	Northeast of Milwaukee
Lake Winnebago	July 27, 1964	4:15 PM	Near High Cliff

versa. The funnel-shaped cloud dips to the water where upon the water may appear to boil and turn white as it rises in the funnel. Most authorities say that the funnel of a waterspout is composed of condensed water and is not, as is popularly thought, a column of water.

To make this report complete, a list of reported funnels is included. (Table 6) A funnel is defined as a whirling inverted cloud cone, most frequently found under cumulo-nimbus clouds. When the funnel touches the earth's surface, it is called either a tornado or waterspout. Most funnels never develop to the point of touching the earth, this phenomenon is often confused with mammatus or distant virga. Little or no record of funnels was kept until the late 1950's. Many of the funnels listed were part of a weather system that was generating tornadoes.

TABLE 6. FUNNELS 1916–1964

Place	Date	Time	
	1932		
Polk County	Aug. 10	4:45 PM	Town of Clayton
	1937		
Columbia County	June 15	1:30 PM	
	1956		
Brown County	July 1	12:00 PM	Bellevue
Brown County	July 1	12:00 PM	De Pere
Waushara County	July 15	6:47 AM	Plainfield
Beaver Dam	July 21	4:00 PM	3 funnels
	1957		
La Crosse 25 SE	May 31	1:30 PM	
Northfield	May 31	4:29 PM	
Madison N	July 7	12:36 PM	
Green Bay 5S	July 11	1:00 PM	
Madison 5 S	July 12	9:20 AM	
Madison 8 S	July 12	4:02 PM	
	1958		
Green County	May 31	3:30 PM	
St. Croix County	June 22	3:25 PM	
Walworth	June 22	7:50 PM	
Taylor County	July 14	3:15 PM	
Columbia County	Oct. 9	4:30 PM	
Dodge County	Oct. 9	5:30 PM	
	1959		
Eau Claire 35 NNE	May 4	10:05 AM	
Waupaca County	May 5	12:30 PM	
Eau Claire 4 W	May 5	7:25 PM	
Spring Valley	May 5	7:40 PM	
Rusk County	May 5	7:30 PM	
Chippewa Falls	May 5	7:45 PM	
Chippewa Falls	May 5	8:04 PM	
Eau Claire 6 NE	May 5	8:09 PM	
Ripon 5 N	May 28	3:05 PM	
Arlington	May 28	3:45 PM	
Green Bay	May 28	3:52 PM	
Lancaster	May 29	6:45 PM	
Menomonie	June 26	1:44 PM	
Eau Claire 15 NNE	June 26	5:55 PM	
Manitowoc County	Aug. 14	Evening	
Green Bay 15 S	Aug. 29		
Eau Claire 30 E	Sept. 22	5:30 PM	
Milwaukee 25 SW	Sept. 28	2:23 PM	
Germantown	Oct. 8	4:45 PM	
Milwaukee 40 S	Dec. 9	5:15 PM	
	1960		
Milwaukee	May 8	10:32 AM	
La Crosse 18 ENE	May 27	4:00 PM	
Madison 45 NNE	June 28	5:52 PM	
Madison 35 SE	July 2	5:30 PM	
Milwaukee 10 S	July 2	8:25 PM	
Madison 45 NNW	July 27	8:00 PM	

TABLE 6. FUNNELS 1916–1964—Continued

PLACE	DATE	TIME	
Green Bay	Aug. 13	8:55 PM	
Madison 40 NE	Aug. 20	10:00 AM	
Milwaukee 20 NW	Aug. 20	3:00 PM	
Green Bay 60 WSW	Aug. 28	6:10 PM	
Green Bay 25 SW	Aug. 28	6:40 PM	
Summit Lake 6 W	Sept. 7	5:00 PM	
Racine County	Sept. 24	4:25 PM	
Belleville	Nov. 15	6:15 PM	
	1961		
Milwaukee 50 W	May 14	4:00 PM	
Neillsville	May 14	Afternoon	
Winchester	May 14	Late afternoon	
Lone Rock	June 10	5:30 PM	2 funnels
Eau Claire 40 NE	June 21	2:56 PM	
Ladysmith	Aug. 4	Evening	
Sheboygan 1 W	Sept. 22	1:50 PM	
	1962		
Eau Claire 10 N	May 14	2:00 PM	
Appleton 16 SE	June 8	9:22 PM	
Columbus 7 N	June 17	5:00 PM	
Butte des Morts	June 17	7:15 PM	2 funnels over lake
Portage County	June 17	7:30 PM	
Lake Winnebago	June 18	10:00 AM	2 funnels over northern part of lake
Oshkosh 30 SW	July 11	2:58 PM	
Eau Claire 6 S	July 17	3:45 PM	
Eau Claire 10 SW	July 17	3:45 PM	
Eau Claire 20 WNW	July 17	3:45 PM	
La Crosse 30 SE	July 22	6:40 PM	
Green Bay	July 24	7:40 PM	2 funnels northeast of Green Bay
Madison 35 NE	Aug. 29	9:10 PM	
	1963		
Hartland	June 8	7:45 PM	
Burlington 10 SW	June 8	8:00 PM	3 funnels
Madison	Sept. 2	5:25 PM	
	1964		
Blue River	June 22	11:30 AM	

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3. INCREASE A. LAPHAM, "Personal Papers", Wisconsin Historical Society Library.
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7. Quotation from Increase A. Lapham papers.
8. Since there are no times of tornado occurrences given by windfall records, Lapham's "tornadoes" interpretation would have been more correctly labeled "tornado paths", which may or may not have occurred in the same storm.
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REGIONALISM IN THE THREE SOUTHS

*Kimball King**

Every corner of America in the late nineteenth century boasted its share of regional writers, but the local color movement in the South was especially significant. The South had produced so few novelists and poets before the Civil War that their appearance in large numbers afterwards was observed with particular interest. Southern writers recorded the passing of a way of life and the resulting social upheaval. The rest of the nation watched with the proverbial interest of the conqueror in the conquered. The most popular literary descriptions of Southern life appearing after the Civil War were nostalgic eulogies of a vanishing chivalric world. Such oversimplified appraisals of Southern institutions gained public acceptance but failed to reflect the complexity of the South and its literature.

The plantation literary tradition and its chief spokesman, Thomas Nelson Page, tended to overshadow the contributions of Southern writers who were concerned with the future of their region and who protested that the real South lay undiscovered. By investigating the myths of Southern life and the seldom recognized attempts of a few Southerners, such as George W. Cable and Mary Murfree, to refute these myths we learn a good deal about our nation as a whole and also about one of its more "curious" regions. It is interesting that a just survey of Southern literature reveals themes which appear in the Midwestern stories of Hamlin Garland. A closer look at the Southern literature of this period will illustrate the common bonds between dissimilar localities.

Southern literature is not the product of one, but of three regions: the Tidewater and Atlantic coastal South, the mountaineers' South, and the deep South. Before the first World War the literary image of the South was dominated by accounts of life on the Tidewater plantations. More recently the Southern image has been shaped by writers describing Mississippi, Alabama, and Louisiana. A meaningful survey of Southern letters involves the consideration of authors from all three regions.

Although the early settlers of the Southern Atlantic states prided themselves on their cultural sophistication, they were strangely unconcerned with reading or authorship. Page apologetically declared that the role of the planter class in shaping a democratic

*The author is a member of the Department of English at the University of North Carolina.

government and an equitable system of law interfered with a purely belletristic attitude toward letters. Less than five percent of the white population of the South were slave-holders[1] and only a minute portion of these comprised the so-called planter class. Yet it was the men with the greatest commitments to the plantation system and to self-government who became the literary spokesmen for their region. Nearly all significant ante-bellum literature therefore has as its focus plantation life. Francis Pendleton Gaines, surveying this field of literature in 1925, notes the long tradition of plantation literature beginning with John Pendleton Kennedy's *Swallow Barn* in 1832. *Swallow Barn* is a series of sketches in the tradition of Washington Irving's *Bracebridge Hall* (1822). As such it portrays the happier aspects of old-time society in the South. The author's concern is in illustrating regional types rather than in developing believable personalities. Two decades after *Swallow Barn* and Kennedy's later novels, *Horseshoe Robinson* and *Rob of the Bowl,* Philip Pendleton Cooke and his brother, John Esten Cooke, added some glamorous chapters to the plantation legend. Philip Cooke's stories of Virginia life and John Cooke's novels, *Leather Stocking and Silk* (1852) and *Virginia Comedians* (1854), exaggerated the virtues of the Southern landowner. Page accused John Cooke of "writing through the rose-colored lenses of Sir Walter Scott,"[2] and George W. Bagby in 1859 declared his intention to bring about "the unkind but complete destruction"[3] of Cooke's reputation. Later Bagby turned romancer himself in "The Old Virginia Gentleman" (1877) ; he and Page did more to encourage ancestor worship and nostalgia for the Old South than any of their literary predecessors. As an example, note Bagby's description of the plantation mistress which was the inspiration for Page's heroines in *Red Rock* (1898) and *In Ole Virginia* (1887) :

> The ways of the great world had ceased long ago to be her ways. She lived in a little world of her own. She could not keep pace with the fast-changing fashions, which, in her pure mind, were not always for the better. Her manner was not, in the usual sense, high-bred; for hers was the highest breeding, and she had no manner. But her welcome as you entered her door, and her greeting, meet her where you might, on the endless round of her duties, in-doors or out, was as simple and genial as sunshine, and as sweet as spring water.[4]

William Gilmore Simms was more involved in sponsoring a Southern literary renaissance than in praising the aristocracy. With James Wright Simmons he founded the *Southern Literary Gazette*

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[1]H. R. Floan, *The South in Northern Eyes:* 1831–1861, (Austin, Texas, 1958), p. viii.

[2]Quoted by J. O. Beatty, *John Esten Cooke,* pp. 67–70.

[3]Spiller, Robert E., Willard Thorp, Thomas H. Johnson and Henry Seidel Canby, eds., *Literary History of the United States,* pp. 848–49.

[4]G. W. Bagby, *The Old Virginia Gentleman,* (New York, 1911), p. 20.

"to encourage the efforts and to do justice to the claims of native genius."[5] Simms' novels, such as *Martin Faber* (1832), *Beauchampe* (1842) and *Charlemont* (1856), were based on historical incident, as was his most widely read book, *The Yemassee* (1835), which deals with an Indian uprising and is often compared to James Fenimore Cooper's stories of the frontier. Simms believed the future of Southern letters depended on a judicious use of local materials to present themes of universal interest. In his preface to *The Wigwam and the Cabin* (1856) he made some prophetic remarks about the proper goals of regional authors:

> To be *national* in literature one must needs be *regional*. No one mind can fully or fairly illustrate the characteristics of any great country; and he who shall depict one section faithfully has made his proper and sufficient contribution to the great work of national literature.[6]

Simms nevertheless recognized the need to justify Southern institutions to a national reading public. He wrote to B. F. Perry that he was supporting the *Southern Quarterly Review* so that "we may have at least one organ among ourselves to which we may turn when it becomes necessary to express Southern feelings and opinions."[7] The *Southern Quarterly Review* supported the social and economic ideals of the plantation system. So, too, did the Uncle Remus stories of Joel Chandler Harris, the short stories of Armistead Gordon and the poetry of Irwin Russell.

Page was unquestionably the most eloquent spokesman for the plantation system. Although Page followed Kennedy, the Cookes, Bagby, and Simms in a well-established literary tradition, Gaines has noted that Page surpassed his predecessors in embellishing the image of an ideal society:

> [Page is] far more passionate in the maintenance of a hypothesis of departed glory, paints in more glowing colors, is uniformly more idealistic, descends less frequently—if ever—from the legends of romantic vision.[8]

From the works of Page it is possible to construct the image of an aristocratic society which Americans in other regions accepted as an accurate picture of the ante-bellum South. Beginning with "Uncle Gabe's White Folks," a dialect poem Page wrote in 1876, the Virginia author gained an eager audience throughout America. His popularity resulted partly from the interest of Northeastern and Midwestern readers in the recently defeated South. Page gave detailed accounts of an heroic people and their unusual customs and heritage. Edmund Wilson has observed that the nation was

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[5]E. W. Parks, *William Gilmore Simms as Literary Critic,* (Athens, Ga., 1961), p. 89.

[6]W. G. Simms, *The Wigwam and the Cabin,* (Chicago, 1856), pp. 4–5.

[7]Quoted by Parks, pp. 101–102.

[8]F. P. Gaines, *The Southern Plantation,* (New York, 1925), p. 77.

anxious to suppress unhappy memories of the Civil War and that Page's idealized view of the South suited the public's demand that "the old issues be put to sleep."[9] Page's stories and novels were written in the spirit of reconciliation. Although he extolled the bravery of Confederate soldiers, he noted the original reluctance of his heroes to become involved in war and praised their gracious acceptance of defeat and their renewed allegiance to the Union after the War. In an infrequently cynical moment Page accounted for his literary success to Grace King:

> Now I will tell you what to do; for I did it. Just rip the story open and insert a love story. It is the easiest thing to do in the world. Get a pretty girl and name her Jeanne, that name always takes! Make her fall in love with a Federal officer and your story will be printed at once! The publishers are right; the public wants love stories. Nothing easier than to write them.[10]

Page's allusion to "the publishers" is significant. Scribner's and other important national magazines welcomed the sentimental tales of local color writers. Northern magazine editors encouraged their Southern contributors to take part in creating a mythical kingdom below the Mason–Dixon line. The unwitting contribution of abolitionists in the early nineteenth century to ante-bellum glory is often forgotten. Mrs. Stowe, William Lloyd Garrison, Wendell Phillips and Whittier in their vehement denunciations of Southern institutions sketched the outlines of a mythical society which would later inspire partisans of the Southern cause. The abolitionists generally had a scanty first-hand knowledge of the South and overemphasized the aristocratic basis of plantation life. The plantations they described were more lavish than great European estates while the landlords were as rich and autonomous as English noblemen. Howard R. Floan has called attention to Phillips' beliefs that the slaveholders possessed a terrible but magnificent domain:

> He conjured up a land of whipping posts and auction blocks, a feudal society in which newspapermen, politicians, and clergymen were vassals. The nobility controlled family, church, and government. The slave power he described as a cable of three strands: the prejudice of race, the omnipotence of money, and the almost irresistible power of the aristocracy. Nobility and aristocracy were evocative terms in the New England of his day, and the most summary abstraction of them all was Phillips' epithet, "the South is the thirteenth and fourteenth centuries."[11]

Page applied new value judgments to the abolitionists' collective portraits. He emphasized the medieval concepts of *gentilesse,* the exalted position of women, and the chivalric behavior of the

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[9]Edmund Wilson, *Patriotic Gore,* (New York, 1962), p. 613.

[10]Quoted by J. B. Hubbell, *The South in American Literature: 1607–1900,* (Durham, N.C., 1954), p. 735.

[11]Floan, p. 13.

landlords. The wealth and power of the Virginia planter is magnified in Page's fictional representations, and his descriptions of the Tidewater country possess more the aura of Augustan Rome than of colonial America. In the creation of an ideal civilization Page blended the history and folk-lore of Virginia with his boyhood memories of plantation life. He believed in an ordered society, roughly based on the principles of the Chain of Being but modified by Christian charity and paternalism. The harmony of civilization depends, he believed, upon a stratified society whose leaders are guided by duty and honor. While Page's view of society was anachronistic and his attitudes toward art derivative of English culture, he recognized the value of tradition[12] which so many chauvinistic regional writers denied. One recalls Garland's narrow-mindedness in *Crumbling Idols* (1894) where he tends to dismiss the accomplishments of the past, asserting that "to apply ancient dogmas of criticism to our life and literature would be benumbing to the artist and fatal to his art."[13]

Page's noble characters are often romantic stereotypes, but we must remember that the passing of a civilization is an epic subject. Individuals too realistically defined would detract from the author's eulogy of the Old South. As Corra Harris observed, Page's legendary figures are unlike "real men or women, but they are created in the spiritual, mettlesome likeness of ten thousand who did live in the South at that time."[14] One explanation for the unqualified nobility of Page's heroes is that they are cast in the image of Robert E. Lee. Lee was to Page the ideal Virginian. The shadow of the Confederate leader, gigantic in the sunset of an era, became for Page the measure of a gentleman. Lee's attributes are reflected in the author's most important fictional spokesmen, such as Dr. Cary in *Red Rock*. Dr. Cary loses his only son in the war he hoped to avoid fighting; he is evicted from his plantation when he cannot pay the property taxes. But he proudly resigns himself to life in his former overseer's cabin and attends to the sicknesses of his poverty-stricken neighbors and ex-slaves. His last act of Christian charity is a visit to an ailing carpetbagger whose cruelty has subjected the Cary family to innumerable privations. The doctor's subsequent death demonstrates the aristocrat's unremitting sense of duty.

Page indicates the two-sided aspects of paternalism in his works. Negroes remain loyal to their masters after the Emancipation, and the masters offer their protection and trust in return. In Page's story, "Meh Lady," the mistress of the plantation on her deathbed

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[12]Note Page's lifelong interest in classics and his book-length study of Dante written just before his death.

[13]Hamlin Garland, *Crumbling Idols,* (Chicago, 1894), p. 66.

[14]Corra Harris, "The Waning Influence of Thomas Nelson Page," *Current Literature,* XLIII (August, 1907), 171–172.

entrusts her daughter's well-being and her material possessions to her butler, Unc' Billy. The author's most famous tale, "Marse Chan," is a vivid illustration of the principle of *noblesse oblige.* Colonel Channing is blinded when he runs into a burning barn to save one of his slaves. Similarly young Marse Chan's Negro manservant, Sam, risks his own life to accompany the young soldier to battle and to bring home the boy's body when he is killed. "Marse Chan" was Page's first published story, and it epitomizes the spirit of the author's eighteen-volume Plantation Edition of novels, stories, poems and essays. Sam tells a passer-by that life on the Channings' plantation before the War "wuz de good old times, marster, de bes' Sam ever see."[15] Sam recalls the lavish hospitality of the plantation and the gallant behavior of the young aristocrats. He glories in the recollection of Marse Chan's bold courtship of Anne Chamberlain; he notes with pride the boy's knightly impetuosity, his quick defense of Colonel Chamberlain's honor. While Sam's narrative gives the story the ring of authenticity, the reader is aware of the tenuous line between myth and reality. Gerald W. Johnson referred to Page's South as "the recrudescence of the Arthurian legend of loyalty, love and derring-do all compact—in short, romance."[16] The spirit of romance which suffuses the stories of Page and his many imitators after the War satisfied the demands of a nation exhausted by realities. The plantation tradition with its emphasis on an idealized feudal order became the most widely accepted expression of Southern life.

The early French and Spanish settlers of Florida and Louisiana and the Gulf Coast states fostered a way of life which differed considerably from the Atlantic coastal plantation society extolled by Page and his literary predecessors. Early inhabitants of the Louisiana territory, for example, had no control over their government which was run by France and which was autocratic rather than democratic. Louisiana's law was based on Roman rather than English common law; the prevailing customs and institutions of the state were continental in spirit. Creole landowners did not possess the agricultural estates of the Virginia planters although they were frequently more worldly and more adept at mercantile pursuits. The first literary endeavors were written in French, and even spoken English was shunned by the leaders of the community. Charles Gayarré is notable as one of the earliest Creoles to write proficiently in English. American literary history in the Mississippi region begins therefore in 1830 when Gayarré published his "Essai historique sur la Louisiane." Gayarré's *Fernando de Lemos: Truth*

[15] T. N. Page, *In Ole Virginia,* (New York, 1908), p. 13.

[16] G. W. Johnson, "To Live and Die in Dixie," *Atlantic Monthly,* CCVI (July, 1960), 31.

and Fiction (1872) is the first novel of consequence to come from the deep South. This region did not excite much literary interest until after the Civil War when the Creoles were described in the novels of George W. Cable, Kate Chopin and Grace King. Mrs. Chopin and Miss King were primarily concerned with Creole customs and Louisiana's exotic settings. Cable emphasized the decadence of New Orleans' upper class and the social destructiveness of miscegenation. Clement Eaton believes that the literature of this region is distinctive because it has "the flavor of a semi-tropical civilization affected by Negro slavery and by the Latin temperament."[17] While Eaton does not define what he means by "Latin temperament", he suggests that the mixed French and Spanish ancestry of the Creoles resulted in an aristocratic order quite different from the feudal society of predominantly Anglo-Saxon Virginia.

Grace King presents a favorable study of Creole society in *Monsieur Motte* (1888), *Tales of Time and Place* (1892) and *Balcony Stories* (1893). She acknowledges the pride and vanity of the Creoles, but she credits them with warm-heartedness and wisdom. In matters of race she plays down the cruel treatment of Negroes by the Creoles and stresses the loyalty of docile, ignorant slaves to their masters. A testimony to the social interest of her region, however, is Miss King's treatment of Louisiana's quadroon caste, which is separated from both the black and white communities by its mixed blood. In "Madrilene: or, The Festival of the Dead," she tells of a servant girl rescued from the degradation of slavery by the unexpected discovery that her parents are white.

Kate Chopin revealed the prideful nature of the Creoles as Miss King had done. A Creole in "A Gentleman of Bayou Têche" (1894) refuses to accept two badly needed dollars from a photographer in search of "local color" characters for his magazine. The Creole fears he might be mistaken in a photograph for an Acadian or a poor white. Mrs. Chopin's Creoles are childish, fun-loving people. She avoids the less savory aspects of their life, such as race prejudice and miscegenation.

Unlike Miss King and Mrs. Chopin, Cable does not minimize the faults of the Creoles. When he speaks of them in the aggregate, Cable condemns their basic attitudes toward society and questions their morality and wisdom. Especially he deplores their inhumanity to the Negroes. The kindly paternalistic masters of Page's Hanover County are replaced in Cable's Louisiana by capricious masters who flog their male slaves, seduce their female slaves and shoot any slave who becomes troublesome. Cable's concern for the Negro inspired his best writing. *Old Creole Days* (1879), *The Grandissimes*

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[17]Clement Eaton, *A History of the Old South*, (New York, 1949), p. 196.

(1880), and *Madame Delphine* (1881) mark Cable as an ardent supporter of civil rights. He shows that society falls victim to horrible perversions when these rights are ignored. In *The Grandissimes* an old Negro woman is shot down in cold blood because she has trespassed on a Creole plantation. When an African prince, Bras-Coupé, disobeys his white master, his ears are cut off and he dies. The vengeance of Bras-Coupé's mulatto wife and the attempt of a Creole, Honoré Grandissime, to make retribution for his family's cruelty provides a framework for the novel. Richard Chase says that the Bras-Coupé episode "anticipates Faulkner"[18] in intensity of atmosphere and exploration of guilt. The tragic consequences of miscegenation which are examined in *The Grandissimes* also remind one of the guilty behavior of white supremacists. Cable applied the scientific method to the race question, repeatedly denying that racial superiority could be proved. He challenged the Creoles' belief that racial "instinct" alienated Negroes and whites.

While the defenders of the old regime recalled the glories of the Southern past, Cable urged the "New South" to keep abreast of modern scientific and social developments. He realized that the plantation system was doomed, not only by the emancipation of the slaves but by the revolutionizing influences of technology. Unlike Cable many Southern authors after the Civil War refused to consider the relationship of the races on a scientific basis.[19] Instead they appealed to a white reactionary audience which felt its political, social, and economic power threatened by the abolition of slavery. In most Reconstruction literature the re-establishment of the Union was accepted with grace, but the welfare of the Negro was still considered a regional problem. Cable, however, in all of his novels and essays railed against Southern autonomy in handling the race problem. In *Lovers of Louisiana* (1918) Rosalie Durel's Creole father expresses a common Southern attitude toward the freedman's position: "We call it a strictly Southern question, which we will take care of if the rest of the country will only let us alone."Durel is refuted by a Scottish friend who answers wryly, "But it isn't and ye don't."[20] The Scot comprehends that Negro rights are an American, not a Southern problem. He is also the

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[18]Richard Chase, "Cable and his Grandissimes," *Kenyon Review*, XVIII (Summer, 1956), 374.

[19]Clement Eaton in *Freedom of Thought in the Old South* (Durham, N.C., 1940), p. 309, comments that very few Southerners were concerned over Darwin's hypothesis of evolution, largely because they were too involved in sectional controversies. Eaton does mention, however, that before Darwin published *On the Origin of the Species* (1859) Langdon Cheves of South Carolina advanced the theory of the origin of the species by transmutation and the survival of the fittest. Cheves was refuted by Agassiz's pupil, Le Conte.

[20]G. W. Cable, *Lovers of Louisiana*, (New York, 1918), p. 27.

author's spokesman in a haunting prophecy when he maintains that the race question is not solved:

> T'isn't dead, I say. It's but lost its place in the line and has been sent back to the wurrld's tail end . . . and there's a day ahead, whether far or near God only knows, when that question—and they that are out o' fashion wi' it—will come round again, as big and ugly as hoop-skirts.[21]

Along with improving the status of the Negro, Cable envisioned other social reforms for America. He advocated education for the masses, a revision of the penal system, and worked to elevate the nation's cultural interests by establishing Home Culture Clubs.[22] The heroes in Cable's fiction enthusiastically embrace the doctrine of progress and re-evaluate their traditions. Philip Castleton in *Lovers of Louisiana* notes that "we who dearly love them [our traditions] ought to have a well-shapen, rational policy for speeding them on, instead of a shapeless, emotional one for holding them back."[23] Cable's ideas on human progress evolved slowly, thoughtfully and reservedly. He was too aware of the frailties of human nature to anticipate the millenium. His social goals were reasonable ones and his hopes for the future were always modified by his regard for the more honorable traditions of the past.

Cable's respect for the past, however, did not hinder his opposition to a Creole minority's domination of Louisiana. He battled the forces which chose to leave the Acadians in poverty and ignorance when he wrote *Bonaventure* (1888). Earlier in *The Grandissimes* he had ridiculed the Creoles' distrust of the Anglo–Saxons. Because the maintenance of a privileged society depended on autonomous statehood, the Creole characters in Cable's fiction are fiercely opposed to the Union and refer contemptuously to their neighbors of the North, East, and West as "les Américains." In *The Grandissimes* Agricola Fusilier's dying words, "Louisiana Forever," epitomize the old guard Creole's rejection of federal government. Cable was opposed to sectionalism in government or in literature. One of his most eloquent pleas for national unity is contained in an address to the University of Mississippi on the state of letters in the South (1883):

> . . . We shall no more be Southerners than we shall be Northerners. The accidents of latitude shall be nothing to us. We shall be the proud disciples of every American alike who adds to the treasures of truth in American literature and prouder still if his words reach the whole human heart and his lines of light run through the varied languages of the world. Let us hasten no longer to be a unique people. Let us search provincialism

[21]*Ibid.*, p. 224.

[22]See Philip Butcher, *George W. Cable: the Northampton Years*, (New York, 1959).

[23]Cable, *Lovers of Louisiana*, p. 264.

> out of the land as the Hebrew housewife purged her dwelling of leaven on the eve of the Passover.[24]

Cable's belief that an author could work with regional materials and yet avoid provincialism is similar to theories which Garland expressed in *Crumbling Idols.* Garland urged that "local art must be raised to its highest expression."[25] Though Garland was sixteen years younger than Cable, the two men were good friends and frequently exchanged ideas.[26] Both writers were raised in penurious circumstances and recorded the hardships of their youth in their novels. They were initiated into authorship as local color writers but soon established themselves as social realists. Their novels were the work of reformers. Garland, impressed by Henry George's *Progress and Poverty* (1879), proposed specific economic platforms to alleviate the hardships of the farmer's life. Cable discussed economic problems in *Dr. Sevier* (1885) ; in nearly all of his books his primary concern was equality for all races.

The Southerner and Midwesterner agreed on the role of the novelist as an artist who recorded life as factually as possible but was motivated by strong moral convictions. On March 13, 1894, Cable met with Garland and Hamilton Mabie to discuss the problem of realism vs. romanticism. The debate was summarized the next day on the New York *Times* editorial page. Garland made some astute observations on French realism:

> So-called French realists are rarely veritists. They deal too largely and too often with the abnormal and the unwholesome. On the other hand American veritism has the breath of the pine forest. It is psychological rather than pathological.[27]

Garland separated realism from veritism as Cable did. Cable analyzed society objectively and dispelled the romantic myths of antebellum Southern life. He refused to paint in the merely sordid or obscurely decadent details of that period, but there are few social or personal evils which are omitted from his canvas. Garland defended the reticence of Cable and other realists in not depicting the salacious side of life:

> It is as fully within the jurisdiction of realistic fictionists to write of the wholesome as well as the impure or the erotic, to deal with the happy, though commonplace, domestic lives, that are without great incidents, as to deal with murder or forgery. Imagination may explore the light as well as the dark.[28]

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[24]Quoted by Arlin Turner, "George W. Cable's Revolt Against Literary Sectionalism," *Tulane Studies in English*, V (1955), 20–21.

[25]Garland, *Crumbling Idols*, p. 66.

[26]It is possible that Cable's familiarity with Darwin, which was an apparent influence on his scientific thought though never acknowledged, began in his talks with Garland and Haljimar Boyeson.

[27]See the New York *Times*, March 14, 1894.

[28]*Ibid.*

Here, possibly for Cable's benefit, Garland appeared to be distinguishing between realism and grossness. Cable indicated that he preferred realism in lieu of naturalism. What he objected to in writing was a slavish devotion to detail at the expense of imagination. He distrusted fiction which represented the minutiae of life but lacked a moral purpose:

> Facts are realistic but truth is higher, is beautiful, is romantic. It is the business of fictionists not to testify to fact alone, but more to truth . . . The eternal verities of the human heart are without restriction to the petty facts of the everyday round.[29]

Cable was a true Southerner in his love of his region but he was an objective social critic. His ability to group new trends of thought and re-evaluate traditional prejudices enabled him to predict the future of the South. He absorbed the current ideas of evolution, heredity and environment and accepted the doctrine of progress. Cable was twelve years older than Page, but his viewpoint was nevertheless more contemporary than the conservative Virginian's. Cable was the first Southern writer to challenge the aristocratic bias of the plantation tradition and to describe its institutions realistically.[30]

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[29]*Ibid.* Here it is interesting to note the similarity between Cable's literary theory, as expressed here, and the ideals which Faulkner, as a contemporary Southern realist, expressed in his Stockholm address: "He (the writer) must teach himself that the basest of all things is to be afraid; and, teaching himself that, forget it forever, leaving no room in his workshop for anything but the old verities and truths of the heart, the old universal truths lacking which any story is ephemeral and doomed—love and honor and pity and pride and compassion and sacrifice."

[30]Cable was the most prominent Southern liberal to earn a literary reputation after the War, but several other Southern writers approached the problems of their region realistically. Virginius Dabney in *Liberalism in the South* (Chapel Hill, N.C., 1932) cites the following writers, along with Cable and Mary Murfree, as forward-looking Southerners:

Sidney Lanier (1842–1881) liberalized Southern literature by promoting sound scholarship and honest criticism and by experimenting with metrical patterns and unusual imagery in his own poetry. He published his first novel, *Tiger Lilies,* in 1867 and his first collection of poetry, *Poems,* in 1877.

Joel Chandler Harris (1848–1908) recognized the appeal of the plantation tradition, but in his Uncle Remus stories he introduced the Negro as the central character of his fiction. He did not hesitate in his stories to discuss "the darker aspects of slavery, such as the sufferings of fugitives, the tragedy of mixed blood, the separation of families or the occasional cruelties of overseers."

William Peterfield Trent (1862–1939) wrote a controversial biography of Simms in 1892 in which he asserted that "secession was wrong in itself." His book caused a furor, but he was retained at Sewanee where he founded the enlightened *Sewanee Review* (1892).

Henry Watterson (1840–1921) became editor of the Louisville *Courier–Journal* in 1868 and made it one of the most politically influential newspapers in the South. He advocated free trade and conciliation between the North and South and opposed the Ku Klux Klan. In *The Compromises of Life* (1906) he defended his bold political opinions and also satirized America's superficial "Four Hundred" society. In his declining years he reversed many of his liberal opinions, however, and opposed woman suffrage and the League of Nations.

Walter Hines Page (1855–1918) was decidedly more liberal in his political opinions than his cousin, Thomas Nelson Page. He ridiculed his fellow North Carolinians for their worship of the Confederate dead, their strict adherence to religious orthodoxy, and their fear of the Negro. In his novel *The Southerner* he made harsh but constructive criticisms of his native region.

While Page defended and Cable challenged Southern traditions, both men focused on the white landowners and Negro slaves and freedmen of their respective regions. The poor white families of the South intrigued them less, although Page in "Little Darby" and "Run to Seed" and Cable in *Bonaventure* described with some accuracy the existence of average citizens who lived apart from the plantation system. Tales of the small farmer seemed tepid, perhaps, to a reading public accustomed to chivalrous Virginians and haughty Creoles. Yet there was a small, persistent number of writers who attempted to depict the spirit of the plain people. Most of them chose the frontier areas as settings for their stories.

Augustus B. Longstreet's *Georgia Scenes,* which appeared in 1835 and 1840, describes the Georgia Crackers. Longstreet visited the rural areas as a circuit judge and his earthy, humorous tales were widely read in the South. There are occasional notes of condescension in Longstreet's treatment of crude back country characters. He usually prefaced a racy dialogue with the comment, "I should certainly omit such expressions as this could I do so with historic fidelity . . ."[31] Also in 1840 William Tappan Thompson wrote *Major Jones's Courtship,* a comic story composed of letters describing episodes in rural Georgia. More than two decades passed before another Southerner wrote a significant book about the poor whites. George W. Harris's *Sut Lovingood Yarns* appeared in 1867 and was a major contribution to American humor. Harris was the first Tennessean to write of the Appalachian mountains. His chief character, Sut Lovingood, is a rough mountaineer of the Great Smoky region who speaks irreverently of the dances, funerals, and camp-meetings he has attended. Lovingood's dialect is more comic than accurate, and his Rabelaisian humor and love of the practical joke indicate that he is intended to burlesque mountain life rather than create an authentic atmosphere.

Mary Noailles Murfree, who wrote under the pseudonyms of R. Emmet Dembry and Charles Egbert Craddock, became a more important chronicler of the mountaineers than Harris. Miss Murfree's stories and novels are conscientious studies of a people who, according to Lucy Lockwood Hazard, "approximate the rank and file of the pioneers more closely than do any other contemporary Americans."[32] Feuds, gambling and revivals provide the chief recreation for Miss Murfree's pioneers and she records their superstitions and customs with amused sympathy. The bleak lives of her characters are contrasted ironically with the grandeur of the Tennessee mountains. She acknowledges her fondness for setting

[31]Quoted by John D. Wade, *Augustus Baldwin Longstreet,* (New York, 1924), p. 164.

[32]L. L. Hazard, *The Southern Frontier,* (New York, 1927), p. 81.

in an unpublished letter she wrote to L. M. Hosea in 1886. Hosea had sent Miss Murfree some water-colors to remind her of the mountains after she had returned to St. Louis to write. Miss Murfree writes in this letter:

> I have just received the charming water-color sketches of Tuckaleechee Cove and Little River with the Great Smoky in the background, which you kindly sent to me. They are so imbued with the spirit of the locality that I have only to glance at them to feel I am again among the mountains.[33]

Miss Murfree's first volume, *In the Tennessee Mountains* (1884), is a collection of eight stories which had previously appeared in the *Atlantic*. The book was an instant success and went through fourteen editions. The individual stories in the volume are impressionistic sketches, as F. L. Pattee has observed:

> Strictly speaking, her short stories are not short stories at all save in the one element of their shortness. She records simple, everyday incidents in their natural sequence and stops when the space alloted to her has been filled. She moves leisurely from incident to incident in the monotonous vacuity of mountain life, as a minutely written journal might move.[34]

The first novel which Miss Murfree wrote was her most popular. *The Prophet of the Great Smoky Mountains* (1885) tells the story of Hiram Kelsey, a religious leader who loses his own faith. Kelsey and the rakish Mink Lowrey of Miss Murfree's *In the Clouds* (1886) are mountain men without literary parallels in other areas of the South. The women in Miss Murfree's books resign themselves stoically to hard work and boredom, and they remind us of Garland's long-suffering farm wives in Wisconsin and the Dakotas. Consider Garland's description in *A Son of the Middle Border* of his own mother's duties:

> . . . With the widening of the fields came the doubling of the harvest hands and my mother continued to do most of the work herself—cooking, sewing, washing, churning and nursing the sick from time to time . . . Even on Sunday . . . she was required to furnish forth three meals, and to help Frank and Jessie dress for lunch. She sang less and less, and the songs we loved were seldom referred to.[35]

Miss Murfree did not share Garland's interest in economic reform; she limited herself to sympathetic observations of a people she respected. The quality of her work is uneven and the best of it is dated now by excessive geographical description and sentimentality. But her accomplishment is significant if we consider her as a spokesman for a forgotten segment of society.

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[33]Mary Murfree, Letter to L. M. Hosea written on March 1, 1886, in St. Louis. Unpublished letter, permission of Southern Historical Collection, University of North Carolina.

[34]F. L. Pattee, *The Development of the American Short Story*, p. 272.

[35]Garland, *A Son of the Middle Border*, (New York, 1962), pp. 132–33.

The fiction of the deep South and the Appalachian Mountain territory is as much a part of the whole South as the literary tradition of the Tidewater. But the myths of plantation life better suited the public demand for romance after the Civil War. The preference of readers from the South, North, Midwest and far West for idealized rather than realistic studies of Southern life indicates a national reluctance to face the issues raised by the War and bears testimony to the complicity of the whole nation in keeping alive a tottering legend.

SURFACE-DRIFT INSECTS AS TROUT FOOD IN THE BRULE RIVER

*Robert L. Hunt**

Food obtained from the water surface can be important in the diet of trout during certain months. Studies by Metzelaar (1929), Needham (1930), Dimick and Mote (1934) and Benson (1953) in the United States, Ricker (1930) and Idyll (1942) in Canada, and McKeown (1934) and Butcher (1945) in Australia consider use of this food resource by trout in streams, and those of Leonard (1949) in Michigan, Allen (1938) in England, and Nilsson (1954) in Sweden by trout in lakes. O'Donnell and Churchill (1954) analyzed the stomach contents of 440 trout collected from several stretches of the Brule River during 1944. They stated: "The trout food consists of insects principally; the proportion of aquatic forms being very high during the spring and decreasing during the summer. In late summer and early fall land insects are the predominant food." None of these investigators related utilization of surface-drift food to any measurements of its abundance. Hess and Schwartz (1940) proposed the concept of "forage ratios" to compare the abundance of various foods of fish in the environment and in fish stomachs, but they did not use surface-drift food in these comparisons.

My investigation concerned: (1) utilization of surface-drift food by trout in one stretch of the Brule River during a 10-week period, (2) daily changes in the composition of this food resource during the period, and (3) consumption of this resource by trout in relation to its daily abundance. The study was conducted in the "Spring Lake" section of the Brule River (Section 3, T46N, R10W) in Douglas County, Wisconsin, the last of three such broad reaches on the upper river. The depth of "Spring Lake" varies from a few inches to several feet, and the substrate is composed of sand, muck, and organic debris. Rooted aquatic vegetation is usually abundant by July and becomes enmeshed with thick growths of filamentous algae as summer progresses. The river banks are lined by a strip of white cedar in association with white birch, speckled alder, and aspen. Elevation of the river at this point is approximately 995

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feet, or 27 feet lower than the source. The river drops approximately 440 feet over its 49-mile length. A thorough description of the river and its watershed has been published in a series of papers in the Transactions of the Wisconsin Academy of Sciences, Arts and Letters, Volumes 36 and 37.

Wild populations of brook trout *(Salvelinus fontinalis)*, brown trout *(Salmo trutta)* and rainbow trout *(Salmo gairdneri)* are present in Spring Lake but little is known about their abundance.

Methods and Materials

Using the drift-net described by Needham (1928) as a guide, a net 15 feet x 3 feet was constructed from No. 2 bolting cloth. A hole was made at its center and a standard No. 2 plankton-net was attached to serve as a central collecting basket. During the period of June 16–September 7, 1958, this net was used to make 33 one-hour collections of organisms drifting on the surface of the river. All collections were made at the same site. Stream width at this point was 67 feet, average depth was 26 inches, and average surface velocity was approximately 1 foot per second. Each collection consisted of three 20-minute samples. A sample was taken near each bank and the third in midstream. It was necessary in practice to reduce the net-length from 15 feet to 7 feet for more convenient handling. The net was tended while staked in place and periodically cleaned of debris to reduce disruption of normal current-flow into the net. The contents of each 20-minute sample was transferred to a temporary container and preserved in alcohol. All collections were made between 10 a.m. and 12 noon.

Immediately following the surface-drift collection a sample of trout was collected with fly-fishing gear. Fishing was limited to a two-hour period. Trout stomachs were preserved in alcohol. Species, length, and weight data were recorded for each specimen.

In the laboratory each hourly collection made with the drift-net was poured into a white porcelain pan and organisms were sorted from the debris. For convenience these organisms will hereafter be collectively referred to as "insects" since this Class accounted for 99 percent of the total. Each collection of insects was portioned into two categories:

1. subsurface insects that lived on the bottom of the stream or in midwater
2. Surface-drift insects that consisted of:
   a. mature forms that had emerged from the water after completing their aquatic stages of development
   b. mature and immature terrestrial insects

Insects in the first category were discarded. Insects in the second category were counted and assigned to subtotals a) and b) listed above and classified to Order. Data for hourly collections were compiled into weekly, monthly, and seasonal series.

Food in each trout stomach was also assigned to subsurface and surface-drift categories. Numbers of insects in each category were recorded and the volumes of each category were measured to the nearest 0.1 ml. by water displacement. Insects in sub-surface fractions were not classified; those in the surface-food fraction were classified to Order. Data for individual stomachs were grouped for each species of trout and for all three species combined.

Findings and Discussion

When the numbers of surface-drift insects in hourly net catches were paired with mean numbers of surface-drift insects per group of stomachs obtained on corresponding days, a positive correlation was indicated. Utilization of surface food appeared to be directly related to its abundance. This relationship between numbers of surface-drift insects in net catches and trout stomachs, illustrated in Figure 1, is statistically highly significant ($r = 0.47$, $F = 8.78^{**}$, d.f. $= 30$). Collectively the daily groups of stomachs represented in Figure 1 are a composite 179 rainbow trout, 56 brown trout, and 36 brook trout. Correlations between surface-drift insects in net collections and trout stomachs grouped by species are statistically significant at the 95 percent level for brown trout ($r = 0.58$) and at the 99 percent level for brook trout ($r = 0.90$) and rainbow trout ($r = 0.47$).

Of the 293 stomachs retained for analysis, one was empty, 21 contained food that had been digested to an unrecognizable condition, and 271 contained identifiable items of food. Distribution of this last group according to collection date and species is summarized in Table 1. The number of trout stomachs in daily groupings varied from 3 to 16. Mean sample size was 7 in June, 7 in July, 9 in August, and 10 in September.

Numbers of surface-drift insects netted per hour ranged from 30 to almost 6,000. Peak numbers were collected during the second and third weeks of August (Table 2) with reproducing and dying Ephemeroptera *(Trycorythodes sp.)* accounting for 98 percent of all surface-drift insects netted during this two-week period.

Surface-feeding activity also reached peak intensity during this period. Stomachs of trout collected were grossly distended. The stomach of a 10-inch rainbow trout caught on August 9 contained 3,380 adult mayflies.

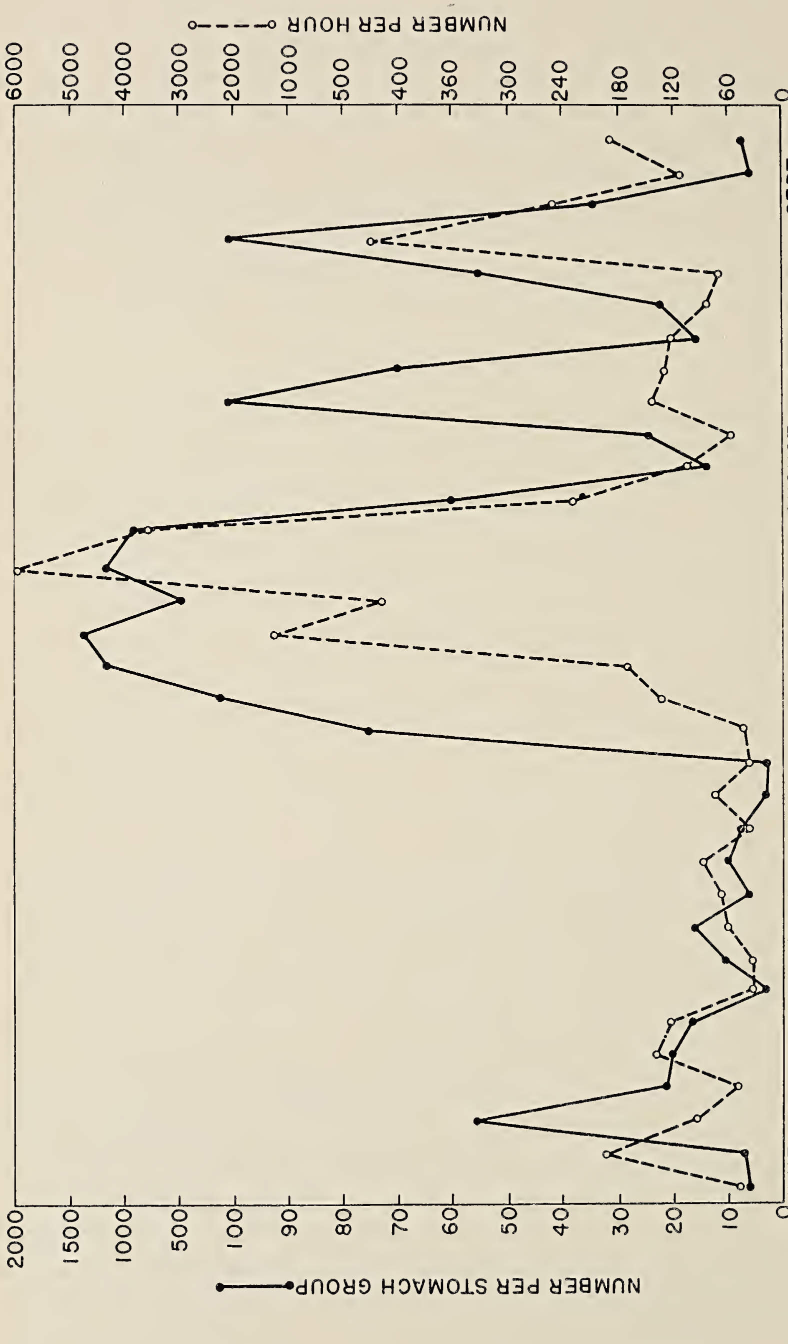

FIGURE 1. Relation between the mean number of surface-drift insects per group of stomachs and the number of surface-drift insects captured per hour by catch-net. (Based on 271 stomachs—Brook, Brown, and Rainbow)

TABLE 1. A SUMMARY OF THE CATCH DISTRIBUTION BY MONTH AND DAY OF 271 TROUT USED FOR STOMACH ANALYSIS

Month	Day	Number of Trout				Mean Sample Size for Month
		Rainbow	Brown	Brook	Total	
June	26	3	—	—	3	
	27	10	1	—	11	
Total		13	1	—	14	7
July	1	1	4	—	5	
	3	5	—	—	5	
	5	8	1	3	12	
	7	1	1	4	6	
	9	3	—	1	4	
	10	8	—	2	10	
	14	6	3	5	14	
	17	2	1	2	5	
	18	4	3	2	9	
	21	4	1	1	6	
	22	4	1	—	5	
	24	2	1	—	3	
	29	4	1	—	5	
	31	4	5	—	9	
Total		55	22	21	98	7
August	4	3	4	—	7	
	7	8	8	—	16	
	9	7	2	2	11	
	13	7	—	1	8	
	17	10	—	—	10	
	19	6	3	1	10	
	21	3	2	1	6	
	23	5	3	—	8	
	25	4	3	2	9	
	26	8	1	1	10	
	28	6	1	1	8	
	30	6	—	—	6	
Total		73	27	9	109	9
September	1	10	—	1	11	
	2	5	2	1	8	
	4	13	1	—	14	
	6	4	2	3	9	
	7	6	1	1	8	
Total		38	6	6	50	10

Approximately 86 percent of the food present in the total collection of 271 stomachs consisted of surface-drift insects. Within weekly groupings of stomachs the numerical contribution of surface-drift insects ranged from 8 percent during the last week in June to 98 percent during the second week in August. The 10-week mean was 56 percent. On a volumetric basis surface-drift insects accounted for 76 percent of the food in all stomachs and 29–98 percent of the volume in weekly collections. The 10-week volumetric mean was 59 percent. In 6 of the 10 weeks both the number and volume of surface-drift insects consumed exceeded consumption of subsurface food (Table 3).

Approximately 31 percent of the surface-drift insects in stomach samples consisted of terrestrial insects. In the net catches terrestrial insects constituted an average of 26 percent of the weekly col-

TABLE 2. NUMBER OF SURFACE-DRIFT INSECTS COLLECTED PER HOUR WITH A CATCH-NET AND THEIR ORIGIN ACCORDING TO TERRESTRIAL OR AQUATIC SOURCES

Month	Week	Day	Total Number per Hour	Terrestrial		Aquatic	
				Number	% of Total	Number	% of Total
June	4	26	48	30	62	18	38
		27	192	119	62	73	38
Weekly Average				74	62	45	38
July	1	1	159	8	5	151	95
		3	60	22	37	38	63
		5	144	15	10	129	90
		7	134	50	37	84	63
Weekly Average				24	19	101	81
	2	9	30	4	13	26	87
		10	30	14	47	16	53
		14	68	32	47	36	53
Weekly Average				17	39	26	61
	3	17	72	34	47	38	53
		18	87	50	57	37	43
		21	45	27	60	18	40
Weekly Average				37	54	31	46
	4	22	70	34	49	36	51
		24	37	17	46	20	54
		29	46	8	17	38	83
		31	130	4	3	126	97
Weekly Average				16	22	55	78

TABEL 2. NUMBERS OF SURFACE-DRIFT INSECTS COLLECTED PER HOUR WITH A CATCH-NET AND THEIR ORIGIN ACCORDING TO TERRESTRIAL OR AQUATIC SOURCES—Continued

Month	Week	Day	Total Number per Hour	Terrestrial		Aquatic	
				Number	% of Total	Number	% of Total
August	1	4	169	23	14	146	86
		7	1,224	15	2	1,209	98
Weekly Average				19	3	678	97
	2	9	414	17	4	397	96
		13	5,936	15	1	5,921	99
Weekly Average				16	1	3,159	99
	3	17	3,582	17	1	3,565	99
		19	224	26	12	198	88
		21	96	33	34	63	66
Weekly Average				25	2	1,913	98
	4	23	41	14	34	27	66
		25	136	30	22	106	78
		26	126	15	12	111	88
		28	112	21	19	91	81
		30	75	12	16	63	84
Weekly Average				18	19	79	81
September	1	1	64	23	36	41	64
		2	447	199	45	248	55
		4	240	74	31	166	69
		6	72	9	13	63	87
		7	180	86	48	94	52
Weekly Average				78	39	122	61
10-Week Totals and Mean of Weekly Means			14,490	1,097	26.0	13,393	74.0

lections of surface-drift insects but only 8 percent of the total of 14,490 surface-drift insects from all 33 hourly samples (Table 2). Most of the insects floating on the river were adult forms having aquatic stages of development. Some were still in the final stages of maturation, while others had returned to deposit eggs or had died and fallen to the surface. Carried along by the current they formed the bulk of the daily supply of surface food during the sampling period. The numbers of aquatic and terrestial insects in each hourly collection of surface-drift and their percentages of each total sample are summarized in Table 2.

TABLE 3. NUMERICAL AND VOLUMETRIC CONTENT OF SUBSURFACE FOOD AND SURFACE-DRIFT FOOD

Month	Week	No. of Stomachs	Subsurface Food Averages				Surface-drift Food Averages			
			No.	%	Vol. ml.	%	No.	%	Vol. ml.	%
June	4	14	54	92	0.5	71	5	8	0.2	29
July	1	28	25	44	0.2	25	32	56	0.6	75
	2	28	27	73	0.3	75	10	27	0.1	25
	3	20	33	89	0.3	75	4	11	<0.1	25
	4	22	53	36	0.5	50	93	64	0.5	50
Monthly Total or Average		98	34	61	0.3	56	35	39	0.3	44
August	1	23	20	2	0.1	2	1,302	98	4.1	98
	2	19	12	2	<0.1	4	788	98	2.5	96
	3	26	42	11	0.2	14	328	89	1.2	86
	4	41	60	50	0.3	43	59	50	0.4	57
Monthly Total or Average		109	34	16	0.2	16	619	84	2.1	84
September	1	50	37	45	0.2	50	45	55	0.2	50
10-Week Total and Mean of Weekly Means		271	36	44	0.3	41	267	56	1.0	59

Ephemeroptera and Diptera ranked first and second in abundance in net collections and stomach samples. Ephemeroptera accounted for 52 percent of the number of surface-drift insects netted per week and 65 percent of the number of surface-drift insects in weekly groupings of trout stomachs.Diptera accounted for 22 percent of the weekly net catches and 11 percent of the weekly consumption of surface-drift insects. Nine orders of insects plus Araneida (spiders) were represented in the surface-drift collections (Table 4).

According to O'Donnell and Churchill (1954), two of the most common fish in the Brule River other than salmonids are the white sucker *(Catostomus commersonnii)* and the mottled sculpin *(Cottus bairdii)*. In 32 collections of fish obtained with electro-fishing gear white suckers were approximately twice as numerous as trout. Sculpins, plus minnows and darters, were five times as numerous as trout. While some minnows and darters utilize surface-drift food, suckers and sculpins do not (Starrett, 1950 and Dineen, 1951). It was not the intent of my investigation to determine the degree of competition for food between trout and associated species of fish in the Brule River. However, this investigation has shown that surface-drift constituted an important food resource for trout during the summer months, and that it was utilized in approximate relation to its abundance. Therefore, if competition for subsurface food does exist, the surface-feeding behavior of trout takes on added importance. Surface-drift insects account for a major fraction of their total food consumption during the summer, and when trout rise to feed at the surface they no longer have to compete with the white sucker and mottled sculpin for food.

TABLE 4. TAXONOMIC COMPOSITION OF SURFACE-DRIFT INSECTS IN WEEKLY NET COLLECTIONS AND STOMACH SAMPLES

ORDER IN	% OF TOTAL NUMBER OF INSECTS										MEAN OF WEEKLY MEANS
	June	July				August				Sept.	
	4	1	2	3	4	1	2	3	4	1	
Araneida—Net	1.7	—	3.1	2.4	1.0	—	<0.1	—	0.2	0.2	0.9
—Stomachs	2.9	0.2	1.0	2.2	0.1	—	—	—	<0.1	0.1	0.6
Coleoptera—Net	27.6	6.0	5.5	10.3	5.3	0.2	0.1	0.2	1.7	11.2	6.8
—Stomachs	27.9	1.5	7.6	13.5	0.5	—	<0.1	<0.1	0.2	0.7	5.2
Diptera—Net	30.1	29.3	45.3	48.5	20.3	3.6	0.3	3.4	23.1	14.3	21.8
—Stomachs	32.4	24.3	8.2	29.2	0.3	<0.1	—	<0.1	11.5	3.4	10.9
Ephemeroptera—Net	5.4	54.2	11.7	5.4	53.3	94.8	99.2	95.6	56.8	47.5	52.4
—Stomachs	2.9	64.0	5.2	3.4	98.2	99.7	99.9	99.9	83.4	91.8	64.8
Hemiptera—Net	—	0.2	0.8	3.4	7.0	0.1	0.1	—	2.0	1.3	1.5
—Stomachs	—	0.3	1.0	7.9	—	—	—	—	0.2	0.4	1.0
Homoptera—Net	6.7	2.4	6.2	6.4	3.3	0.6	0.1	0.3	7.2	11.3	4.4
—Stomachs	16.2	4.8	30.2	19.1	0.2	<0.1	—	—	1.2	0.9	7.3
Hymenoptera—Net	13.4	4.6	19.5	13.7	4.7	0.4	0.1	0.3	3.5	7.9	6.8
—Stomachs	2.9	1.7	15.8	9.0	0.4	—	—	<0.1	0.4	1.2	3.1
Lepidoptera—Net	0.4	—	—	—	—	—	—	—	—	—	0.1
—Stomachs	1.5	—	—	—	—	—	—	—	—	<0.1	0.1
Psocoptera—Net	—	—	0.8	1.5	—	—	—	—	1.5	1.4	0.5
—Stomachs	—	0.1	2.4	2.2	—	—	—	—	0.2	—	0.5
Trichoptera—Net	14.6	3.2	7.0	7.8	3.0	0.3	0.2	0.2	3.9	4.8	4.5
—Stomachs	13.2	3.1	22.7	5.6	0.4	0.3	<0.1	<0.1	2.8	1.3	5.0
Unidentified —Stomachs	—	0.1	5.8	7.9	—	—	—	—	—	—	1.4

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THE CONTRIBUTION OF *DIE FREIEN GEMEINDEN* TO SCIENCES, ARTS AND LETTERS IN WISCONSIN

*Berenice Cooper**

In the record of Wisconsin's contribution to sciences, arts and letters, the part of a small group of nearly forgotten liberals deserves recognition. No group of pioneers in the 1850 to 1880 period of state history was more devoted to the encouragement of the intellectual life than were *die Freien Gemeinden,* the Free Congregations, in the German–American settlements. In the midst of a rugged physical struggle against the hardships of pioneer life, they never lost sight of the need to nourish the mind as well as the body; their ideal was to promote a continuous search for more and more knowledge and to use that knowledge for the general welfare.

These forgotten humanists of 1850–80 were devoted to the principle expressed later by the Regents of the University of Wisconsin in their 1894 report:

> Whatever may be the limitations which trammel inquiry elsewhere, we believe that the great State University of Wisconsin should ever encourage that continual and fearless sifting and winnowing by which alone the truth can be found. (II, 110.)

Die Freien Gemeinden were minority groups in the German–American settlements which were established in Wisconsin from 1848 to 1880: the majority of the German immigrants were orthodox Lutherans or Catholics who did not approve of the Free Congregations. The history of these Free Congregations had begun in Germany between 1840 and 1844, when groups within both Protestant and Catholic churches had declared their independence from orthodoxy in church dogma and authoritarianism in church government. It was the victory of the conservative forces after the failure of the German Revolution of 1848 which influenced many members of *die Freien Gemeinden* to join the immigration of Germans to the United States.

During the next twenty-five or thirty years after the first migration of 1848, societies of *die Freien Gemeinden* were found in many German settlements from New York to San Francisco, and subscription lists published in their monthly magazine, *Blätter für*

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*Miss Cooper is Professor Emeritus, Department of English, Wisconsin State University–Superior.

freies religiöses Leben, show individual members as far south as Texas. The strongest *gemeinden* were those established in Philadelphia, St. Louis, Sauk City, Milwaukee, and San Francisco, but smaller ones existed for a time in communities in Ohio, Michigan, Indiana, Illinois, and Minnesota. Wisconsin had 32 in 1852, according to Eduard Schröter, who traveled about the state giving lectures on the principles of the Free Congregations and organizing the smaller groups. But by 1862, he was lamenting the decrease in membership and the apathy within the groups (I, Dec., 1862, 91). Today the only active groups in Wisconsin, and perhaps in the United States, are Sauk City and Milwaukee.

Although the Free Congregations have been fading away in Wisconsin and in the rest of the United States, they made a contribution to the intellectual life of the period in which they were active forces in some of the German–American settlements. Their contributions of a lively interest in nineteenth century science, in encouragement of music, debate, and drama, in the study of philosophy, history, and literature deserve recognition.

It is the purpose of this paper to present evidence of the contribution of *die Freien Gemeinden* to the Wisconsin philosophy of untrammeled inquiry in the search for truth and to the encouragement of the sciences, arts and letters in the 1850–1880 period in the history of Wisconsin. The examples that follow come from the constitutions of these societies, from their statements of belief, and from the content of their monthly magazine, *Blätter für freies religiöses Leben,* published from 1856 to 1876.

The constitutions of the two surviving Free Congregations of Wisconsin contain many phrases affirming the intellectual freedom of the individual, the importance of continuous search for truth through the study of nature and history, the belief that knowledge of truth grows from age to age, and the ideal that increasing knowledge should be used to make the world a better place for human beings.

Sauk City Free Congregation, in its constitution adopted in 1853, expresses its belief in freedom of thought for the individual member:[1]

> There shall be no doctrine formally stated and authoritatively proclaimed or laid down as by a church . . . The object of this organization is, therefore, not the subjection of man to extraneous authority of one person or one book for the purpose of rendering him blest, but on the contrary, the *intellectual and moral freedom of man,* his independence and individuality in thinking, deciding, and acting . . . *We have no doctrines or creeds established for all time,* but instead *fundamental principles and views of life which are subject to continual reclarification and examination.* (IV)

[1]In all quotations which follow the italics are mine and are intended to call attention to the emphasis upon the right of free injuiry, the continuous search for truth, and the tentative character of all statements of belief.

The Milwaukee Constitution emphasizes the importance of education and the use of science to make a better world:

> Conscious of the limitations of the human mind and aware of our dependence upon forces known and unknown amid which our brief lives are spent, we seek nevertheless *through education and dissemination of the truths of science to dispel ignorance and mysticism and destroy superstitions* --
>
> --
>
> *to establish through observation and experience* a system of philosophy wide as the world and embracing all men, which will attempt to ascertain *man's relation to the universal forces about him* and place him in harmony with such forces mentally and physically.
>
> Through knowledge of his common origin, his common end, and a realization of his common needs and tasks, to which we subscribe, man will eventually be able *to make of this earth, which is his home, a place where the good and true and beautiful will survive.* (III)

In 1856, Friedrick Schünemann–Pott, speaker of the Philadelphia *Gemeinde* and editor of the *Blätter* . . ., wrote an article to answer the question "What do the *Freie Gemeinde* of Philadelphia believe?" After stating that they do not tie themselves to a creed, he says:

> We say that the *Freie Gemeinde* wishes the rule of reason or rests upon the unconditional freedom of the human spirit revealing itself in moral acts, or it aspires toward the universal development of human beings in the way of knowledge and the moral life . . . . .
>
> But to answer the requests for a *Freie Gemeinde* creed, with the understanding that no one is bound by it for all time and that it is a gradually developing belief, I will set down the following:
>
> --
>
> --
>
> We do not wish to form a new sect but to reconcile the unhappy conflict of men about the forms of religion by promoting reasonable beliefs.
>
> In this sense all religions of past and present appear to us as a part of the spiritual development of mankind.
>
> For us religion consists in the reasonable knowledge of the world and its laws, especially the knowledge of the earth and of developing human nature and the consistent application of this knowledge upon the form of our own life and society's, or in other words the essence of all truth, justice, and love.
>
> We do not inclose the content of our religion in any narrowing limiting creed or hold any external customs, but consider the entire life itself in its manifold evidences an expression of moral and reasonable world view.
>
> We have no holy book, no holy places, holy times, holy customs, no holy priesthood. Instead of a holy book, nature and history; instead of holy places the entire and unified world, instead of holy times, the whole life of humanity from the beginning to the end; instead of holy customs every good and beautiful thing born of perception . . .; instead of privileged priesthood there is with us the independence of all members with equal rights, who choose by their own free judgment their speakers, teachers, and all officers.

When the *Freie Gemeinde* of Plymouth, Wisconsin, reorganized in 1870 after a period of inactivity, they summarized their philosophy of life in a statement which shows the influence of nineteenth century science and rationalism:

> We place reason above revelation; in place of faith, free search for knowledge; in place of two world, one (of whose existence we are certain); in place of miracle, natural law; in place of God's providence, man's own providence; in place of predestination, fate; in place of man torn between body and soul, the unified, harmonious man; in place of trust in God, self-confidence; in place of humility, the consciousness of human dignity; in place of abstinence, the moderate use of pleasure; in place of desire for reward, the love of good for its own sake; in place of heaven on the other side, heaven on this side (in the hearts, homes, the societies, the states) among the people; in place of values on the other side, values on this side; in place of inexplicable secrets (mysteries), unsolved problems; in place of the Bible, the book of nature and history; in place of the pulpit, the speaker's platform; in place of the preacher, the speaker; in place of supernatural salvation of the soul, the natural education of the spirit and heart; in place of prescribed ritual, free customs; in place of the Christian school, the free Humanisitic school. We strive for welfare, education, freedom for all without distinction in religion, in race, in nation, in rank, in sex.
>
> Our religion is free Humanism, for it has its origin in man, including his development and continuing education through humanity, and consists essentially in the perception of and reverence for humanity.
>
> This is our present general rule and plumb-line. *But there are no irrevocable conclusions of faith.* We can make for our thought and life in the future better rules and plumb-lines as it may be possible to do. Each age is its own law-giver.

The above statements show that in the nineteenth century conflict between fundamentalist religion and science, *die Freien Gemeinden* supported the new science. Further evidence of the Free Congregations' interest in science is contained in the list of the topics for lectures given at the meetings of the Sauk County Free Congregation and in the contents of the monthly magazine *Blätter für religiöses Leben.*

Mrs. Clara Runge lists among the lecture topics the following: "Bacteria, their Relation to Agriculture"; two lectures by the famous University of Wisconsin scientist, Max Otto, "Darwinism," and "Mentality of the Higher Apes"; lectures on such scientists as Kepler, Copernicus, Galileo, and Alexander Humboldt (IX, 20–26).

The table of contents of the *Blätter* . . . includes many articles on scientific topics: "New Discoveries About Sun and Sunlight," "On the Meaning of the Process of Decay in Nature," "The Wonders of Astronomy," "Recent Research into the Formation of Meteors," "What Chemistry Can Do and Can Not Do," "The Evolution of Organic Forms and the Evolution of Man," "Science and

Darwinism," "Progress or Rotation in Human Evolution," "The Laws of Evolution in Human History," "The History of the Earth," "The Ice Age."

The emphasis upon the evolution of the universe and of man in the lectures and the magazine articles is consistent with the statements of belief in the book of nature and history as the source of authority and in the evolution of man's knowledge about his environment, which are asserted in the constitutions of Sauk County and Milwaukee and the statement of principles by Plymouth.

In the *Blätter* . . . one finds also exerpts from new books on science of that period: M. J. Schleiden's *Plants and Their Life;* Hudson Tuttle's *History of the Laws of Creation;* a chapter, "People of the Amazon," from Humboldt's *Journey in the Region of the Equator;* the chapter "Fossils," from Bernard von Cotta's *Geology.* There are two articles by Alexander Humboldt on the study of nature: "The Influence of Knowledge of Nature upon the Enjoyment of Nature," and "The Importance of the Study of Nature for the Culture and Life of the People."

Scientific interest extended into the study of language; in the issue of January 1870, the *Blätter* . . . carried an article on "A Few Differences Between the Chinese Language and the European Languages."

Examples such as these are part of the evidence that the Free Congregations in Wisconsin encouraged the spirit of continuous search for more and more truth about the nature of the world and man's relation to it.

In the *Blätter* . . . and in their *gemeinden* activities *die Freien Gemeinden* did not neglect arts and letters. They included articles upon philosophy and literature, such as "Zur Erinnerung an Lessing," "Talents and Innate Ideas," "Difference Between Traditional and Scientific Ideas," "Greeks and Barbarians," "Pantheism and Our World Philosophy," "The Faust Legend." Mrs. Runge's list of lectures at Sauk City includes "The Grimm Brothers," "Emerson the Idealist," "Koerner the Poet," "Tolstoi," "Schiller's Life and Works," "Goethe's Faust," "Voltaire," "Anatole France" (IX, 20–26). Eduard Schröter in his reminiscences speaks of working on lectures on Fichte for the meetings of his congregation (I, Aug. 1862, 21–24).

A typical *gemeinde* participated in singing societies: men's, women's, and mixed choruses rehearsed regularly and gave concerts. Milwaukee still continues its musical activities, as the announcements in its monthly magazine, *Voice of Freedom,* show. In 1962 Milwaukee sent a chorus to the International Song Festival in Germany.

In addition to musical organizations, dramatic performances and evenings of declamation and debate encouraged the speech arts in any *gemeinde* large enough to manage such a program. Although Sauk City is now too small to keep up such activities, the scenery still stored in the balcony of their hall testifies to their former interest in drama. Like the Turner societies, the Free Congregations were eager to keep alive their heritage of German literature and music, and considered the education of the next generation an important responsibility. (VI, 59–71).

The interest of the members in the world of letters was stimulated by their libraries. Even so small a society as Bostwick Valley established a little library (VI, 67). The reports of a *gemeinde* to the National Association always included the number of books in the library along with a list of musical and literary activities carried on (VI, 59–71). Milwaukee and Sauk City still hold typical *gemeinde* libraries containing the works of great German writers, histories of Germany and of the United States, volumes on the science of the mid-ninteenth century, encyclopedias, dictionaries, and, of course, many books and pamphlets on the principles of Free Religion and Humanism.[2]

The membership of the Free Congregations was a group interested in the life of the intellect. Some were professional people, some were prosperous merchants, some were skilled artisans. They were all people of independent minds. When they settled in Wisconsin, even those who took up land and had to become pioneer farmers in order to make a living in their new home, continued their interest in intellectual activities. Eduard Schröter tells of his visit in the farm home of Herr Collip on "a half-island on Silver Lake, near Portage." Collip had come to "this lonely island before the Forty-eighters and in the roughness of the wilderness had made his dwelling a little temple of culture. In his study he had the works of Lessing, Hegel, and Schiller" (I, Nov. 1868, 71–72).

In Schröter's own case, there was a powerful conflict between the intellectual life and the need to keep up a little farm to supplement the salary of only $150 per year as speaker at Sauk City. At one time he was preparing a lecture on Fichte for the regular meeting of the congregation but was much aware of the fact that the corn needed hoeing. The conflict between the two duties oppressed his spirits, but after thinking it over, he decided that the more important duty was to be well-prepared for his lecture. "I remained with Fichte," he tells us (I, Aug., 1862, 21–24).

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[2]The Milwaukee *Freie Gemeinde* published a catalogue of its library in March, 1945. The writer of this paper has had opportunity to work in the library of the Free Congregation at Sauk City, which is not catalogued, and to make a partial bibliography of the books on the history of *die Freien Gemeinden* in Germany and in the United States.

These two pictures of the scholar-farmer are typical of the *Freien Gemeinden* members, who made a place in their busy pioneer lives for intellectual growth and for enjoyment of literature and music.

No one can make the claim the *die Freien Gemeinden* were a major influence upon the history of Wisconsin's contribution to sciences, arts and letters. But as a minority group who valued the cultivation of the intellectual life and sought to free religion from all that was inconsistent with developing knowledge in science and history, these forgotten humanists deserve recognition. No one who reads their records of beliefs and activities can deny that they were a part of those who encouraged the untrammeled search for truth and stimulated the study of sciences, arts and letters in the state of Wisconsin.

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PINE INTERNODES AS INDICATORS OF NON-DETERMINABLE ENVIRONMENTAL INFLUENCES

*S. A. Wilde**

The morphology of red pine, *Pinus resinosa,* white pine, *P. strobus,* and several other American pines exhibits a unique feature of annually produced single whorls of branches. The whorls sharply delineate internodes or segments of the tree trunk which represent the height increment of trees during one growing season.

The length of the interwhorls or internodes is determined by the inherent growth capacity of trees and by conditions of the habitat. In a reduced light and on soils deficient in water, air, or nutrients, the internodes measure but a few inches; in a favorable environment they may be longer than 4 feet.

In young plantations established on open lands, the light factor plays a small part and the height growth usually reflects the edaphic and biotic influences. A deficiency of nutrients in the depleted surface soil layers and consumption of water by weeds are the most common conditions depressing the early growth of planted trees. More than 7 internodes below the breast height reveal a pronounced depression of young red and white pines.

With advance of age, the growth relations of the plantation undergo profound changes. Closing of the canopy and extention of roots aggravate the competition of trees for moisture and nutrients. Simultaneously, however, the overshading reduces competition of ground vegetation, and the growing roots encounter deeper soil layers of varying productive potentials. In consequence of all these changes, the growth of current internodes may be either retarded or accelerated. In turn, the sequence of internodes presents a conspicuous record of the chronological growth pattern of trees induced by environmental factors (Figure 1).

As our investigations have disclosed, the single readily determinable value which expresses the influence of site and soil factors is the ratio of the total height of trees of average diameter to the length of five internodes above breast height, or so-called "five-year intercept" (Wakeley and Marrero, 1958). Both components of this

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FIGURE 1. The chronological growth pattern of red pine marked by the length of internodes and including a period of starvation of the tree on a nutrient-deficient soil and an explosively accelerated height growth induced by an application of fertilizer. Courtesy of Prof. S. O. Heiberg, New York State University College of Forestry. (Photo by C. Wesley Brewster, Syracuse 10, N.Y.)

quotient can be rapidly and accurately measured by means of a hypsometer and an expandable 10-foot rod.

To facilitate calculations, the heights and intercepts are recorded in inches on per year basis, i.e., average height of measured trees over age (H) and the total length of the intercept over 5 (I). For example, a 20-year-old stand with average height of 25 feet and total length of the 5-year intercept of 100 inches has the H/I ratio of $(25 \times 12 \div 20) \div (100 \div 5)$ or 0.75. A discussion of the influence of weeds, composition of soil profiles, and ground water on the growth of trees follows.

The Height-Intercept Quotients of Plantations on Different Sites

Plantations established on areas which are reasonably free from weeds as a rule show a rapid height growth during the first ten to fifteen years, that is, during the period which determines the size of the 5-year intercept. A few years after closing of the canopy, the height growth usually begins to decline because of the increased competition of larger trees for water and nutrients. As a result, forest plantations between 15 and 40 years exhibit a fractional H/I quotient. In more than 75 per cent of surveyed red pine plantations of Wisconsin, the H/I quotient varies from 0.5 to about 0.9. The low H/I values are particularly common to plantations established on non-podzolic sandy soils underlain by purely siliceous substrata of fluvial deposits. This soil group is exemplified by members of *Boone* and *Sparta* series (Hole and Lee, 1955). According to observations in New York (Stone, 1963), a low H/I ratio is also characteristic of red pine plantations on poorly drained soils; on such sites a seemingly normal growth is followed by a drastic decrease in height increment and even death of trees.

A reverse of this stem morphology is caused by competition of weeds, which at times is especially severe on fine textured soils, e.g., those of *Miami, Casco, Dubuque, Kennan,* and *Ontonagon* series. On such sites, the early growth is retarded until the trees suppress weeds by their canopy. In consequence, the H/I ratio approaches or exceeds 1.0 at the plantation's age of 25 or 30 years.

A similar pattern of stand growth is common to plantations located on sandy soils with surface layers depleted in organic matter and nutrients by severe fires or prolonged agricultural use, but with fertile substrata enriched in alumino-silicate minerals. Particularly striking examples of such soils are the *Omega* and *Superior* soils, formed in blanket-like post-glacial deposits of aeolian sand, covering granitic outwash or lacustrine clays.

The most conspicuous irregularity in the pattern of height growth, expressed by the H/I ratio between 0.9 and 1.3, is found on naturally subirrigated soils with ground water at depths of from 4 to 9 feet (Wilde and Iyer, 1963). A contact of roots with the capillary fringe of these soils is manifested by a rapid acceleration of the height increment.

The two extreme patterns of tree morphology induced by ecological conditions are outlined schematically in Figure 2.

Although the H/I ratio varies with the age of stands, its amplitude is delineated by conditions of the habitat. Plantations on soils of quartzitic substrata show during their growth from 15 to 40 years a very narrow range of H/I values, descending from 0.8 to 0.6. Plantations of a similar age span on subirrigated soils also exhibit a limited H/I range, ascending from 0.9 to 1.3. On the other hand, weed-invaded soils and soils with depleted or strongly podzolized surface layers may show a very wide amplitude of the H/I quotient, ranging from 0.6 to more than 1.0. At the age between 40 and 50 years, the ratio attains an equilibrium and then begins to decline. A cursory examination of the habitat usually leaves no doubt as to the significance of the immediate H/I ratio.

Chronological Pattern of Stand Growth and Concept of Site Quality

As indicated in Figure 2, under the influence of soil, two stands can attain the same average height growth, let us say 40 feet at 30 years, by increments following diametrically opposed concave and convex curves. One of the stands can grow 25 feet during the first 15 years and 15 feet during the second 15 years of its life; another stand can grow 15 feet during the first and 25 feet during the second 15-years. In consequence, the stands of the same immediate site index may exhibit intercepts of 100 and 60 inches, and corresponding H/I ratios of 0.8 and 1.3, revealing essentially different chronological growth patterns. This information is of critical importance in understanding soil-forest relationship and in constructing yield tables; it indicates the necessity of a rigid ecological stratification of mensuration data of the stands even though they exhibit the same immediate height and site quality. A failure to comply with this requirement unavoidably leads to distortion of the polymorphism of natural growth curves, complication of statistical analyses by erratic data, and gross inaccuracies in the values of yield tables.

If Scotch pine and Norway spruce had as distinct internodes as some American pines, the two hundred-year-old European silviculture might have made greater progress in the two closely related fields of forest mensuration and ecology. Thus far it is only the Finnish school of Cajander (1909) and Ilvessalo (1923) that

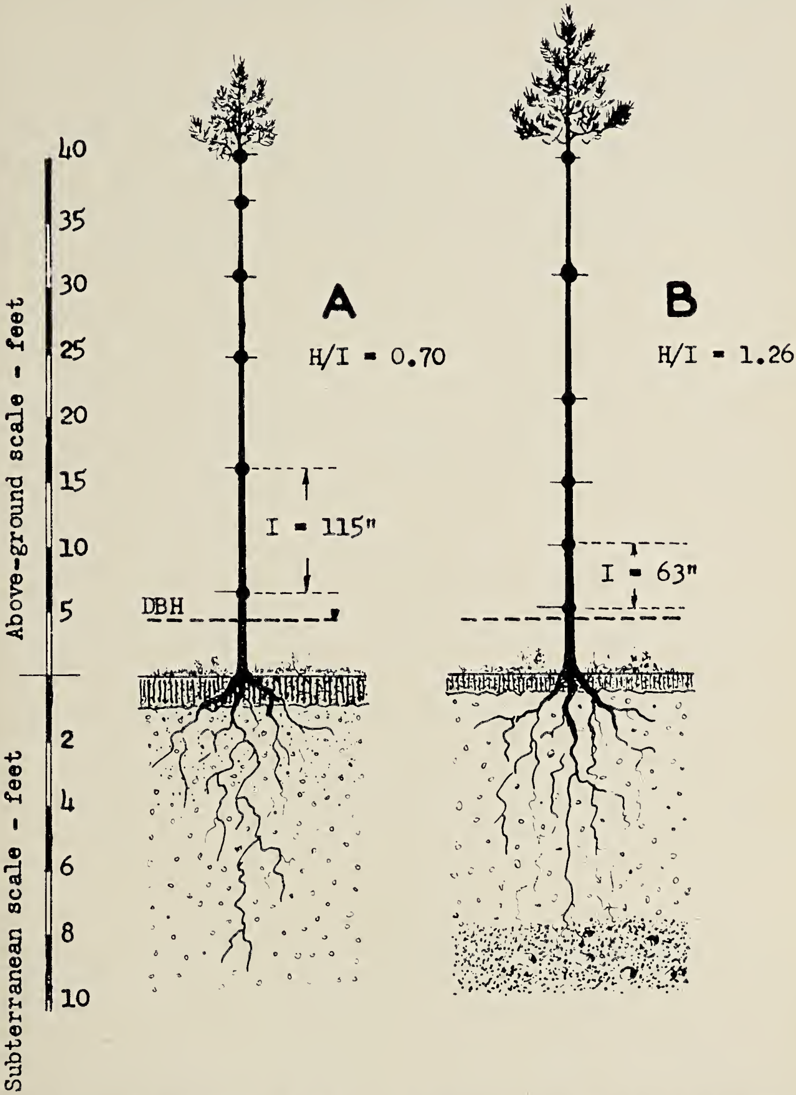

FIGURE 2. Growth patterns of red pine plantations imparted by soil conditions: A. Progressively declining height growth resulting from inadequate supply of water and nutrients in a soil with an infertile quartzitic substratum; B. Explosively accelerated growth caused by a contact of roots with water- and nutrient-bearing fine textured layer. Horizontal lines mark 5-year growth periods. Both plantations exhibit at the age of 30 years an identical site index of 58.

has placed mensuration on a natural ecological basis and thus liberated yield tables from empiricism and unwarranted generalities.

The Role of Internodes in the Appraisal of the Habitat

With availability of modern hypsometers, the determination of the H/I ratio makes possible a quick silvicultural appraisal of stands composed of internode-forming trees. The height-intercept relationship broadens the understanding of the kinetic aspects of forest growth and helps to visualize the intermittent growth-retarding and growth-promoting effects of soil profile.

A forester of the old school might have said that the H/I ratio helps one "to read the book of nature." In a large degree, his statement would be true because the chronological growth pattern of trees does not reflect only the potential of the growing stock and the effect of determinable properties of surface soil layers; it reveals also the unmeasurable influences of fluctuating ground water, nutrient bearing strata located beyond the depth of practicable excavation, and the competition of ground vegetation. The effect of these latter factors on the growth of trees is obvious and easily detectable, but it cannot be expressed in concrete figures with means at our disposal. These factors form the axiomatic foundation underlying the study of forest entities, many aspects of which cannot be cast into a regression equation and calculated, electronic computers notwithstanding. In part this is because "the world was created out of things which do not appear" (Barnett, 1952). A neglect of the non-calculable functions of environment and of the entire principle of mathematical uncertainty can only lead to a non-scientific juggling of figures and a regression from reality.

Summary

The stem morphology of internode-forming pines presents a conspicuous record of environmental conditions which influenced the growth of trees during different periods of their life. The ratio of the total height of trees (H) to the length of five internodes above breast height (I) reflects the chronological growth pattern of trees and provides a clue to the effects of competing vegetation, make-up of the soil profile, and ground water.

Within the age range of 20 to 40 years, plantations established on soils underlain by infertile substrata or a shallow water table are characterized by low values of H/I quotient descending with age from 0.8 to 0.6. Plantations of the same age span established on weed-invaded soils, especially those of fine texture, soils with depleted surface layers, but underlain by substrata enriched in

aluminum-silicate minerals, and soils with ground water at depths from 4 to 9 feet exhibit high values of the quotient, ascending with age from 0.9 to 1.3.

The paper emphasizes the importance of the chronological pattern of growth and the polymorphism of natural growth curves, indicated by the H/I quotient. In turn, rigid ecological stratification of mensuration results is suggested as a means of reducing complications of statistical analyses by erratic data and eliminating gross errors in appraisal of young plantations on the basis of their immediate site index.

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THE USE OF HISTORY IN BISHOP HURD'S LITERARY CRITICISM

*Stephen J. Curry**

A curious, persistent notion still circulates about literary criticism in the mid-eighteenth century. This is the period, we remember, that brought to public attention the diversified personalities of Richard Hurd, Joseph and Thomas Warton, Samuel Johnson, and Joshua Reynolds. It is a period in which the mainstream of bookish thought seems for a while to alter its course, changing as it were into little whirlpools that gather force as 1798 draws near. The basic problem as so often happens is a difficulty in terms. We run into the labels "preromantic" and "neoclassical," and depending on our own predilictions, we too often fail to observe the simple truth that the word is not the thing. In this paper I shall attempt to show that the really significant critical work of these middle years is not involved in a battle of words; the problem is more subtle. The Augustan critics are still making their presence felt; but the new critics at this time, almost as a justification for the brilliant work of the past, merely serve to broaden and deepen understanding of all English works that would appear to be drowned were it not for the fact of their gigantic intuitive appeal. Richard Hurd shows this deepening of critical appreciation, and we turn to him as a representative figure not because he is the best, but because he is often the least understood. Hurd does not espouse any kind of preromanticism. If we take the English manipulation of "neoclassical" (and the term is dangerous only if we use it as condemnatory), we cannot, except by great stretches of the imagination, call this man a forerunner of the early nineteenth century.

Our first task, then, is to avoid the idea that the middle part of the eighteenth century is not in itself valuable. What posterity does with its ideas is one thing; what the critics of the time attempt to do for themselves is quite another. To treat Hurd, the Wartons, and Bishop Percy only as direct contributors to the following century is ridiculous; the period does, after all, have value in itself. Critics and scholars need to review and to interpret what went on at that time. To be sure, the notion of "preromanticism," if we look at it in one way, has its own validity: Joseph Warton liked nature; so did Coleridge. But if we are to simplify the character of literary movements, then we must ultimately relinquish their in-

*The author is Assistant Professor of English, Alfred University.

dividual meaning and importance. No one will argue that Johnson suffers the same kind of dejection as Coleridge. And even disregarding the notable difference of character in these two authors, we can separate out elements in their thinking that are specifically appropriate to the main areas of thought in their time. But the aim of this article is not to prolong a dispute that is unanswerable by means of simple terminology. Rather, we are concerned here with the shape of thinking about various literary ages. This often maligned and frequently neglected middle period of the eighteenth century has a shape of its own, and we can see it clearly in the speculations of Bishop Hurd.

* * *

More than any other work from the mid-eighteenth century, Hurd's *Letters on Chivalry and Romance* (1762) has been hailed as a harbinger of Romantic criticism. Because it has so often been classified as "preromantic," it has never been analyzed at length except to show its real or supposed affinities with nineteenth-century thought.[1] What has been consistently neglected is the importance that the work may claim in its own right as sound criticism today. Upon a close reading of this work and others by Hurd, the reader immediately meets an odd fact: Hurd's edition of Horace, published before the *Letters,* and his edition of Addison, published after the *Letters,* are read as perfectly conservative by critics from Saintsbury to the present, whereas the *Letters* has been considered by a great majority to be in advance of its age, if not actually prophetic. And, to be sure, Hurd's work on Spenser differs widely from that of critics from Dryden through Thomas Warton. The difference does not lie in appreciating Spenser's "sublimity," "fancy," and ability to tell stories, or in explaining the nature of the plot in the *Faerie Queene.* Dryden had already explained that the plot was based upon a way of life which still existed in the court of Elizabeth; Prior had praised Spenser's plot, imagery, and even his diction and versification. Hughes, taking the lead from Dryden, remarks that the plot of the *Faerie Queene* has a solid basis but, being unfinished, is confused; and Upton praises the fact that Spenser treats unreality consistently—that is, he follows Aristotle's "probable impossible." As far as showing that the Romances of Spenser (in addition to those by Chaucer, Tasso, and Ariosto) are based on reality, Warburton expands a hint given by Dryden and Hughes into an eight-page explanation of Cervantes'

[1]The following works are some of the main studies of Hurd as a precursor of Romanticism: Aisso Bosker, *Literary Criticism in the Age of Johnson* (Groningen, 1953); Audley L. Smith, "Richard Hurd's *Letters on Chivalry and Romance*," *ELH,* VI (1939), 58–81; Edwine Montague, "Bishop Hurd's Association with Thomas Warton," *Stanford Studies in Language and Literature,* ed. Hardin Craig, 1941, pp. 233–256.

satire in *Don Quixote*. Even fuller accounts of the historical background of the Romances were to be found in two works, the first definitely, the second possibly, a source for Hurd's *Letters:* Sainte-Palaye's "Mémoirs sur l'Ancienne Chevalerie" and Chapelain's "Sur la Lecture des Vieux Romans."[2]

This kind of source-hunting often goes on indefinitely; other writers whom Hurd used for ideas in the *Letters* and Hobbes, Locke, Addison, and the three classical critics that Hurd, like his contemporaries, used constantly, Horace, Aristotle, and Longinus. Saintsbury (more than his followers) realizes that the *Letters* is derivative; he makes a point highly relevant to our study: "Scraps and orts of Hurd's doctrine may of course be found earlier—in Dryden, in Fontenelle, in Addison, even in Pope; but, though somebody else may know an original for the whole or the bulk of it, I, at least, do not."[3] Even though the "originality" Saintsbury finds has been proven derivative by later critics, it is perfectly true that something in the *Letters* makes the reader feel that there is something new being said. The main reason for this feeling is the sense of excitement running throughout this treatment of Spenser and the Italians; the critical reaction to Hurd's tone is that no one can talk so emphatically about the literature of "imagination" without being at least partly "Romantic." And, after all, in the history of taste such an emphasis upon Spenser, though rare in any age, is especially noteworthy in the eighteenth century, when Spenser was generally praised and criticized in a few lines or paragraphs. Previous to Hurd, extended discussions on Spenser are present only in his editors (Hughes and Upton) and Thomas Warton.

Yet the extreme nature of Hurd's praise ought to be balanced against a passage given as epigraph to the edition of Addison containing Hurd's notes, a passage which saddened Saintsbury:[4]

> I set out, many years ago, with a warm admiration of this admirable writer [Addison]. I then took a surfeit of his natural, easy manner; and

[2]John Dryden, "A Discourse concerning the Original and Progress of Satire," *Essays*, ed. W. P. Ker (Oxford, 1900), II, 28. Matthew Prior, *Literary Works*, ed. H. Bunker Wright and Menroe K. Spears (Oxford, 1952), I, 231–232, 307–308. John Hughes, ed., *The Works of Mr. Edmund Spenser* (London, 1715), I, xxvi–xxvii. Relevant material from Upton's edition is reprinted in William R. Mueller, ed., *Spenser's Critics* (Syracuse, 1959), p. 42. Warburton's work on Cervantes is reprinted in his edition of Shakespeare, (London, 1847), vol. II (unnumbered pages after *Love's Labours Lost*). Sainte-Palaye's work may be found in *Memoires de L'Academie des Inscriptions et Belles–Lettres,* XX (Paris, 1753), 595–847; Hurd refers to this study three times as a source for his information: *Works* (London, 1811), III, 190, 191; IV, 261. References to Hurd's writings, unless otherwise noted, will be given in the text and will refer to this edition. Because the *Letters on Chivalry and Romance* is available in so many editions, I shall cite only the Letter involved. Chapelain's essay (first printed in 1728) is given in Scott Elledge and Donald Schier, *The Continental Model* (Minneapolis, 1960), pp. 31–54. On the possible influence of Chapelain, see Victor M. Hamm, "A Seventeenth-Century French Source for Hurd's *Letters on Chivalry and Romance,*" *PMLA*, LII (1937), 820–828.

[3]George Saintsbury, *A History of Criticism* (Edinburgh, 1949), p. 78.

[4]Saintsbury, p. 72. The edition of Addison was published in 1811.

> was taken, like my betters, with the raptures and high flights of Shakespeare. My maturer judgment, or lenient age (call it which you will), has now led me back to the favorite of my youth. And, here, I think, I shall stick: for such useful sense, in so charming words, I find not elsewhere. His taste is so pure, and his *Virgilian prose* (as Dr. Young styles it) so exquisite, that I have but now found out, at the close of a critical life, the full value of his writings.

This passage gives us a clue to one of Hurd's main traits as a critic: he has not given up Shakespeare; he is merely giving Addison as much praise as possible, for he speaks highly of Shakespeare in the edition of Addison itself.[5] The truth is that Hurd gives high praise to any great writer who succeeds completely in any type of writing; in the same way Horace is praised in Hurd's edition of the *Ars Poetica* and Cowley in Hurd's edition of his selected works. Others so praised in Hurd's criticism include Chaucer, Pope, Dryden, Tasso, Ariosto, Richardson, and many classical writers. One modern critic finds such catholicity of praise to be eclectic,[6] but Hurd would not have agreed, for he had a sound theory on which to base his admiration for many types of literature. In Letter X of the *Letters* we find a passage given so diffidently that we are apt to pass over it without realizing that it is central to all of his criticism; we refer to the description of three main types of poetry: those appealing to the judgment, to the heart, and to the imagination. Thus Addison, Cowley, and Spenser (or Shakespeare) are all great because each achieved near perfection in following the rules of a particular type of poetry. Such a view based upon empirical psychology may be "eclectic," but it is not necessarily disorganized, unphilosophical, or romantic.

That the *Letters* is typical of neoclassicism has also been shown clearly by critics who have emphasized Hurd's use of *a priori* reasoning, of determining rules through psychology, and of applying these rules according to genre.[7] However, such criticism, though it aids to balance the view of Hurd as a romantic, does not show why people differ in interpreting his criticism of Spenser and the Italian poets. It is obvious that Hurd has modified the neoclassical system of his predecessors in such a way as to make the nature of his critical system unclear to modern readers. Hurd's underlying assump-

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[5]See Hurd's note to line 67 of "An Account of the Greatest English Poets" in the edition of Addison.

[6]René Wellek, *A History of Modern Criticism*, I (New Haven, 1955), p. 130: Hurd "could not escape an unreconsiled dualism between head and heart." We might note that Hurd would not want to escape; his theory of the three types of poetry reflects the best philosophical and psychological thought of his time, especially the work of Hobbes and Locke.

[7]The neoclassical foundations of Hurd's criticism are outlined by Hoyt Trowbridge, "Bishop Hurd: A Reinterpretation," *PMLA*, LVIII (1943), 450–465. An excellent though general commentary on Hurd's type of criticism is included in R. S. Crane, "On Writing the History of English Classicism, 1650–1800," *University of Toronto Quarterly*, XXII (1953), 376–391.

tions have been clearly shown by modern critics, but his unique contribution to the history of critical methods has not. This contribution we may call the recognition of history and its influence on art; he is the first to give a convincing demonstration of how neoclassical rules need modification if the critic is to accept the influence that environment had upon writers of the past. And Hurd presents his case for accepting this modification by basing his criticism upon recent literary, theological, historical, and philosophical developments.

Hurd gives the rationale for his use of the historical method in the opening epistle of the Letters: "Nothing in human nature . . . is without its reasons. The modes and fashions of different times may appear, at first sight, fantastic and unaccountable. But they, who look nearly into them, discover some latent cause of their production." Hurd then shows that the oddities in Spenser and the Italian poets are results of their historical environment and are not artistic flaws. He maintains that once the surface dissimilarity is removed, a reader may ascertain the rules of their works and judge these poets in their proper standing in relation to classical and modern writers of imaginative poetry. We are now able to see that Hurd is not making a defense of individuality or of the uniqueness of the poet's vision; rather he is arguing the classical belief that human nature is universal, even though local manners vary. Certainly no preromanticism exists in this view, which is the most typically eighteenth-century attitude in Hurd. Art is universal, but the reader must use two ways to understand the artist's aim: "Sometimes a close attention to the workings of the human mind is sufficient . . .: sometimes more than that, the diligent observation of what passes without us, is necessary" (Letter I). The second method, historical, is needed for Spenser and others similar to him, and is important because "the greatest geniuses" of modern poetry—Ariosto, Tasso, Chaucer, Spenser, Milton, Shakespeare—have been "seduced by these barbarities." To show why these great poets used material from "Gothic" romance, the critic must explain the "rise, progress, and genius of Gothic chivalry" (Letter I). It is possible, in other words, for an artist to write poetry in accord with the necessary rules for intellectual, emotional, or epic works while following modes, techniques, or subject matter different from that emphasized by earlier French and English critics. Such latitude does represent a change in the literary climate, a transitional element that in the next century permits far greater license than the eighteenth century ever dreamed of. But at the same time, nothing in his theory can possibly be distorted into a case for preromanticism. Hurd is still highly derivative; his rules are relatively strict, though his taste may be more catholic. It is this change in taste, the emphasis upon a set of poets different from those stressed in the times of Dryden and Pope, that shows a movement towards the nineteenth century. The theory and rules of this criticism by Hurd is totally neoclassical.

The most derivative part of the *Letters* (II–V) deals with a historical account of chivalry and a proof that chivalric manners are more "sublime" (by which Hurd seems to mean a combination of the pictorial and the terrifying or strange) than classical ones. The critical idea informing these epistles may be conveniently summed up by one comment: "*Jerusalem* was to the *European,* what *Troy* had been to the *Grecian* heroes" (Letter V). This is Hurd's first defense of the medieval and Renaissance Romance: the material imitated in these works is as valid as that in the works of Homer and Virgil. But not all works dealing with this legitimate material are praiseworthy as art; they merely contain the raw material which must be transformed by a great artist. The quality of "sublimity" (or greatness, a meaning Hurd frequently gives this word) is not automatically in the subject matter but is rather a rhetorical quality gained by the skill of the poet joined to appropriate material. Thus nothing in the medieval Romances is worthy of praise as art; Hurd uses Milton as an authority who praises Chaucer and Spenser, "not the writers of *Amadis* and *Sir Launcelot of the Lake*" (Letter VII). The writings of Chaucer and Spenser "may incline us to think with more respect than is commonly done, of the *Gothic manners;* I mean, as adapted to the uses of the greater [i.e. epic] poetry" (Letter VII). This last comment is important; for Hurd, as for neoclassic critics in general, art is always a process of changing or ordering actuality. In his witty attack on Hobbes (the Letter to Davenant), Hurd shows this belief that greatness in art lies not only in subject matter but also in the ability or genius of the artist:

> I readily agree to the lively observation, 'That impenetrable armour, inchanted castles, invulnerable bodies, iron men, flying horses, and other such things, are easily feigned by them that dare.' But, with the observer's leave, not so feigned as we find them in the *Italian* poets, unless the writer have another quality, besides that of courage (Letter X).

Hurd's main attempt to deal with this other "quality" begins with Letter VIII, the most important section dealing with the *Faerie Queene* and its unifying elements; here the notion of the Classical–Gothic parallel is carried into literary criticism of a very high order. Hurd finds two types of unity possible in an epic poem: the classical or Aristotelian unity of action and the Gothic unity based upon a "design" of multiple actions. This section of the Letters has received high praise from a recent Spenser critic, John

Arthos, who considers his own book to be a continuation of Hurd's work: "Bishop Hurd's discussion of the unity of the *Faerie Queene* is one of the most fruitful that has been offered." The critic points out that Hurd, by saying that unity of design brings the whole "under one view," "avoids treating design as a form of unity with an existence of its own." To illustrate Hurd's view, Arthos discusses comments by other neoclassical critics on this type of unity, showing that it is "derived . . . from the peculiar interests of the poet, his temperament and his way of imagining or dreaming . . . . Except for a certain sophistication of philosophy . . . all of these ideas appear to have been part of the great debates in Italy in the sixteenth century" and were all considered by Tasso himself.[9] This comment is of great interest in a study of Spenser and the romantic epic, but its applicability to Hurd is at best doubtful.

Actually there are enough English precedents for this use of the word *design:* Hughes uses the word but does not apparently think of the *Faerie Queene* as being unified.[10] The use of the word that is closest to Hurd's is that of William Warburton in his discussion of the unity of the *Aeneid:* he finds a lack of unity in the action, but a unity of design in political allegory.[11] Warburton does not give a "picture" of the design, however, as does Cinthio, who claims that the epics of Tasso and Ariosto have a unity shaped like a human figure. Hurd's picture of the structure of Spenser's poem is more like a wheel than Cinthio's figure, but the two ideas are otherwise similar:

> This *Gothic* method of design in poetry may be, in some sort, illustrated by what is called the *Gothic* method of design in gardening. A wood or grove cut out into many separate avenues or glades was among the most favorite of the works of art, which our fathers attempted in this species of cultivation. These walks were distinct from each other, had, each, their several distination, and terminated on their own proper objects. Yet the whole was brought together and considered under one view, by the relation which these various openings had, not to each other, but to their common and concurrent center. You and I are, perhaps, agreed that this sort of gardening is not of so true a taste as that which *Kent* and *Nature* have brought us acquainted with; where the supreme art of the designer consists in disposing his ground and objects into an *entire landskip;* and grouping them, if I may use the term, in so easy a manner, that the careless observer, though he be taken with the symmetry of the whole, discovers no art in the combination (Letter VIII).

The picture of the *Faerie Queene* is of a wheel: the spokes are the adventures of the twelve knights; the hub is the feast of the

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[9]John Arthos, *On the Poetry of Spenser and the Form of Romances* (London, 1956), pp. 189–192.

[10]Hughes, I. lii–liii.

[11]William Warburton, *The Divine Legation of Moses Demonstrated* (London, 1755), I, 251 (on types of unity other than that of action), 276 (on "design" as opposed to unity of action).

Queen. Arthos is wrong, however, in claiming that Hurd's notion of Gothic unity is based on a sense of the individual nature of an artist's vision. Hurd's notion is far simpler and more concrete: the unity of the poem "consists in the relation of its several adventures to one common *original,* the appointment of the *Fairy Queen;* and to one common *end,* the completion of the Fairy Queen's injunctions" (Letter VIII). The unity of the poem lies solely in the fact that its twelve stories were meant to begin and end together; Hurd seems to have taken into account Spenser's interest in the unity of the whole, not Spenser's talent in individualized stories and peculiar method of story-telling. The traditional nature of Hurd's critical system here is shown by another aspect of his gardening metaphor: Kent's method "may be the truest taste in gardening, because the simplest." in other words, Homer's classical unity of action is the truest although the Gothic unity of design has an inferior beauty which can at times be highly successful.[12]

This judgment that classical and simple unity supercedes the Gothic and complex is highly revealing. For one thing, it shows Hurd remaining true to his neoclassical standards. But, more importantly, it shows his method, an approach characteristic of many critics who follow him. The historical method is used to arrive at a point where one can put the traditional rules into practice. Unlike Lord Kames, who uses the new empiricism to arrive at rules for art, or Dr. Johnson, who uses his awareness of "nature," Hurd (like Thomas Warton and Bishop Percy) uses his knowledge of history to arrive at rules and value judgments, and he uses it in his theological writings in addition to his critical ones. As a matter of fact, it is possible that the traditional form of Anglican sermons has influenced this entire historical movement in the eighteenth century; three of the most important historical critics were bishops: Hurd, Percy, and Warburton. An example of this theological method is seen in one of Hurd's sermons when Hurd is discussing the text for the day: "If there be any difficulty in these words, it will be removed by considering the *manners* of that time, in which Jesus lived, and the *ideas* of those persons, to whom he addressed himself" (VI, 1). To develop this passage, Hurd has to discuss the primarily agricultural nature of life at that time, the monetary distresses that resulted from such a system, and the nature of the various textual references that were obscure to his listeners; like a good preacher of any age, Hurd makes the passage specifically applicable to his listeners: "We, of this nation, have

[12]Hurd goes on to criticize Spenser for weakening his "Gothic" unity by using three other devices: the adaptation of Ariosto's method of interwoven stories; the use of Prince Arthur in an attempt to gain classical unity of action; the didactic use of allegory. The result is "a perplexity and confusion, which is the proper, and only considerable defect of this extraordinary poem" (Letter VIII).

not been so happy as to want examples of such distresses" (VI, 16). He then explains the character of a particularly horrible type of Antinomianism which caused trouble about the time of the Restoration and the nature of the "Popery" and "Atheism" which reigned after the former menace had been dispelled.

This sermon is an example in little of the same method Hurd uses in the *Letters* and in many other works of criticism, especially his editions of Horace and Cowley, the Preface of his *Dialogues,* and many passages in his theoretical essays and letters to friends.[13] The shape of Hurd's thought may perhaps best be described with an equation: as post-Restoration heresy is to disorders in Biblical times, so supposed defects in Spenser's poetry are to supposed beauties in Homer's. We might put this another way and say that merely because a passage in the Bible is obscure, we are not to decide that the Bible does not follow the rules of writing; the fault lies in our imperfect knowledge. The relevance to literary criticism is clear and shows Hurd's method of thought: Spenser, Tasso, medieval Romances, and Chaucer all seem strange to eighteenth-century readers, but it is the latter who are in error owing to their lack of historical information. Hurd has used his knowledge of historical theology well in his writing of historical criticism.

So far we have seen Hurd using history to show that Spenser and the Italian poets based their fictions, even many of their supposed miracles (see the first half of Letter X), upon actual happenings of their age. But his argument changes in the middle of Letter X to a discussion of the poems as art rather than as reflections of history: "this is not the sort of defence I mean chiefly to insist on. Let others explain away these wonders, so offensive to certain philosophical critics [he is thinking especially of Hobbes, whom he mentions twice in this letter]. They are welcome to me in their own proper form, and with all the extravagance commonly imputed to them." After quoting Addison on "the Fairy way of writing," Hurd sums up his argument about the poetic use of the supernatural; this passage is generally given as one of the most "romantic" in the *Letters:*

> So little account does this wicked poetry make of philosophical or historical truth: all she allows us to look for, is *poetical truth:* a very slender thing indeed, and which the poet's eye, when rolling in *a fine frenzy,* can but just lay hold of. To speak in the philosophic language of

[13]The edition of Horace (London, 1749) uses the method to show that the *Ars Poetica* was intended as a work of drama; the Preface to the edition of Cowley (1772, 1777) explains Cowley's false wit in terms of its age. The essays on imitation show the historical learning requisite to distinguish imitations of nature from imitations of other writers. One of his letters shows his knowledge of the historical method in his denial of the authenticity of Ossian: the letter is addressed to Warburton (December 25, 1761) in William Warburton, *Letters from a Late Eminent Prelate to One of his Friends* (New York, 1809), pp. 247–248.

> Mr. HOBBES, it is something much *beyond the actual bounds, and only within the conceived possibility of nature* (Letter X).

To understand this quotation, we ought to give another in the same Letter; this following passage is generally ignored by those who emphasize Hurd's "Romanticism":

> We must distinguish between the *popular belief,* and *that of the reader.* The fictions of poetry do, in some degree at least, require the first (they would, otherwise, deservedly pass for *dreams* indeed): but when the poet has this advantage on his side, and his fancies have, or may be supposed to have, a countenance from the current superstitions of the age in which he writes, he dispenses with the *last,* and gives his reader leave to be as sceptical and as incredulous, as he pleases (Letter X).[14]

This limitation upon the poet's ability to "create" is central to Hurd's criticism and shows his agreement with the majority of French and Italian critics of the epic. The first quotation above, in addition, shows a revealing use of the comment by Hobbes. First of all, Hurd characteristically adds *much* to intensify the idea; if the poet is to go "beyond the actual bounds," then he should go as far as possible; Hurd never advocates half measures. Secondly, he misuses Hobbes's comment, which originally meant that the poet ought to use idealized creations, a principle closer to Reynolds's "general nature" than to the Gothic use of supernatural beings. Hurd shows by the order of argument in Letter X that he knows what Hobbes's comment means; here he enjoys turning the great philosopher's words against himself.

Hurd continues his argument about the supernatural when he claims that the epic poet is not restricted to "the known and experienced course of affairs in the world" but "has a world of his own, where experience has less to do than consistent imagination" (Letter X). "Experience" for Hurd is always treated as material to be changed by the poet; as Hurd says in an essay written in the same year as the *Letters,* poetry "assembles, combines, or corrects its ideas, at pleasure; in short, prefers not only the agreeable, and the graceful, but, as occasion calls upon her, the vast, the incredible. I had almost said, the impossible, to the obvious truth and nature of things" (II, 9). Such poetry must be "consistent," must be tied well together with suitable images which are

[14]This quotation can raise an interesting question in view of Hurd's ironic reference to fiction which "would . . . pass for *dreams* indeed." We can ask what he would have thought of Coleridge's poetry of the supernatural. A poem like *Kubla Khan* would be beyond his ken because Hurd assumes that only the known world is ever a fit subject for art. This limitation upon the use of the supernatural is discussed in H. T. Swedenberg, Jr., *The Theory of the Epic in England,* 1650–1800, in *University of California Publications in English,* XV (Berkeley, 1944), 110, 139n.; also see Trowbridge, p. 460.

not contradictory.[15] This kind of criticism may well appear revolutionary if compared to the Preface by Pope to the 1717 edition of his works, but the comparison would be false, for Hurd is not here discussing pastorals and imitations but the epic. The similarity of idea in Pope and Hurd is much closer when we recall Pope's Preface and notes to the *Iliad,* especially the stress in the Preface upon Homer's matchless "invention." Neither critic, however, has in mind anything like Coleridge's notion of the imagination; the two eighteenth-century critics think of "invention" as a new mirroring of actuality (if we can consider superstitions and exaggerations as being "actual"), not as a uniquely personal response to, or creation of reality.

Possibly the finest touch in the *Letters* is Hurd's casual[16] introduction of the three types of poetry; this passage in Letter X, seemingly unconnected to the rest of the *Letters,* is actually the rationale behind the entire defense of Spenser and the Italians. He divides all poetry into the poetry of "men and manners," the poetry that addresses itself to the heart "through the *passions,*" and the poetry of the imagination. The first two are restricted to the believable (the first must be true historically, the second true of human nature), but the third is not because the imagination permits "fanciful exhibitions." Just as imitations of historical and social fact and representations of emotion have their own rules, so the imagination, which does not represent things directly to the eyes (as the drama does), has rules based upon what the reader is able to feign to himself. This leads Hurd to his belief that imaginative art must be based upon beliefs or superstitions of the poet's age. He is thus able to conclude his argument in a suitably traditional manner by claiming that no epic can succeed without "admiration"; this quality "cannot be affected but by the marvellous of celestial intervention, I mean, the agency of superior beings really existing, or by the illusion of the fancy taken to be so." As proof of his assertion he gives the failure of two epics which attempt to reach greatness without using the supernatural: Vol-

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[15]What Hurd means by "consistent imagination" is clarified by a remark by Upton in his Preface to Spenser: "'tis required that the fable should be probable. A story will have probability, if it hangs well together, and is consistent: And provided the tales are speciously told, the probability of them will not be destroyed, though they are tales of wizards or witches, monstrous men and monstrous women; for who, but downright miscreants, question wonderful tales": Mueller, p. 42.

[16]One difficulty we find in analyzing the *Letters* is the lack of systematic thought displayed throughout; Hurd is writing differently from what is usual in a critic who is generally over-systematized. But Hurd, always respectful of genre, is writing in the "Epistolary mode of writing," which has three rules: there must be "an unity in the subject"; there must also be "a connexion in the method"; it is imperative "that such connexion be easy" (I, 24). This passage is from the edition of Horace; the Preface contains elaborate rules for the epistle, all of which are relevant for Hurd's style and organization in the *Letters,* including his casual organization, familiar style, and ironic or mocking comments. Hurd, in other words, looked upon this defense of imaginative poetry as more than literary criticism; it was to be a work of art itself.

taire's *Henriade* and Davenant's *Gondibert*.[17] This breakdown of all poetry into types which correspond to the empirical division of the human faculties (judgment, imagination, and passion) is the most admirable theoretical doctrine in the *Letters;* by a consistent application of his theory of the three types of poetry Hurd is able to clarify many neoclassic confusions over the relation of judgment and fancy.

Finally, this defense of imaginative poetry shows what might be considered Hurd's most classical attribute as a critic—his insistence that each work of art achieve its proper effect and no other. This attitude permeates Hurd's criticism (we have seen it operate in the discussion of conflicting unities in the *Faerie Queene),* but it is stated most bluntly, even obsessively, in his essay "On the Provinces of the Drama": "though *mixed dramas* [tragedies using persons of low estate, comedy with those of high estate] may give us pleasure, yet the pleasure, in either kind, will be LESS in proportion to the mixture. And the *end* of each will be then attained MOST PERFECTLY when its character, according to the ancient practice, is observed" (II, 84). Such a desire for purity, for simplicity of one type of means leading to one end, besides being part of Hurd's personality, is an essential part of the classical view of art. Even though English art has rarely attempted this kind of unity, it is a high ideal as the dramas of the Greeks and Racine testify, and it is the only ideal that Hurd, at least in theory, ever accepted despite his love of Shakespear, Spenser, and Chaucer: Hurd always claims that the great poets of English literature would have been even greater if they had strictly observed unity.

We are now able to make one generalization that seems to cover Hurd's position on literary criticism: that is, the rules are rules only when they take into account all the relevant literature that has been found to be effective. This is a doctrine very important to the future development of practical criticism because it opens a critic's eyes to what is actually in a work of art before the critic decides what should be there. Thomas Warton does not subscribe to this kind of latitude; he finds pleasure in Spenser, but he also believes that the *Faerie Queene* is corrupt because it does not adhere strictly to the form found in classical writers.[18] Hurd would say that if the reader is satisfied, the rules have been followed to

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[17]The notion that a successful epic must contain the "marvellous" was common in the period; Pope attacked Voltaire's epic for this reason: see Austin Warren, *Alexander Pope as Critic and Humanist* (Princeton, 1929), p. 219.

[18]Warton's inability to make his taste and rules consistent is discussed fully by Raymond D. Havens, "Thomas Warton and the Eighteenth-Century Dilemma," *SP,* XXV (1928), 36–50. We should note, however, that Havens's thesis does not apply to the entire period; as we have seen, Hurd refuses to admit a conflict between theory and effect.

the extent of the poet's success with the reader; it is impossible to please in spite of the rules because Hurd claims that only rules followed correctly create pleasure. Suppose a reader were to find some literary work to which the so-called rules do not apply; Hurd would find that such a judgment means the rules in question either are not rules or are not interpreted well by the critic. Directly owing to this flexible attitude toward the rules, Hurd is able to make his main contribution to the development of literary criticism: his successful use of the historical method in the form which is basically the same as that which is used today. It is not his actual rules that are in any way original, for these are typical of neoclassicism in England; most critics of Hurd's century would find nothing odd in his notions of genre; of the ordering of a story; of the purpose of imagery, description, and versification. These rules are all deduced and all apply to all poetry. Hurd's importance lies in his realization that the specific application of these rules always depends upon the work being discussed. In this manner Hurd finds that much art of the past, which had previously been poorly analyzed by critics, follows the essence of neoclassical rules. His criticism is not romantic because his view of art is the same as that found in Dryden, Pope, and the other English Augustans. Hurd's difference lies in his full discovery of how to use history as an important adjunct to criticism.

THE INSECT PARASITES OF THE EUROPEAN PINE SHOOT MOTH, *RHYACIONIA BUOLIANA* (SCHIFFERMÜLLER) (LEPIDOPTERA:TORTRICIDAE) IN WISCONSIN WITH KEYS TO THE ADULTS AND MATURE LARVAL REMAINS

*Torolf R. Torgersen and Harry C. Coppel**

The European pine shoot moth, *Rhyacionia buoliana* (Schiffermüller), was introduced accidentally into North America. It was first discovered damaging pines at Great Neck, New York in 1913, but it was not definitely identified until 1914 (Busck, 1914). Transportation of infested nursery stock resulted in the rapid spread of the shoot moth, and by 1951 it was present throughout the Northeast, southward to Virginia, and westward to Wisconsin and Illinois. The shoot moth was first reported in the Pacific Northwestern United States in Washington in 1959 (U.S.D.A., Pacific N.W., 1960). By 1961, infested ornamental pines had been discovered in several cities in Washington and Oregon, and in northern California (U.S.D.A., Pacific N.W., 1962; U.S.D.A., Pacific S.W., 1962).

The preferred hosts of the shoot moth are the hard pines. In North America the most commonly attacked species are *Pinus resinosa* Ait., *P. sylvestris* L., and *P. mugho* Turra. Although the shoot moth does not usually kill trees, larval feeding in buds and elongating shoots inhibits their growth and deforms them so that they are unsuitable for future harvest.

R. buoliana has been present in Wisconsin since 1951. In 1953, four counties reported infestations, and by 1959, pine plantations in 27 southern and eastern counties had infestations (Wis. Conserv. Dept., 1953, 1959; Benjamin *et al*, 1959). In 1960, a project was undertaken to investigate the bionomics of the shoot moth in Wisconsin, and to determine the structure of its parasite and predator complex. The information was compiled from field collections and laboratory studies of material collected during the summers of 1961–1963 from five forest plantations in the Point Beach State Forest, Two Rivers, Wisconsin.

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The authors are Research Assistant and Associate Professor, respectively, Department of Entomology, University of Wisconsin–Madison.

This paper deals with the known parasites of *R. buoliana* in Wisconsin. Keys for the separation of the parasites based on the remains left in the bud after the parasite has emerged; and for the separation of the parasite adults are given. Descriptions of the final-instar cephalic structures, and spiracles of Hymenoptera, puparia and buccopharyngeal armature of Diptera, and notes on the biology of the parasites are also included.

Methods

The material upon which the keys are based consisted of adult parasites, and host and parasite remains from buds that could be positively associated with the parasites emerging from them. The adults were identified by the staff of the Insect Identification and Parasite Introduction Branch of the U. S. Department of Agriculture at Beltsville, Maryland.

Material used in the preparation of the key to parasite remains included host larval and pupal remains; empty egg chorions (in a few instances), cast larval and pupal skins, and cocoons of the hymenopterous parasites; and puparia with the included buccopharyngeal armature of the dipterous parasite. Cast larval skins of the hymenopterous parasites were removed from the buds, softened in 10 percent potassium hydroxide for 30 minutes to several hours, and washed in distilled water. Skins could be dyed lightly by first running them up to 70 percent alcohol, and then immersing them in a solution of iodine crystals dissolved in 70 percent alcohol; the skins were then mounted on microscope slides in non-resinous mounting medium (Turtox CMC–10) or in Hoyer's medium.

Illustrations of parasite remains were made with the aid of a projecting prism for gross characters and outlines, and an Ernst Leitz binocular compound microscope fitted with an ocular grid for fine details. The terminology used for the parts of the cephalic structures and spiracles of the final-instar larvae of Hymenoptera, and, in part, the buccopharyngeal armature of the Diptera is the same as that compiled from various authors by Finlayson (1960). Zuska (1963) was referred to for the terminology used in describing the puparium of the Diptera.

Drawings of the parts of adult parasites were made from pinned specimens with the aid of a Bausch & Lomb binocular dissecting microscope fitted with an ocular grid. Illustrations of wing venation were made with the aid of a prism projector, from wings mounted on microscope slides in non-resinous mounting medium.

Parasites Obtained

The following parasites, including two species of Diptera and 18 of Hymenoptera have been reared from *R. buoliana* in Wisconsin:

Diptera

Chloropidae: *Oscinella conicola* (Greene).
Tachinidae: *Erynnia tortricis* (Coq.)

Hymenptera

Braconidae: *Apanteles* sp., *Bracon* n. sp., *Bracon gelechiae* Ashmead.
Ichneumonidae: *Exeristes comstockii* (Cresson), *Scambus tecumseh* Viereck, *Scambus* sp., *Itoplectis conquisitor* (Say), *I.* ? *evetriae* Viereck, *Coccygomimus annulipes* (Brullé)., *Gambrus* sp., Porizonini, *Atrometus* sp.
Eulophidae: *Elachertus pini* Gahan, *Hyssopus thymus* Girault.
Eupelmidae: *Eupelmus cyaniceps* Ashmead, *Macroneura vesicularis* (Retzius).
Pteromalidae: *Habrocytus thyridopterigis* Howard.
Eurytomidae: *Eurytoma pini* Bugbee.

Two keys have been prepared for the separation of the above species. The first is designed to aid in separating the parasites on the basis of the host and parasite remains left in the bud after the parasite has emerged. Twelve species of parasites, one dipteron and eleven hymenopterons, are included in the key to parasite remains. The remaining seven species have not been included because insufficient material was available. The second key is for the identification of the adults of the parasites of *R. buoliana.*

KEY TO THE PARASITES OF *R. BUOLIANA* BASED ON PARASITE REMAINS[3]

1. Internal solitary parasites emerging from fully developed pupae; parasite remains inside host pupal skin ______ 2
External solitary or gregarious parasites or hyperparasites of larvae or pupae; parasite remains in host gallery ____ 5

2.(1) Parasite remains a dipterous puparium (Figs. 1–4). ____ ________________________________*Erynnia tortricis* (Coq.)
Parasite remains consisting of the shed larval skin of final-instar hymenopterous larva ____________________ 3

[3]Final-instar larval skins of Hymenoptera, or dipterous puparia and buccopharyngeal armature.

3.(2) Hypostomal arms present (Fig. 18); atrium of spiracle nearly the same width as the stalk (Fig. 35) ____*Atrometus* sp.
Hypostomal arms lacking (Figs. 15, 16); atrium of spiracle not as above; atrium large, leading into a narrower stalk (Fig. 34), or directly into a closing apparatus by a small opening (Fig. 33) ____________________________ 4

4.(3) Atrium of spiracle about three times as wide as the stalk; stalk ends in a well-developed closing apparatus (Fig. 34) ______________________________*Itoplectis* ? *evetriae* Vier.
Atrium of spiracle without a stalk; connected directly to a well-developed closing apparatus through a small opening (Fig. 33) ________*Coccygomimus annulipes* (Brullé)

5.(1) Cephalic structures reduced. only mandibles, or mandibles and clypeus, developed (Figs. 19, 21, 24) ____________ 6
Cephalic structures well-developed, not limited to the above ____ 8

6.(5) Cephalic structures consisting of mandibles and a heavily sclerotized clypeus armed with denticles (Fig. 21) ______ ________________________*Macroneura vesicularis* (Retz.)
Cephalic structures apparently consisting only of mandibles ______________________________________ 7

7.(6) Atrium with chambers tapering gradually, ending at a distinct closing apparatus (Fig. 38) __________________ ______________________*Habrocytus thyridopterigis* How.
Atrium with chambers tapering sharply, ending in a long, thin, finely-annulated stalk; very small closing apparatus present (Fig. 36) _______________*Hyssopus thymus* Gir.

8.(5) Mandibles armed with a single large denticle posteriorly (Fig. 27); cephalic structures limited to little more than pleurostomata bearing the superior and inferior mandibulary processes __________________*Eurytoma pini* Bugbee
Mandibles armed with two rows of fine teeth, or several thin leaf-like teeth; cephalic structures consisting of epistoma, pleurostomata, hypostomata, and labial sclerite __ 9

9.(8) Mandibles armed with several thin leaf-like teeth in addition to the heavily sclerotized primary mandibular blade (Figs. 8, 11) ______________________________________10
Mandibles armed with two rows of tiny hair-like teeth on the primary mandibular blade (Fig. 13) ______________ _________________________*Exeristes comstockii* (Cress.)
Scambus (Scambus) tecumseh Vier.
and *Scambus (S.)* spp.

10.(9) Row of leaf-like teeth limited posteriorly by the posterior angle of the mandible which is drawn out into a tooth

(Fig. 8); spiracle with a distinct closing apparatus (Fig. 30) ---------------------------------- *Bracon* n. sp.
Row of leaf-like teeth not limited posteriorly by a tooth, posterior angle smoothly rounded (Fig. 11); spiracle without closing apparatus (Fig. 31) --*Bracon gelechiae* Ashm.

KEY TO THE ADULTS OF THE PARASITES OF *R. BUOLIANA*[4]

[4]*Apanteles* sp. and *Oscinella conicola* (Gr.) are included as questionable parasites of *R. buoliana.*

1. Wings extremely abbreviated, apparently absent; reduced to tiny opaque, nearly acute pads whose apical portion is bent erect --------------*Macroneura vesicularis* (Retz.)
Wings well-developed -------------------------- 2
2.(1) One pair of wings; Diptera ------------------------ 3
Two pairs of wings; Hymenoptera ------------------- 4
3.(2) Thorax with a complete transverse suture; body with many bristles; insect much like a small (5 mm.) housefly in appearance -------------*Erynnia tortricis* (Coq.)
Thorax without a transverse suture; body covered with fine setae, only a few bristles; tiny (1 mm.), black shining flies ----------------------*Oscinella conicola* (Gr.)
4.(2) Wing venation reduced (Figs. 40–43); antennae geniculate ------------------------------------ 5
Wing venation well-developed (Figs. 44–46); antennae filiform ------------------------------------- 9
5.(4) Abdomen compressed, shining black; head and thorax coarsely punctate; venation as in Fig. 40 --------------- -------------------------------*Eurytoma pini* Bugbee
Abdomen not compressed, more or less flattened ------ 6
6.(5) Stigma in forewing furcate (Fig. 43); tarsi 4-segmented; black minute insects ------------------------------ 7
Stigma in forewing not furcate (Figs. 41, 42); tarsi 5-segmented; bright metallic green or blue insects ------ 8
7.(6) Stigma in forewing strongly furcate (Fig. 43); pro- and mesothoracic femora and tibiae nearly entirely fuscus -- -------------------------------*Hyssopus thymus* Gir.
Stigma in forewing not so strongly furcate as in Fig. 43; pro- and mesothoracic femora and tibiae nearly white -- --------------------------------*Elachertus pini* Gah.
8.(6) Mesoscutellum (scl_2) acute anteriorly, axillae (ax) nearly touching medially (Fig. 51); marginal vein more than four times as long as stigmal vein (sv) plus stigma (st) (Fig. 42) -----------------*Eupelmus cyaniceps* Ashm.

Mesoscutellum truncate anteriorly, axillae widely separated (Fig. 52); marginal vein only slightly longer than the stigmal vein plus stigma (Fig. 41) ---------------------------------- *Habrocytus thyridopterigis* How.

9.(4) Forewing with a single recurrent vein (rv) (Figs. 44, 45) -- 10

Forewing with two recurrent veins (Fig. 46) -------- 12

10.(9) Forewing with both 2nd marginal (2nd M) and 2nd submarginal (2nd SM) cells present (Fig. 45) ---------- 11

Forewing with neither 2nd marginal nor 2nd submarginal cells present (Fig. 44) ------------------ *Apanteles* sp.

11.(10) Mesopleuron, and at least anterior half of mesonotum glabrous and shining black; abdomen mostly yellow-brown, sometimes with darker shading caudally; tergum of petiole and anterior medial portion of segment II black -- *Bracon* n. sp.

Mesopleuron and mesonotum not glabrous and shining, rather dull black, clothed in short grey hairs; abdomen entirely fuscus above; inner margin of eyes each marked with two yellowish semi-circles—*Bracon gelechiae* Ashm.

12.(9) Major axis of the petiole (ab_1) and that of the rest of the abdomen forming a distinct angle (Figs. 53, 54); petiole distinctly elongate ------------------------------------ 13

Major axis of the petiole and that of the rest of the abdomen more nearly parallel (Fig. 55); petiole not distinctly elongate -- 15

13.(12) Abdomen extremely compressed; petiole (ab_1) and the second abdominal segment (ab_2) about six times as long as their greatest diameter (Fig. 53); head and thorax patterned with yellow ---------------------- *Atrometus* sp.

Abdomen not markedly compressed; petiole and second abdominal segment as in Fig. 54 -------------------- 14

14.(13) Propodeum divided into several areas set off by propodeal carinae; abdominal segments mostly dark, terga of segments II and III each with fusco-testaceous areas laterally, sometimes joined medially -- Porizonini: Unknown species 1

Propodeum not divided into areas by propodeal carinae; abdominal segments I, II, III, and the anterior portion of segment IV ferruginous ------------------ *Gambrus* sp.

15.(12) Hind tibia dark at extreme base, i.e. tibia with apical and basal bands and a median pale band ---------------- 16

Hind tibia pale at extreme base, i.e. tibia with or without bands, but pale at base, or with apical and subbasal dark bands and median basal bands -------------------- 18

16.(15) Inner margin of eye weakly concave above antennal socket (Fig. 50); tarsal segments 1, 2, and 3 without distinct bands basally ________*Coccygomimus annulipes* (Brullé)
Inner margin of eye rather strongly concave at antennal socket (Fig. 49); tarsal segments 1, 2, and 3 with distinct white bands basally ____________________________17

17.(16) Abdominal terga with white or cream-colored posterior margins ___________________*Itoplectis conquisitor* (Say)
Abdominal terga entirely dark _*Itoplectis* ? *evetriae* Vier.

18.(15) Nervellus (nv) intersected by the discoidella (dsc) at or below the middle (Fig. 48) __________________________19
Nervullus intersected by the discoidella near or above the middle (Fig. 47) _________*Exeristes comstockii* (Cress.)

19.(18) Median pale band on hind femur incomplete ventrally ____ ____________________*Scambus (Scambus) tecumseh* Vier.
Median pale band on hind femur complete ventrally _____ ________________________________*Scambus (Scambus)* sp.

NOTES ON PARASITE BIOLOGY AND DESCRIPTIONS

Diptera

Chloropidae

Oscinella conicola (Greene)

This tiny choloropid was recorded from *R. buolinana*-infested buds by Watson and Arthur (1959), who stated that it had previously been known to feed in red pine cones, and considered it as having a questionable role as a shoot moth parasite. Torgersen and Coppel (1962) reared two *O. conicola* from a shoot moth-infested bud and listed it as a parasite. No shoot moth emerged, and the bud was not dissected to ascertain the status of the association. According to Kulman (personal communication to H. C. Coppel), in West Virginia, *O. conicola* is very abundant in infested tips, but there appears to be no adverse effect upon the shoot moth. As members of this family may be parasitic or predacious as well as phytophagous (Borror and DeLong, 1960; Imms, 1960), it seems that the role of this insect is still not adequately clarified.

Tachinidae

Erynnia tortricis (Coq.)

Figs. 1–6

Four shoot moth pupae, collected in 1963, were parasitized by *E. tortricis*. Two pupae, from which the flies had already emerged, were collected on July 12. Two adults emerged on July 14 from host pupae collected on June 26 and 28.

E. tortricis is an internal parasite emerging from the pupa of *R. buoliana*. A puparium is formed within the host pupal skin, and two stigmatophores borne on a single variably shaped trunk protrude through the host pupal skin where the wing pads, legs, and antennae terminate (Fig. 1). Zuska (1963) stated that the stigmatophores are formed as late as during the pupation of the larva. This might account for the variable shape of the stigmatophore trunk since it may be exserted through the hard host pupal skin while still soft and pliable; hardening taking place as the exserted portion dries. Exit from the puparium is through an opening made by fractures along the horizontal and vertical sutures to form a dorsal and ventral flap. The host pupal skin is forced open along a line between head and prothorax, down one or both sides along the sutures separating the wings from the legs and mouthparts. The resulting flap may or may not remain attached to the host pupal skin.

Puparium (Figs. 2, 3) 4.61 to 5.12 mm. long, not including the stigmatophores; 2.05 to 2.56 mm. in diameter at widest point. Spiracular plate (Fig. 4) perforated by four to six orificia arranged in a roughly radial pattern. Number of orificia often variable between stigmatophores on a single individual; five orificia probably normal. Distance from anus to posterior spiracles (as defined by Zuska, 1963) slightly less than one one-third largest diameter of puparium. Buccopharyngeal armature (Figs. 5, 6) 0.39 to 0.45 mm. long; attached to inside of ventral flap at site of secondary mouth opening. Mandibular hooks moderately heavy, curving slightly anteroventrally; two or three teeth along ventral margin; in dorsal view (Fig. 6) each hook bears a denticle on either side. Lightly sclerotized salivary gland plate present. Articulation between mandibular hooks and intermediate sclerite difficult to distinguish even after lengthy clearing; no articulation present between intermediate and basal sclerites. Basal sclerite divided into two dorsal wings that become progressively less sclerotized posteriorly; distinctly veined posteriorly. Ventral wings fused medially to form lightly sclerotized flap.

Hymenoptera

Braconidae

Microgasterinae

Apanteles sp.

Fig. 44

A single specimen of *Apanteles* sp. was collected in the insectary on July 24, 1963. The specimen had escaped from a bag of *R. buoliana*-infested buds that had been collected the previous day. This species is included as a questionable parasite of *R. buoliana*.

FIGURE 1. Pupal skin of *Rhyacionia buoliana* (Schiff.) with the puparium of *Erynnia tortricis* (Coq.) *in situ.*

Braconinae

Bracon n. sp.

Figs. 7–9, 30

According to C. F. W. Muesebeck (personal communication) this species is apparently undescribed. The parasite develops externally on the shoot moth larva, one, two, or three to a host. Eight individuals were recovered from six host larvae. These emerged from July 1 to July 16. The collections of buds from which these parasites emerged were made from June 18 to June 24, 1963. In one instance, a single host larva supported three braconids of this species and six *H. thyridopterigis,* all of which emerged successfully. The pteromalids emerged nearly two weeks after the braconids.

Cocoon tan; a regular ellipse approximately 2 mm. by 5 mm.; exit hole cut at one end of cocoon about 1.25 mm. in diameter. Cocoon constructed near host remains; tied down by spreading mat of silk strands. Meconium, pupal skin, and mature larval skin are found in cocoon. Exit from host gallery through gallery entrance kept open by host larva before death.

Cephalic structure (Fig. 7) characterized by fusion of epistoma, pleurostomata, and hypostomata to form a vaulting arch over the mandibles, stipital sclerites, and labial sclerite. Superior mandibulary processes well-developed; inferior processes simple, each accompanied by a lacinial sclerite. Primary mandibular blade followed by several thin, leaf-like teeth posteriorly; these leaf-like teeth limited posteriorly by the posterior angle of mandible which is drawn out into a heavily sclerotized tooth (Fig. 8). Stipital sclerites form nearly a straight line with one another; encounter dorsal arms of labial sclerite at a point immediately below a line drawn through the labial palpi. Labial sclerite open dorsally; thickened along ventral margin; dorsal arms narrower than ventral margin, widened slightly at their ends where they enclose a silk press that is nearly as wide as long. Maxillary and labial palpi bear two sensoria each. Antennae about twice as long as basal diameter; antennal sockets not apparent. Larval skin densely covered with tiny spines (Fig. 9) and scattered setae 0.03 mm. long. Spiracle (Fig. 30) consists of a large atrium on a thick, nearly parallel-sided stalk that is clearly annulated; stalk ends at a distinct closing apparatus. Atrium sculptured on its inner walls by two sub-parallel rings made up of continuous lines of minute warts.

Braconinae

Bracon gelechiae Ashmead

Figs. 10, 11, 31, 45

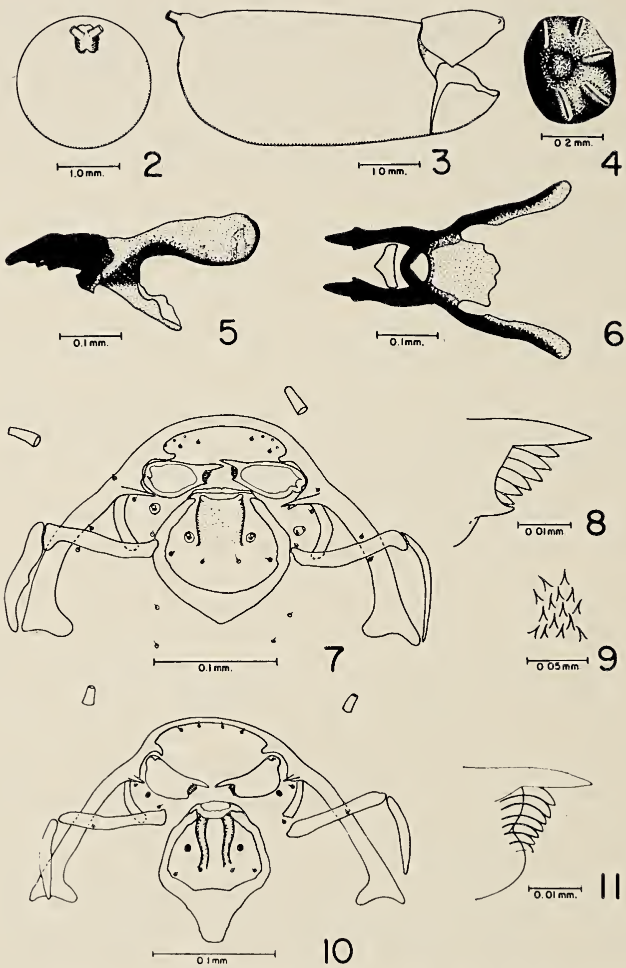
B. gelechiae was originally described as a parasite of gelechiids on oak (Muesebeck *et al*, 1951). It has since been recorded from *R. frustrana,* as *Microbracon gelechiae,* by Cushman (1927), and from *R. buoliana* by Schaffner (1959) in the Northeast, and by Watson and Arthur (1959) in Ontario. Miller and Neiswander (1955) in Ohio, listed *B. gelechiae* as a species of unverified status in connection with parasite rearings from bud collections containing *R. buoliana.*

Nine specimens of *B. gelechiae* developed on five shoot moth larvae. This species is a gregarious external parasite of the larva; from one to four parasites develop on a single host individual. The emergence period lasted from July 3 to July 17. Collections from which these individuals emerged were made from June 15 to July 3, 1963.

According to Cushman (1927) *M. gelechiae* develops as a solitary or gregarious external parasite on large larvae of *R. frustrana.* He stated that the pupal period is spent in a dense brown cocoon. In the material collected at Two Rivers, the cocoon of this parasite was very light, nearly white. The roughly elliptical cocoon is not closely associated with the host remains, and may be found as distant from the host remains as the entrance to the gallery. The cocoon is about 1.1 mm. by 4.1 mm.; exit from the cocoon is through a hole about 0.8 mm. in diameter cut at one end. Meconium, pupal skin, and the final-instar larval skin may be found in the cocoon, but they are often missing.

The cephalic structures of this species (Fig. 10) were prepared from a single damaged specimen, consequently the juxtaposition of its parts is not accurate. The general aspect of *B. gelechiae* is the same as the *Bracon* species above. In particular, this species differs from the former in the following respects; The cephalic structures are smaller overall; the dorsal arms of the labial sclerite are narrow as compared with the width of the ventral portion; the silk press is longer than wide; the mandibles bear several thin leaf-like teeth, however, they are not limited posteriorly by a tooth, but rather the posterior angle of the mandible is smoothly rounded (Fig. 11); the antennae are slightly less than twice their basal diameters in length. The larval skin, like that of *B.* n. sp., is covered with minute spines and a few scattered setae. Spiracle (Fig. 31) with a large atrium atop a scarcely tapering, distinctly annulated stalk ending in a short non-annulated, parallel-sided section;

there is no closing apparatus. Inner wall of atrium bears two rings of fine wavy lines around its lower half; these lines not composed of a series of warts as in the previous *Bracon* species.



FIGURES 2–6. Puparium and buccophyaryngeal armature of *Erynnia tortricis* (Coq.): 2, puparium, posterior view; 3, puparium, lateral view; 4, stigmatophore plate, dorsal view; 5, final-instar buccopharyngeal armature, lateral view; 6, final-instar buccopharyngeal armature, dorsal view. 7–11. Cephalic structures and spines of final-instar hymenopterous larval skins: 7–9, *Bracon* n. sp.; 7, cephalic structure, anterior view; 8, distal portion of right mandible, ventral view; 9, portion of skin showing spines; 10–11, *Bracon gelechiae* Ashm.; 10, cephalic structure, anterior view; 11, distal portion of right mandible, ventral view.

Ichneumonidae
Ephialtinae:Pimplini
Exeristes comstockii (Cresson)
Figs. 12–14, 32, 47, 55

Exeristes comstockii is a common parasite of lepidopterous larvae that feed inside the growing shoots or in the cones of pines (Townes and Townes, 1960). *E. comstockii* was recorded as a parasite of *R. buoliana* in Connecticut (Friend, 1935), Massachusetts, Rhode Island, New York, and New Jersey (Schaffner, 1959), Michigan (Miller, 1959), Ohio (Miller, 1953), West Virginia (Harman and Kulman, 1962), Wisconsin (Torgersen and Coppel, 1962), British Columbia (Mathers and Olds, 1940), and Ontario (Watson and Arthur, 1959). Among the other species that are often found in plantations infested with *R. buoliana,* and whose damage is sometimes attributed to the shoot moth, the following are known hosts of *E. comstockii: R. rigidana* (Fern.), *R. frustrana* (Comst.), *Dioryctria zimmermani* (Grote), *Petrova comstockiana* (Fern.), and occasionally *Pissodes strobi* (Peck) (Townes and Townes, 1960).

The biology of *E. comstockii* was studied by Cushman (1927), Miller (1953), and by Arthur (1963), who also illustrated the immature cephalic structures and spiracles. *E. comstockii* is a solitary external parasite on the shoot moth larva. There are two generations per year. The summer generation develops and overwinters on a host other than *R. buoliana,* but it is not known what species serves as the overwintering host at Two Rivers. In Ontario, the adults of the spring generation emerge between June 9 and 27 (Arthur, 1963). Miller (1953), in Ohio, recorded adult emergence from June 6 through July 15. Laboratory emergence at Two Rivers extended from July 2 through July 29. The average peak laboratory emergence date for three years' observations was July 14. The sex ratio is slightly less than 2:1 in favor of females.

From the earliest and latest host collection dates, and the earliest and latest emergence dates from 1961 to 1963, it was calculated that the development time for *E. comstockii* from egg to adult is from 22 to 26 days. Males are produced on the average, in 23 days; females in 26 days. These averages correspond exactly to those of Arthur (1963).

The parasite larva constructs a cocoon of loosely spun white silk. The cocoon is variable in shape depending upon its position in the gallery, and is commonly closely associated with the host remains.

Cephalic structure (Fig. 13) well-developed; epistoma complete, with two setae and one sensorium on either side; labial sclerite encloses labrum with several pairs of setae and at least two pairs of sensoria; suspensorial sclerite present medially behind mandibles. Superior mandibulary processes long, directed ventrad; inferior processes simple, each accompanied by a lacinial sclerite. Mandibles with long, slightly curved blades with two rows of fine hair-like teeth (Figs. 12, 13). Hypostomal arms extend laterad; hypostomal spurs long and narrow; stipital sclerites progressively less sclerotized laterally, most heavily sclerotized medially where they meet hypostomal spurs and labial sclerite. Labial sclerite nearly closed dorsally; ventral portion more than twice the width of the dorsal arms, and irregularly dentate along ventral margin; opening of silk press evident medially where dorsal arms bend inward. Maxillary and labial palpi with two sensoria each. Antennae long, approximately three times as long as average diameter. Vertex with four large pigmented areas, the median areas largest, lateral areas narrower and each accompanied by a much smaller area posteriorly (Fig. 14). Larval skin with fine warty appearance, and scattered setae. Atrium of spiracle (Fig. 32) bears closely spaced annulations and numerous projections on the inside upper one-half of chamber; chamber tapers to a stout stalk with parallel, finely-crenulate sides, enclosing a well-defined closing apparatus. The final-instar spiracle differs from that illustrated by Arthur (compare Arthur, 1963, p. 1086, Fig. 4). The material illustrated in this work had a greater number of annulations, and a stouter general aspect, with a more pronounced taper.

Scambus (Scambus) tecumseh Viereck, and *Scambus* spp.

Ichneumonids in this genus have been reared from shoot moth material rather commonly, but not in large numbers. Raizenne (1952) listed rearings from shoot moth collections made from 1938 to 1948 in Ontario. Also in Ontario, Watson and Arthur (1959) recorded a complex of *Scambus* species, *S. hispae* and *S. tecumseh,* as active parasites of the shoot moth. *S. hispae* was reared as a parasite of *R. buoliana* in the Northeast by Schaffner (1959). Miller and Neiswander (1955) listed *S. hispae* as an unverified parasite of *R. buoliana* in Ohio.

Collections made at Two Rivers, from 1961 to 1963, yielded five specimens in the genus *Scambus.* Three females, identified as *S. (S.) tecumseh* emerged during July of 1963. Emergence dates for these were July 3, 16, and 25, from hosts collected on June 18, 25, and 28, respectively. Two undetermined specimens of *Scambus* emerged on June 7, 1961 and Julyl 1, 1963, from shoot moth-infested buds collected on May 13, 1961 and June 22, 1963. All the *Scambus* species reared at Two Rivers were solitary, external, larval parasites. Incompletely formed pupae were also found associated with the parasite remains. *S. (S.) tecumseh* was sometimes a victim of the cleptoparasitic habit of *Eurytoma pini.*

The final-instar cephalic structures and spiracles of the *Scambus* species and *E. comstockii* are so similar that it was not possible to separate the two adequately. It is suggested that Arthur (1963) be consulted for separation of *E. comstockii* and the *Scambus* complex, since too little *Scambus* material was reared at Two Rivers to make valid comparisons.

Ephialtinae:Ephialtini

Itoplectis conquisitor (Say)

This ichneumonid is an extremely common parasite of lepidopterous pupae and prepupae, especially those exposed or weakly protected. Over 80 species of lepidoptera have been recorded as hosts for *I. conquisitor* (Muesebeck *et al,* 1951; Arthur, 1963). Townes and Townes (1960) stated that it may act as a secondary by parasitizing ichneumonids and braconids within their cocoons. It has been reared as a parasite of *R. buoliana* nearly everywhere this host occurs in North America. Finlayson (1962) illustrated the final--instar cephalic structure and spiracle. Arthur (1963) illustrated the first four larval instar cephalic structures and spiracles, and described the biology of the species. Other notes on the biology of *I. conquisitor,* as a parasite of a *Coleophora* species, were discussed by Doner (1936).

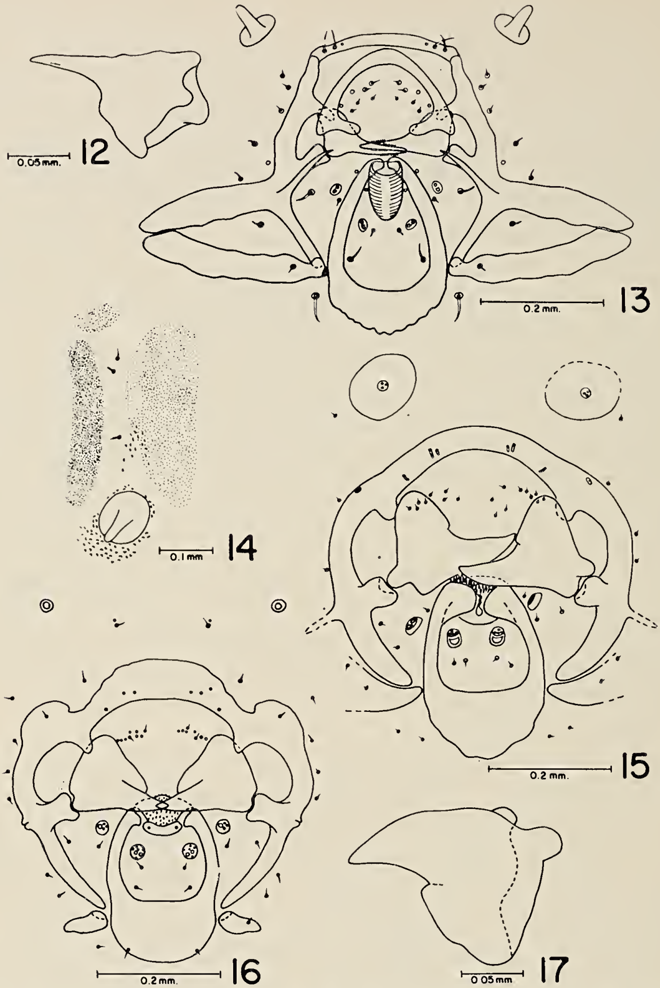
I. conquisitor was not recovered from the shoot moth at Two Rivers, but Wilkinson (1957) reared it from pupae of *R. buoliana* collected in Milwaukee County, Wisconsin. Individuals of *I. conquisitor,* including females apparently searching for hosts, were collected in flight in the plantations at Two Rivers. Field captures, during 1961 and 1962, were made from June 29 to October 8. Most of the individuals were caught in the early half of July of both years. In 1962, the peak flight activity was about ten days earlier.

Nests of *Archips cerasivorana* (Fitch) were numerous on *Prunus* spp. growing adjacent to some of the plantations. Several nests were collected and placed in rearing cages on July 17, 1962. Five individuals of *I. conquisitor* emerged between July 18 and 23.

Itoplectis ? evetriae

Figs. 16, 17, 34

Three individuals, two males and a female, emerged from shoot moth pupae in the summer of 1963. The emergence dates were July 12 and 13 for material collected on June 21; the female emerged on July 20, from a pupa collected on June 30. These specimens were tentatively identified, by L. M. Walkley. as possibly a



FIGURES 12–17. Cephalic structures of final-instar hymenopterous larvae: 12–14, *Exeristes comstockii* (Cress.); 12, right mandible, dorsal view; 13, cephalic structure, anterior view; 14, right side of vertex of head capsule, dorsal view; 15, *Coccygomimus annulipes* (Brullé), cephalic structure, anterior view; 16, 17, *Itoplectis ? evetriae* Vier.; 16, cephalic structure, anterior view; 17, right mandible, dorsal view.

new species near *evetriae,* but more specimens are needed to establish whether the separating characters are stable.

This species is a solitary, internal parasite emerging from the pupa of *R. buoliana.* No cocoon is present, and the host is empty except at the end of the abdomen where the parasite remains are found closely associated with the sclerotized portions of the host genital apparatus. Exit from the host pupa by the adult parasite is through a hole cut in the anterior end of the pupal skin. The exit hole has a jagged margin, and occurs on the pupa at about the middle of the scutellum. The adult parasite escapes from the host gallery by cutting a hole through the silk plug made by the host larva prior to pupation.

Cephalic structure of mature larva (Fig. 16) heavily sclerotized; epistoma, pleurostomata, and hypostomal spurs fused to form a ring broken ventrally by the labial sclerite. Superior mandibulary processes simple, articulate about one-quarter of the way down the articulating surface of each mandible; inferior processes indented to receive the large, blunt mandibular condyles. Hypostomal arms absent, two small projections present opposite the inferior mandibulary processes where the hypostomal arm would ordinarily arise. Hypostomal spurs long and narrow; stipital sclerites reduced. Labial sclerite broadly U-shaped, rectangular; ventral margin greatly widened; dorsal arms widely separated at their apices. Spiny hypopharyngeal region present, bounded laterally by dorsal arms of labial sclerite, and ventrally by pre-labial sclerite. No silk press evident. Mandibles (Fig. 17) heavy, without teeth, but each with a blunt protuberance posteriorly near base of primary blade. Maxillary palpi each with one large sensorium, and about three smaller ones; labial palpi each with two large sensoria, and about five smaller ones. Epistoma with three sensoria on each side. Antennae reduced to buttons. Vertex with two elongate pigmented areas that are more heavily sclerotized than the remainder of the vertex. Larval skin finely textured, with very short, hardly noticeable setae. Atrium of spiracle (Fig. 34) nearly round; numerous irregularly shaped protuberances scattered over its inner wall. Atrium borne on short annulated stalk about one-third its diameter; stalk with about eight rings; terminates at a distinct closing apparatus about twice as wide as the stalk.

Coccygomimus annulipes (Brullé)
Figs. 15, 33, 50

The rearing of *C. annulipes* from *R. buoliana* is a new host record (Torgersen and Coppel, 1962). It had previously been recorded from other Olethreutinae, including *Carpocapsa pomonella* (L). *Grapholitha molesta* Busck, *Gretchena bolliana* (Sling.), and *Laspeyresia nigricana* Steph. (Townes and Townes, 1960).

C. annulipes is a solitary internal parasite that emerges from the pupa of *R. buoliana*. A single female emerged on August 8 from an infested bud collected on July 24. The specimen emerged from a shoot moth pupa containing the remains of a fully formed moth. The thorax of the pupal case was split mid-dorsally, indicating that either the host had already begun to emerge when it was finally killed by the parasite, or the activity of the parasite in attempting to escape, caused the pupal case to rupture. Exit of the parasite adult is made by cutting through the posterior few segments of the pupal case, leaving a jagged margin.

Cephalic structure of final-instar (Fig. 15) heavily sclerotized; epistoma, pleurostomata, and hypostomal spurs form a ring broken ventrally by the labial sclerite. Superior mandibulary processes stout, articulate about one-quarter of the way down the articulating surface of each mandible; inferior processes simple, heavily-bodied, with apical depression in which mandibular condyle articulates. Hypostomal arms absent, lightly sclerotized projections present opposite inferior mandibulary processes where hypostomal arms ordinarily arise. Hypostomal spurs stout; reduced stipital sclerites distinct, heavily sclerotized medially, but less so laterally. Labial sclerite nearly elliptical, as opposed to that of *I. ? evetriae* which approximates a rectangle; widened ventral portion forms nearly a semi-circle; dorsal arms widen markedly apically; nearly meet medially; an indistinct silk press lies between apices of dorsal arms. Hypopharyngeal region bears long teeth. Mandibles heavily-bodied; without teeth, but each bears a protuberance at the base of the blade. Maxillary palpi each with at least two sensoria; labial palpi each with one large sensorium and four small sensoria. Labral sclerite absent, but labral area bears several small setae on either side. Antennae reduced to buttons, each with three sensoria; large sclerotized antennal socket surrounds each antenna. Vertex with two elongate pigmented areas. Atrium of spiracle (Fig. 33) nearly round; its inner wall without protuberances or patterning. Atrium not borne on a stalk; connected directly to a well-developed, deeply fluted closing apparatus.

Gelinae:Mesostenini

Gambrus sp.

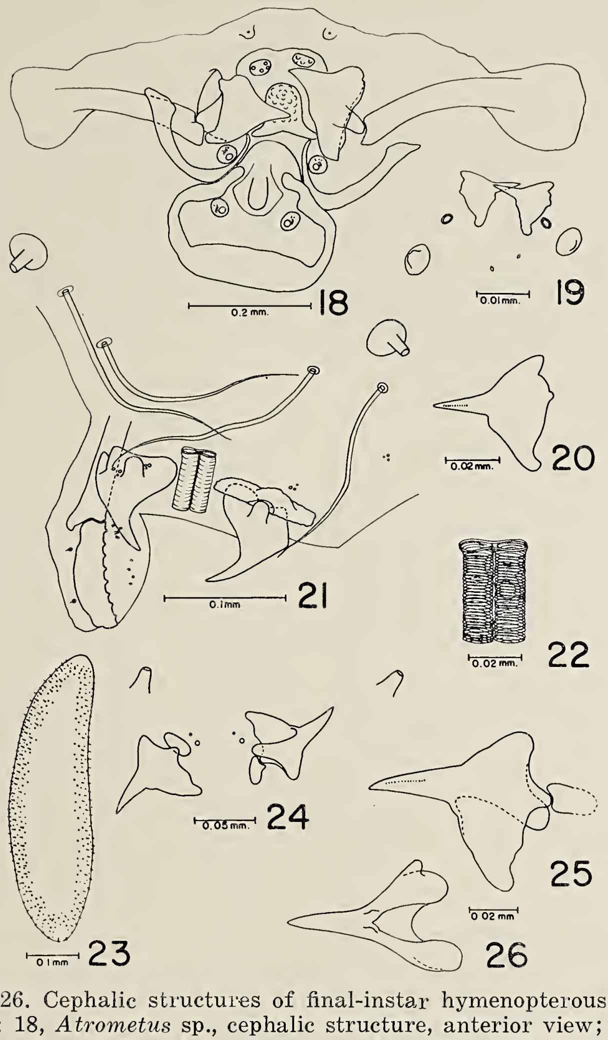
Fig. 54

Two individuals, one male and one female, of this species emerged on July 21, 1961. The buds from which they emerged were collected on July 18. Each specimen developed on a single host.

Ophioninae:Porizonini (=Campoplegini)

Unknown species 1

This tribe commonly parasitizes lepidopterous larvae (Muesebeck *et al,* 1951). Schaffner (1959) listed the rearing of several



FIGURES 18–26. Cephalic structures of final-instar hymenopterous larvae, and egg chorion: 18, *Atrometus* sp., cephalic structure, anterior view; 19, 20, *Hyssopus thymus* Gir.; 19, cephalic structure, dorsal view; 20, right mandible, dorsal view; 21, 22, *Macroneura vesicularis* (Retz.); 21, cephalic structure, dorsal view; 22, silk press, dorsal view; 23–26, *Habrocytus thyridopterigis* Howard; 23, egg chorion, lateral view; 24, cephalic structure, dorsal view; 25, 26, right mandible; 25, dorsal view; 26, posterior view.

campoplegine larvae collected in conjunction with studies of the parasites attacking *R. buoliana* in the Northeastern United States.

A single specimen of an unidentified species in this tribe was reared from shoot moth material collected at Two Rivers in 1961. A male emerged on August 18 from a shoot moth-infested bud collected on July 13.

Anomalini

Atrometus sp.

Figs. 18, 35, 53

The only *Atrometus* species that has been reared from the shoot moth is *A. clavipes,* recorded by Wolff and Krause (1922) in Europe, and by Watson and Arthur (1959) in Ontario. Besides *R. buoliana,* several other tortricids have been recorded as hosts of *A. clavipes.* These are: *Grapholitha molesta* Busck), *Spilonota ocellana* (D. and S.), *Acleris variana* (Fern.) (Muesebeck *et al.,* 1951), and *Ancylis comptana* Froh. (Watson and Arthur, 1959). The individual reared at Two Rivers was identified as *Atrometus* species near *clavipes* (Davis) and *paediscae* (Ashm.). One specimen emerged on July 17 from shoot moth-infested material collected on June 20, 1963. The specimen was a solitary, internal pupal parasite.

The adult parasite emerges from the pupa through a hole cut in the anterior end; the exit hole has a jagged margin around the pupa at about the anterior one-third of the scutellum dorsally, and across the middle of the labial palps ventrally. No cocoon is formed; the larval skin is found at the end of the pupa opposite the exit hole.

Cephalic structure of the final-instar larva (Fig. 18) characterized by a wide epistoma fused on either side with the pleurostomata and hypostomal arms; pleurostomata and hypostomal arms greatly widened, and extend laterally. Superior mandibulary processes stout, articulate in depressions at the dorsal end of the articulating surface of each mandible; inferior processes articulate with stout mandibular condyles. Mandibles heavily-bodied. Hypopharyngeal region with a cobblestone texture. Hypostomal spurs absent; stipital sclerites curve downward from hypostomal arms to meet the labial sclerite, and then curve upward to the hypopharnygeal region. Labial sclerite open, widened ventrally; dorsal arms widened slightly apically where they bend medially. U-shaped mouth of silk press evident between dorsal arms. Labial and maxillary palpi each have one large sensorium, one narrow crescent-shaped sensorium, and two or three small radiating sensoria, respectively. Epistoma with a single sensorium on each side; labral area with two palp-like organs each with four sensoria. Antennae were not located. Larval skin smooth, without setae, but has a few patches of very short stout spines. The condition of the single larval skin did not allow determination of the position of these spines on the larva. Atrium of spiracle (Fig. 35) small, opens directly into closing apparatus that is about equal in diameter to atrium.

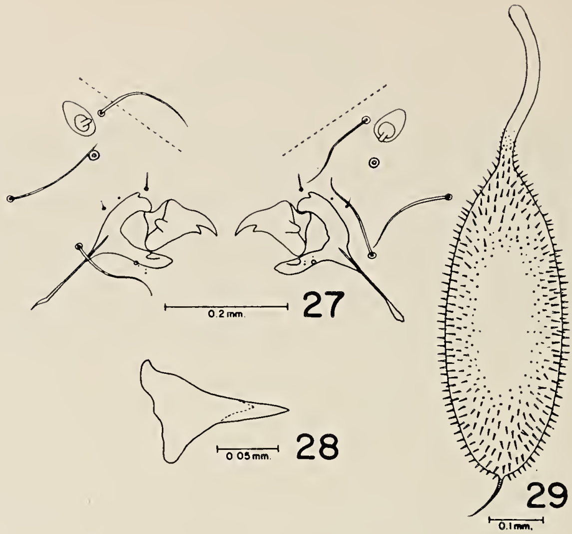
Eulophidae
Elachertinae
Elachertus pini Gahan

Three specimens of *Elachertus pini* were reared from shoot moth material collected in April and May of 1959 by H. C. Coppel, officers of the Wisconsin Conservation Department and the Plant Industry Division of the Wisconsin Department of Agriculture (Torgersen and Coppel, 1962). This was a new parasite record for *R. buoliana*. Previously this parasite had been collected only from a *Dioryctria* species and from *R. frustrana* (Peck, 1963).

Hyssopus thymus Girault
Figs. 19, 20, 36, 43

H. thymus is a very common parasite of *R. buoliana* especially in the Midwestern and Eastern United States, and has also been reared from shoot moth material in Ontario. Friend (1935), Friend and Hicock (1936), and Friend *et al* (1938) recorded it as the most common parasite of the shoot moth in Connecticut. Rearings from shoot moth material collected throughout the Northeast (Schaffner, 1959), showed a preponderance of this species, both in the number of collections yielding the parasite, and in the number of individuals reared. The number of individuals recorded by Schaffner probably represents many fewer hosts because this is a gregarious species, but is not so designated in his paper. However, the figures indicate the tremendous activity of *H. thymus* as a parasite of the shoot moth. At Natrium, West Virginia, *H. thymus* is the most commonly reared parasite of *R. buoliana* (Harman and Kulman, 1962).

The biology of *H. thymus* was studied by Miller (1953), Coppel *et al.* (1955), and Watson and Arthur (1959). This tiny eulophid is a gregarious, external parasite of the shoot moth larva; two generations, and a partial third generation are produced per year. Adults emerge in the spring after overwintering as pupae in the gallery of the dead host. The summer generation of *H. thymus* at Two Rivers emerges between June 18 and August 7. Peak emergence takes place during mid- and late July. From 95 parasitized hosts in 1963, 1,100 *H. thymus* emerged. The range in the number of individuals emerging per host larva was 1 to 86, with an average of 11.5. In 1961, when only 11 hosts were involved, the average was 6.2 parasites per host, with a range from 1 to 13. Longevity studies conducted at Two Rivers showed that adults can survive for an average of 47 days, range for five individuals was 46 to 49 days, if they have a source of food and water.



FIGURES 27–29. Cephalic structure of final-instar larva, and egg chorion of *Eurytoma pini* Bugbee: 27, cephalic structure, dorsal view; 28, right mandible, anterior view; 29, egg chorion, lateral view.

H. thymus emerged successfully from the same hosts with *Eurytoma pini, Habrocytus thyridopterigis,* and *Macroneura vesicularis.* When *H. thymus* develops successfully on a single host with *M. vesicularis,* it is probably due to the failure of the secondary to destroy all of the developing eulophids.

Dissections of buds from which *H. thymus* have emerged reveal the empty pupal skins. These skins are dark brown and fragment either at the time of emergence of the adults, or are broken by their movements following emergence. The final-instar larval skin is attached to the abdomen of the pupal skin or adheres to the gallery wall. The pupal skins are closely associated with the host remains. No cocoon is constructed by the parasite.

Cephalic structure of final-instar larva (Fig. 19) apparently limited to mandibles. Mandible (Fig. 20) with straight blade bearing a row of hair-like teeth. Antennae extremely flattened, much wider than long. Two pairs of sensoria, probably rudimentary palpi, present near the bases of mandibles. Due to shifting and flattening of mounted skins, the above characters may have variable positions. Larval skin smooth, and without setae. Atrium of spiracle (Fig. 36) large, funnel-shaped, and many chambered, ending in a long stalk with a small closing apparatus at the end.

Eupelmidae

Eupelmus cyaniceps Ashmead

Fig. 51

Eupelmus cyaniceps was recorded as a parasite of *R. buoliana* by Raizenne (1952). Only one specimen of *E. cyaniceps* was reared from shoot moth material collected at Two Rivers (Torgersen and Coppel, 1962). An adult female emerged on August 5, 1961 from a bud collection made on July 25. The host remains consisted of a partly devoured larva of *R. buoliana* accompanied by the larval remains of a final-instar *E. comstockii.* Therefore, it can be surmised that *E. cyaniceps* can be a secondary parasite of *R. buoliana* through *E. comstockii.* No cocoon is constructed. The fractured shed pupal skin of *E. cyaniceps* was recovered, but the final-instar larval skin was not found, either attached to the pupal skin, or loose in the gallery.

Macroneura vesicularis (Retzius)

Figs. 21, 22, 37

Macroneura (=Eupelmella) vesicularis is a solitary, external, primary or secondary parasite on a great variety of insects (Peck, 1963). Watson and Arthur (1959) recorded this species as a parasite of *R. buoliana* in Ontario. Only three other species of tortricids are known, or suspected hosts of *M. vesicularis* (Peck, 1963).

Notes on the biology, and illustrations of the immature stages of *M. vesicularis,* as a predator of *Microplectron fuscipennis* Zett. in the cocoons of *Neodriprion sertifer* Geoffr. in Europe, were prepared by Morris (1938). Phillips and Poos (1927) described and illustrated the egg and larval instars as *Eupelminus saltator* (Lind.), and Doner (1936), in Wisconsin, discussed its biology as a parasite of *Coleophora pruniella* Clem. Finlayson (1960) illustrated the final-instar cephalic structure of *M. vesicularis.* This species is thelytokous, and is easily distinguished from the other parasites of the shoot moth by the apparent lack of wings in the adult. The female paralyzes her host before ovipositing, and sometimes feeds at the puncture (Doner, 1936). The egg is similar to that of *Eurytoma pini,* with projections at either end. The two differ in that the eggs of *M. vesicularis* lack spines. According to Doner (1936), after a 36 hour incubation period, *M. vesicularis* takes 20 days to develop to the adult on *C. pruniella,* and emergence occurs from July 13 to 21. At Two Rivers, development takes no fewer than 30 days, and in some cases as many as 43 days; emergence is from July 19 to August 18, with the peak occurring between July 24 and August 2. A single field capture of an adult was made on June 25, 1962, fully a month ahead of laboratory emergence of this species. The lengthy developmental and emergence period is probably due to the cool springs and summers experienced at Two Rivers.

Laboratory dissections of buds from which *M. vesicularis* had emerged indicated that *E. comstockii* and *H. thymus* served as hosts for this secondary parasite. *E. comstockii* was more often the primary involved, possibly indicating *M. vesicularis* prefers the larger host. In a single case of multiple parasitism, both *M. vesicularis* and 20 *H. thymus* developed and emerged successfully on a single host. This case probably indicates a situation wherein the secondary simply overlooked some of its tiny competitors, or the secondary had not reached the voracious final-instar until after the *H. thymus* had pupated and emerged.

No cocoon is constructed by the parasite larva. The shed pupal skin is honey-colored, fragmented, and may or may not be closely associated with the host remains. Exit from the bud is made through a hole cut in the silk plug which was made by the host larva prior to death. The exit hole is about 0.75 to 1.00 mm. in diameter.

Cephalic structure of final-instar larva (Fig. 21) consists of mandibles and a heavily sclerotized clypeus with denticles along its ventral margin; labrum bears four pairs of papillae. Figure 21 shows a portion of the pleurostoma, also part of the inferior mandibular strut. Curved blade of mandibles without teeth. Inferior mandibular condyles stout, articulate in groove of inferior mandibular strut. Mandibular strut was called hypopharyngeal bracon by Phillips (1927). Lightly sclerotized silk press present; apparently consisting of two closely appressed tubes with fine spiral thickenings in its walls (Figs. 21, 22). Maxillary and labial palpi bear three sensoria each. Antennae slightly less than twice their basal diameter in length. Larval skin smooth, characteristically covered with scattered long setae, and a few short setae at the posterior end of the skin. Atrium of spiracle (Fig. 37) narrowly funnel-shaped, numerous chambers decreasing in size to the closing apparatus which is followed by a long annulated stalk.

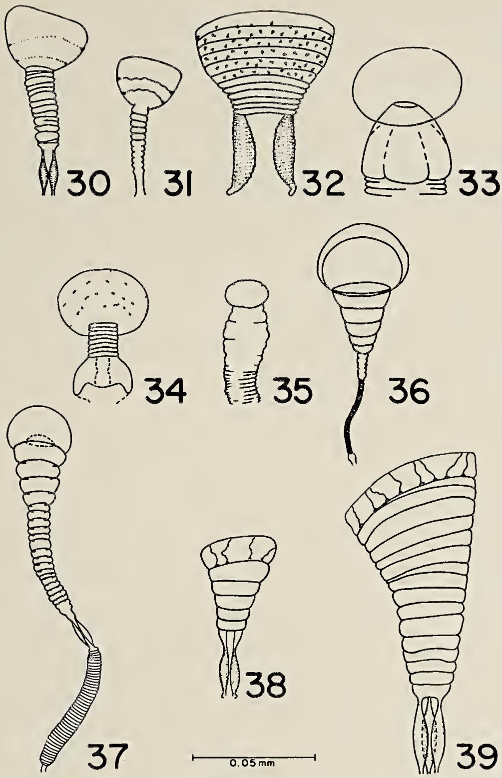
Pteromalidae

Pteromalinae:Pteromalini

Habrocytus thyridopterigis Howard

Figs. 23–26, 38, 41, 52

R. buoliana was recorded as a host of *H. thyridopterigis* by Raizenne (1952) in Ontario, by Schaffner (1959) in the North-



FIGURES 30–39. Spiracles of final-instar hymenopterous larvae: 30, *Bracon* n. sp.; 31, *Bracon gelechiae* Ashm.; 32, *Exeristes comstockii* (Cress.); 33, *Coccygomimus annulipes* (Brullé); 34, *Itoplectis ? evetriae* Vier.; 35, *Atrometus* sp.; 36, *Hyssopus thymus* Gir.; 37, *Macroneura vesicularis* (Retz.); 38, *Habrocytus thyridopterigis* Howard; 39, *Eurytoma pini* Bugbee.

east, and as a questionable recovery from the shoot moth by Miller and Neiswander (1955) in Ohio. This species is a gregarious primary or secondary parasite of the shoot moth at Two Rivers. From 24 host larvae, 68 parasite individuals emerged; an average of 2.83 parasites per host (range 1 to 8). For three seasons, 1961 through 1963, the emergence period was from July 1 to August 15. The peak emergence period was in early August in 1961, and in mid-July in 1962 and 1963. Adults were captured in the field as early as June 9, weeks before this species emerged from laboratory collections.

When *H. thyridopterigis* acted as a primary, it was associated with the larva of the shoot moth. *E. comstockii* was the most common primary parasite hyperparasitized by *H. thyridopterigis*. Remains of *Eurytoma pini* and *H. thymus* were also recovered, indicating that these also served as hosts. This parasite emerged successfully with *H. thymus, Eurytoma pini,* and *Bracon* n. sp. from the same host individuals.

The larva constructs a silken cocoon which may or may not be closely associated with the host remains. The shed pupal skin is lightly golden brown fragmented, and sometimes found outside the cocoon. Mature larval skin does not always adhere to the shed pupal skin and may be loose in the host gallery. Egg elliptical (Fig. 23), more rounded at one end, and evenly patterned with tiny spines and papillae except for the pointed end where the chorion is smooth. Papillae are about equal in diameter to the bases of the spines.

Cephalic structure of final-instar larva (Fig. 24) apparently limited to mandibles, which, on the shed skin, project straight forward. Close examination reveals the presence of fragments of what are probably the superior mandibulary processes attached to the superior mandibular condyle of each mandible (Fig. 25). In Figure 26, the superior mandibulary process is omitted. Mandibles with slightly curved blades bearing a row of hair-like teeth. Palpi present near the bases of the mandibles; their position may vary with the disposition of the parts in handling the skin. Antennae tapered, slightly longer than basal width. Larval skin not distinctively textured; light in color, and with few setae. Atrium of spiracle (Fig. 38) with about seven gradually tapering chambers ending at a well-defined closing apparatus. Apical chamber of atrium patterned with very fine wavy lines.

Eurytomidae

Eurytoma pini Bugbee

Figs. 27–29, 39, 40

In much of the literature on the parasites of *R. buoliana, Eurytoma pini* has been listed as *E. tylodermatis* Ashm. (Friend and Hicock, 1933, 1936; Miller, 1953; Miller and Neiswander, 1955), or *E. appendigaster* (Swed.) (Sheppard, 1933). Bugbee (1958) believed that this species probably occurs wherever pines and its preferred host, *R. frustrana,* are present. It has been recorded as an active parasite of *R. buoliana* in Connecticut (Friend and Hicock, 1933, 1936), Ohio (Miller, 1953), West Virginia (Harman and Kulman, 1962), Wisconsin (Torgersen and Coppel, 1962), and Ontario (Arthur, 1961).

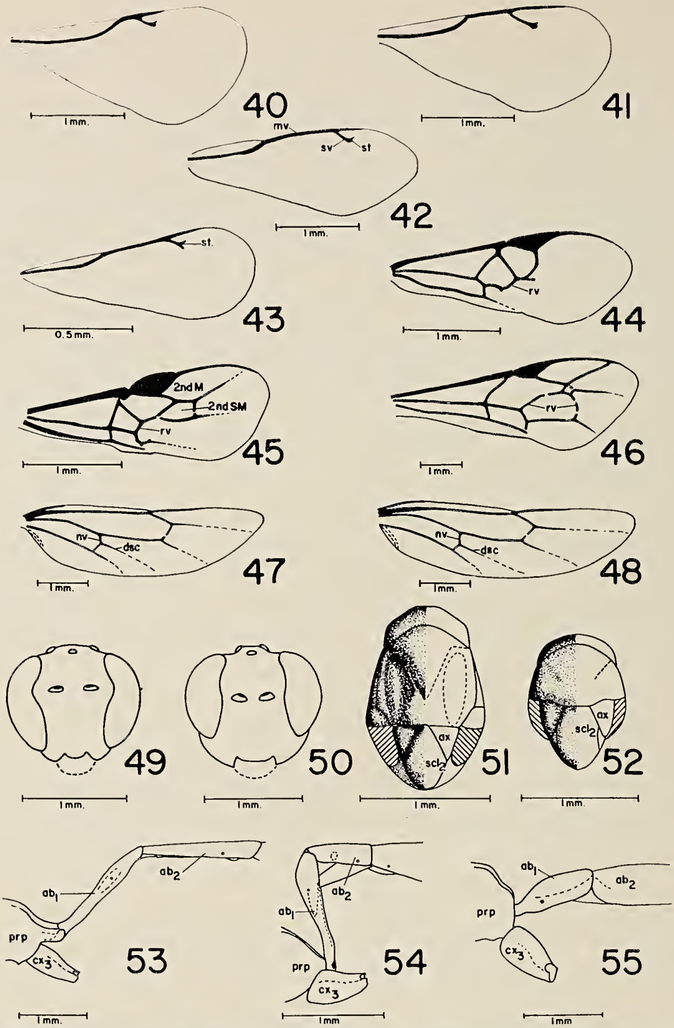
Arthur (1961) described the cleptoparasitic habits of *E. pini,* and illustrated the immature stages. He observed adults emerging from early June to late June, and Miller (1953), in Ohio, recorded emergence from June 21 to July 21. At Two Rivers, the earliest of 44 adults reared from parasitized *R. buoliana* during three years, emerged on July 5, the latest on August 11. Peak emergence occurred between July 18 and 21. The sex ratio is about 2:1 in favor of females; Miller (1953) observed a 3:1 sex ratio. *E. pini* was collected in flight in the field on June 18, about two weeks before emergence began in the laboratory. Unfed adults lived for about six days (range 3 to 12). A single male, fed on honey water, survived for 38 days.

The period required for development from egg to adult, calculated from earliest and latest collection and emergence dates, is approximately 28 days (range 21 to 34). Studies by Miller (1953) showed that, exclusive of the egg and larval feeding period, it takes an average of 18 days for development from the prepupal stage to emergence of the adult.

At Two Rivers, a single adult emerged from each host. Most authors have considered this species to be a solitary parasite, however, Arthur (1961) observed up to three adults emerging from a single host. *E. pini* usually develops on shoot moth larvae, but it is not uncommon to find that it has developed on a pupa; a situation also observed by Miller (1953). Dissections of buds from which *E. pini* had emerged revealed that this parasite had succeeded at the expense of the larva of *Scambus tecumseh* or, more commonly, the larva or pupa of *E. comstockii.* Remains of both *E. pini* and *E. comstockii* were found in buds from which *H. thyridopterigis* developed and emerged successfully. In addition, there was a single case wherein both *E. pini* and nine *H. thymus* emerged from one host larva; and one case in which *E. pini* and *H. thyridopterigis* successfully emerged, having developed either on, or at the expense of *E. comstockii.* From these observations it is possible to claim both secondary and multiple parasitic behavior for *E. pini.*

No cocoon is constructed for pupation. The parasite remains are closely associated with the host remains. The pupa is dark honey-brown, fragmented, and usually has the mature larval skin adhering to it. The adult escapes from the host gallery either by cutting through the silk or resin mass, or directly through a thin portion in the host gallery wall. The exit hole is 1.0 to 1.2 mm. in diameter.

Egg elliptical (Fig. 29) ; slightly more pointed at one end. Blunt end with a sharp barb-like process with a roughened surface; pointed end with a long, smooth, thin-walled closed tube that is slightly swollen at its tip. Chorion armed with numerous spines. The presence of these eggs in a great many of the galleries of *R.*



FIGURES 40–55. Wings, heads, thoraces, and petioles of adult Hymenoptera: 40, *Eurytoma pini* Bugbee, forewing; 41, *Habrocytus thyridopterigis* Howard, forewing; 42; *Eupelmus cyaniceps* Ashm., forewing; 43, *Hyssopus thymus* Gir., forewing; 44, *Apanteles* sp., forewing; 45, *Bracon gelechiae* Ashm. forewing; 46, *Itoplectis ? evetriae* Vier. forewing; 47, *Exeristes comstockii* (Cress.), hind wing; 48, *Scambus tecumseh* Vier., hind wing; 49, *Itoplectis ? evetriae* Vier., head, anterior view; 50, *Coccygomimus annulipes* (Brullé), head, anterior view; 51, *Eupelmus cyaniceps* Ashm., thorax, dorsal view; 52, *Habrocytus thyridopterigis* Howard, thorax, dorsal view; 53, *Atrometus* sp., petiole, lateral view; 54, *Gambrus* sp., petiole, lateral view; 55, *Exeristes comstockii* (Cress.), petiole, lateral view. ab_1 first abdominal segment; ab_2, second abdominal segment; ax, axilla; cx_3, metathoracic coxa; dsc, discoidella; mv, marginal vein; nv, nervellus; prp, propodeum; rv, recurrent vein, scl_2, mesoscutellum; st, stigma; sv, stigmal vein; 2nd M, second marginal cell; 2nd SM, second submarginal cell.

buoliana successfully parasitized by other parasite species attests to the great activity of *E. pini* as a cleptoparasite.

Cephalic structure of final-instar larva (Fig. 27) consists of mandibles and two broadly U-shaped sclerites bearing the mandibulary articulations. Head capsule split medially (dotted lines) down through cephalic structure dividing mouth frame into two parts joined only by the cuticle of the venter of the head. Epistoma absent; pleurostomata bear large superior mandibulary processes; hypostomal arms reduced to narrow strips extending ventrad. Hypopharyngeal bracon (Phillips, 1927) bears the inferior mandibulary articulations. Mandible (Fig. 27) with a large curved blade bearing a large denticle posteriorly. In anterior view (Fig. 28) mandible shows a distinctive curve to the superior mandibular condyle; this hooks behind the mandibulary process on the pleurostoma. "Vestigial maxillary palps" (Phillips, 1927) and three sensoria are present on either side below, or apparently on, the hypopharyngeal bracon depending upon the disposition of the skin. Antenna about twice as long as its diameter; antennal sclerites surrounded by more heavily sclerotized areas than the remainder of the head capsule; a single sensorium is present near each antennal socket. Larval skin smooth; head capsule and skin bear scattered long and short setae 0.07 to 0.15 mm. long; some shorter setae are present around the cephalic structure. Atrium of spiracle (Fig. 39) funnel-shaped with numerous annulations; apical ring of atrium patterned with fine wavy lines. There is a well-defined closing apparatus composed of three distinct spindle-shaped valves.

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Summary

Twenty species of parasites of *Rhyacionia buoliana* (Schiffermüller) have been reared in Wisconsin. Two keys have been prepared to separate the parasites. The first is designed to aid in

identifying the parasites on the basis of the host remains left in the bud after the parasite has emerged. Twelve sepcies of parasites, one Diptera and eleven Hymenoptera, are included in the key to parasite remains. The second is for the identification of the adults of the parasites of *R. buoliana* in Wisconsin. Brief notes on the biology of each species, and descriptions of the final-instar cephalic structures are also given.

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THE INSECT PARASITES OF THE LARCH CASEBEARER, *COLEOPHORA LARICELLA* HUBNER, (LEPIDOPTERA: COLEOPHORIDAE), IN WISCONSIN WITH KEYS TO THE ADULTS AND MATURE LARVAL REMAINS

*Norman F. Sloan and Harry C. Coppel**

The larch casebearer, *Coleophora laricella* Hbn., was first discovered near Northampton, Massachusetts, in 1886 (Hagen, 1886). Its spread to the Lake States Region was rapid: at Ann Arbor, Michigan in the early 1920's (Webb, 1953); in northeastern Wisconsin in 1939 (MacAloney, 1939); at Port Arthur, Ontario in 1947 (Webb, 1953). An outbreak on the western larch, *Larix occidentalis* Nutt. was discovered in 1957 in Idaho and currently infests nearly two million acres (Pechanec, 1963).

The preferred hosts of the casebearer include all species in the genus *Larix*. The eastern white pine, *Pinus strobus* L. (Peirson, 1927) and Douglas-fir, *Pseudotsuga menziesii* (Mirb.) Franco (Webb, 1953) have been recorded also as hosts of the casebearer. Laboratory feeding experiments indicate that it might also survive on the western hemlock, *Tsuga heterophylla* (Rafn.) Sarg. Death of the host tree rarely occurs but has been noted after three years of consecutive defoliation (Patch, 1906). Increment loss may be considerable according to Pechanec (1963), who recorded an average reduction of 55% from 1956–62 in Idaho.

In 1961, studies were initiated on the bionomics of the larch casebearer in Wisconsin primarily to determine the structure of its parasite complex. Data were assembled both from field collections and laboratory studies of material collected during the summers of 1962–64 from three locations in Wisconsin; the University Arboretum, Dane County; near Antigo, Langlade County; and near Bloomington, Grant County.

This paper concerns the insect parasites collected from *C. laricella* in Wisconsin from 1961–1964 and one additional species collected by H. Coppel prior to the study. Keys both for the separation

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of the parasites based on the remains left in the case after the parasite has emerged, and for the separation of the adults are given. The final-instar cephalic structures, spiracles, and adults are illustrated and described. Notes on the biology of the parasites are also included.

METHODS

The material upon which the keys are based consisted of the adult parasites and the remains positively associated with them. The adults were identified by the staff of the Insect Identification and Parasite Introduction Branch of the U.S. Department of Agriculture at Beltsville, Maryland.

The key to parasite remains was based on the characters of the larval and pupal skins of the parasites. The larval skins were removed from the host cases by soaking the latter in a bleach for 2 to 3 minutes to loosen the silk. The parasite skins were softened in 10% potassium hydroxide for 30 minutes to several hours, and washed in distilled water. The washed skins were placed on a slide in a drop of glycerine and carefully spread with insect pins until the mouth parts and spiracles were exposed. The cover slips were ringed with clear fingernail polish.

Illustrations of gross characters and outlines of larval remains and adult parasites were prepared with the aid of a projection prism. An Ernst Leitz binocular compound microscope fitted with an ocular grid was used for the fine details of the larval remains. Adults were drawn with the aid of a Bausch and Lomb binocular zoom microscope fitted with 20X eyepieces and a 2X enlarger lens. Antennae and legs of the adults were removed from the body and placed on slides to allow examination in detail. The terminology used for the parts of the cephalic structures and spiracles of the final-instar larvae of Hymenoptera is similar to that employed by Finlayson (1960).

PARASITES OBTAINED

The following parasites were reared from *C. laricella* in Wisconsin.

HYMENOPTERA

BRACONIDAE: *Agathis cinctus* (Cress.), *A. pumila* (Ratz.), *Apanteles laricella* Mason, *Bracon juncicola* Ashm., *Bracon pygmaeus* Prov., *Bracon* sp.

ICHNEUMONIDAE: *Isdromas* sp., *Gelis tenellus* (Say), *Campoplex* sp. *(Phaedroctonus* group)

EULOPHIDAE: *Sympiesis* sp., *Tetrastichus coerulescens* (Ashm.), *Kratochviliana laricinellae* (Ratz.)

PTEROMALIDAE: *Capellia lividicorpus* (Grit.), *Habrocytus phycidis* Ashm.

CHALCIDIDAE: *Spilochalcis albifrons* (Walsh).

Two keys have been prepared for the separation of the above species. It is possible to separate the parasites on the basis of the remains left in the cases after the adults have emerged. Nine species of parasites are included in the key to parasite remains. The remaining six species have not been included because insufficient material was available. The second key allows identification of nine of the adult parasites of *C. laricella* in Wisconsin.

KEY TO THE COMMON IMMATURE PARASITES OF *C. LARICELLA* BASED ON PARASITE REMAINS

1 Parasite pupal skin found in the host case -------------- 2
Parasite pupal skin not found in the host case ---------- 4

2(1) Parasite emerged from the pupated host; the hypostoma more than half the total length of the cephalic structure (Fig. 8) ------------------*Spilochalcis albifrons* (Walsh.)
Parasite emerged from the larva of the host; the hypostoma not more than half the total length of the cephalic structure -- 3

3(2) Cephalic structure much reduced (Fig. 10); spiracles with closing apparatus very short (Fig. 17) ---------------------------------------*Kratochoviliana laricinellae* (Ratz.)
Cephalic structure reduced with a complete epistoma and hypostoma (Fig. 12); spiracles with closing apparatus nearly equal to ½ the total length of the atrium (Fig. 18) ----------------------------------*Habrocytus phycidis* Ashm.

4(1) Mandibles with distinct teeth (Figs. 1, 2, 5) ------------ 5
Mandibles without teeth or with very small ones (Figs. 3, 4, 8, 9, 10, 12) -- 7

5(4) Epistoma complete (Fig. 2); mandibles each with 4 teeth (Fig. 6); hypostoma not forming a lateral, wing-like structure (Figs. 1, 5); labial and maxillary palpi as single circles; ---------------------------------*Bracon pygmaeus* Prov.
Epistoma incomplete or appearing incomplete (Figs. 1, 5); hypostoma forming a lateral, wing like structure; labial and maxillary palpi each as 3 circles enclosed within a larger circle -- 6

6(5) Antennae appearing as a single semicircle and two crossed semicircles (Fig. 5); incomplete antennal sclerite; labial sclerite joined near junction of stipital sclerite and labial sclerite -------------------------*Agathis cinctus* (Cress.)
Antennae appearing as two small circles within two slightly

larger circles; complete antennal sclerite (Fig. 1); labial sclerite in one piece ______________ *Agathis pumila* (Ratz.)

7(4) Atrium pitted on external surface; chambers tapering sharply without a closing apparatus (Fig. 19); antennae cone-shaped (Fig. 9); maxillary and labial palpi a single circle with a smaller circle inside; four pits located directly above both sets of palpi; two pits appear joined ____ unknown ichneumonid

Atrium not pitted on external surface; chambers, if tapered, with a closing apparatus (Figs. 20, 21); antennae flat topped; maxillary and labial palpi consisting of more than one circle within a larger circle; no pits near the palpi ______ 8

8(7) Atrium tapering with a closing apparatus (Fig. 20); lacinial sclerite present; maxillary and labial palpi consisting of two openings within the larger outer sclerite (Fig. 3); labial sclerite present ______________________ *Gelis tenellus* (Say)

Atrium not tapering but with progressively larger chambers; no closing apparatus (Fig. 21); labral sclerite absent; maxillary palpi a split circle within the outer circle while the labial palpi have two seperate openings within the outer one (Fig. 4) ________________________________ *Campoplex* sp.

KEY TO THE ADULTS OF THE COMMON PARASITES OF *C. LARICELLA*

1 Wing venation reduced (Figs. 27, 29, 31, 32, 33); antennal segments not exceeding 12 ___________________________ 2

Wing venation well developed (Figs. 22, 25, 34, 36); antennal segments exceeding 12 _______________________________ 5

2(1) Hind femur much enlarged and toothed on inner edges; tarsus originating before the apex of the tibia (Figs. 27, 28); dark brown insects with white to cream colored markings on face and body _____________ *Spilochalcis albifrons* (Walsh.)

Hind femur not enlarged ____________________________ 3

3(2) Tarsal segments 4; antennal segments 7, the apical segment pointed and with a false ring; metallic green (Figs. 29, 30) ______________________ *Kratochviliana laricinellae* (Ratz.)

Tarsal segments 5; antennal segments more than 7 ______ 4

4(3) Antennal segments 10; stigmal vein ending almost at the end of the marginal vein (Fig. 33); dark purple-black insects ____________________________ *Capellia lividicorpus* (Grit.)

Antennal segments 12; stigmal vein not ending at the end of the marginal vein, much shorter (Figs. 31, 32); dark green insects; female larger than male with large pointed abdomen ________________________________ *Habrocytus phycidis* Ashm.

5(1) Forewings with a dark stigma ________________________ 6
Forewings without a dark stigma ____________________ 8
6(5) Antennal segments 30; wing venation as in Fig. 25; wings not colored; thorax dark brown with yellow abdomen banded with brown ______________________*Bracon pygmaeus* Prov.
Antennal segments 28; wing venation as in Fig. 22; wings smoky colored; body all black ______________________ 7
7(6) Ovipositor not longer than ⅓ the length of the abdomen (Fig. 23) _______________________*Agathis pumila* (Ratz.)
Ovipositor longer than the entire abdomen (Fig. 24) ______
______________________________*Agathis cinctus* (Cress.)
8(5) Antennal segments 19; banded brown insect with brown bands across the forewings (Fig. 34) __*Gelis tenellus* (Say)
Antennal segments 28; black insect without any colored bands in the forewings (Fig. 36) __________*Campoplex* sp.

NOTES ON PARASITES BIOLOGY AND DESCRIPTIONS

Braconidae

Agathis cinctus (Cress.)

Figs. 5, 14, 24

One individual was collected in Polk County, Wisconsin, prior to the present study by H. Coppel. The parasite is a solitary, internal parasite and emerges from the larva of *C. laricella.* No cocoon is present in the host case. The adult emerges by cutting the silk threads that hold the top of the case closed; thus, no exit hole is found. The host remains consist only of the skin and head capsule which are tightly packed in the bottom of the case. The parasite's meconium is closely associated with the host skin.

The atrium of the spiracle (Fig. 14) is nearly spherical and leads into an irregularly shaped stalk about one-third its diameter. The stalk has about 10 annulations and terminates in a well-defined closing apparatus. The cephalic structure of the final instar larva (Fig. 5) is heavily sclerotized. Lateral wing-like structures are formed by the hypostomata, hypostomal spurs, and the stipital sclerites. The mandibles articulate at two points. The inferior mandibular process is an extension of the hypostoma. The base of the mandible fits into a groove formed in the wall of the hypostoma which serves as the superior mandibular process. The labial sclerite is joined near the top. The silk press is large and fills the area between the two arms of the labial sclerite. The epistoma is incomplete and appears as a thickened area of unpigmented skin. The maxillary and labial palpi are each three-segmented with one sensorium per segment. Three setae are located above the maxillary palpi whereas six setae are found within the labial sclerite frame and above the labial palpi. The antennal sclerites are incomplete. The antennae each appear as a single semicircle and two crossed semicircles.

Braconidae

Agathis pumila (Ratz.)

Figs. 1, 13, 22, 23

This is the most important parasite of *C. laricella* and was reared in large numbers each year. It is a solitary internal parasite which emerges from the larva of *C. laricella.* No cocoon is found in the host case. The adult emerges through the top of the case and does not cut an exit hole. The host remains, parasite larval skin, and the meconium are compacted at the base of the case.

The atrium of the spiracle (Fig. 13) is nearly spherical. It leads into an irregularly shaped stalk about one-third its diameter. Each ring of the stalk is off-set from the next to form a staggered appearance. There are about 27 annulations in the stalk which terminates in a well-defined closing apparatus. The cephalic structure of the final instar larva (Fig. 1) is heavily sclerotized. As in *A. cinctus,* a lateral wing-like structure is formed by the hypostomata, hypostomal spurs, and the stipital sclerites. Articulation of the mandibles is the same as with *A. cinctus.* The labial sclerite is one piece with a cross bar joining the base of the two arms as a curving bridge. The silk press is large and contained within the opening between the arms of the labial sclerite. The maxillary and labial palpi are similar to those of *A. cintus.* The same number of setae are found in *A. pumila* as in *A. cinctus* except for the labral area, but the arrangement is slightly different. *A. pumila* has additional setae in the area of the labrum. A row of three setae is located directly above the mandibles with, additionally, a single seta above the row and two more above and to the side on each half of the labral area. The antennal sclerites are complete. The antennae each consist of two small circles with a sensorium in each circle.

The two *Agathis* species are both dark colored insects, mostly black with white body setae. The antennae each have 28 segments including two basal segments. In Fig. 22 the first basal segment is not shown. There are five tarsal segments. The legs are yellow with bands of dark brown. The hind coxae are black. The wings are smoky colored with small setae on their surfaces. A row of hairs completely encircles the fore and hind wings. The stigma is large (Fig. 22) and dark brown. The second cubital and the radial cells are small.

The two *Agathis* species are distinguished from each other by their size. *Agathis cinctus* is larger. The most striking difference is in the length of the ovipositor, the *A. cinctus* ovipositor being longer than the abdomen whereas the *A. pumila* ovipositor is about one-third the length of the abdomen. The two species are separated from other Wisconsin parasites of the larch casebearer by their general dark appearance and smoky wings. Although *Isdromas* sp. and *Campoplex* sp. are dark colored and of about the same size, their wings are not smoky. *Apanteles laricellae,* a dark colored braconid, has clear wings.

Graham (1948) reported that *A. pumila* had one generation per year in Ontario. The first larval instar overwintered within the host larva. The parasite remained in the host larva until the host development was completed in May or early June. As soon as the host was tied in place for pupation the parasite larva began its development and pupated within the host during the second or third week in June. The presence of the parasite egg or larva did not affect the host larva until pupation time when it was prevented from pupating. Thus, the host larva remained in the field for an additional two weeks in June. Adult parasites emerged during late June and early July, and oviposited during July in the small needle-mining casebearer larvae. Eggs hatched in about 14 days and first instar larvae appeared in July.

Braconidae

Bracon pygmaeus Prov.

Figs. 2, 15, 25, 26

Bracon pygmaeus develops as a solitary, external parasite. It pupates within a white oval cocoon. The parasite larval skin, meconium, and host larval skin are found within the cocoon. Emergence occurs through a hole cut at one end of the cocoon and through the host case. The irregular emergence hole is near the top of the case.

Each spiracle (Fig. 15) has a single large atrium and a stalk with little taper. The closing apparatus is long and consists of two closely arranged valves. The epistoma, pleurostomata, and hypostomata are fused and form an arch over the mandibles and labial sclerite (Fig. 2). The superior and inferior mandibular processes are about equal length. The mandible has a short blade with several teeth posteriorly. The stipital sclerites are in the same plane and above the hypostomata. They are joined with the hypostomal spurs at their junction with the labial sclerite. The two arms of the labial sclerite are joined by a small sclerite which encloses the silk press at its apex. The maxillary and labial palpi are simple with a single sensorium in each. A row of four setae is located along the epistoma and an additional set of four along the upper surface of the labial sclerite. Six setae occur on the lower surface of the labial sclerite. Two additional setae are found, one on each side of the maxillary palpi. A single seta is located outside of the hypostomata and above the arm of the stipital sclerite on each side of the cephalic structure. The antennae are small, about twice as long as the width of their bases. Antennal sclerites are not present.

Bracon pygmaeus is dark colored but easily separated from *Agathis* spp. by the yellow on the abdomen. The amount of yellow is variable, from almost completely yellow to only small bands. The antennae each have 30 segments. There are five tarsal segments. The legs are yellow with brown bands. The body is covered with small white setae. There is a cresent-shaped yellow band bordering each eye. The wings are bordered with a row of long setae and have a covering of short setae on their surfaces. The stigma is large (Fig. 25) and dark brown. The radial cell is large (Fig. 25, r) and the intersticial nervure is continuous with the basal vein (Fig. 25, n).

According to Doner (1936) the ovipositing female of *B. pygmaeus* injected the host larva with a lethal substance. The parasite egg was then deposited on the external surface of the host. The adult parasite may have fed extensively on the body fluids of the host. The egg hatched in about 36 to 38 hours and the young larva began to feed immediately. It molted to the second instar during the second day of development. The second and third instar larvae molted on the third and fourth days, respectively. Larvae were mature 6–10 days from egg deposition. Within 24 hours the delicate white cocoon was spun within the case of the host. The pupal period lasted 4–5 days. There were three generations on the cherry casebearer, after which the parasite disappeared from the area for the remainder of the summer. The overwintering stage was unknown. It was thought that the parasite passed the winter in an alternate host.

Ichneumonidae
Unknown
Figs. 9, 19

Examination of the remains of cases from which *G. tenellus* adults had emerged revealed two cephalic structures of an unknown ichneumoid.

The atrium of the spiracle (Fig. 19) has many small pits on its surface. The pits are concentrated around the edge with few in the center. The stalk is segmented, tapers sharply, and has no closing apparatus. The cephalic structure of what is believed to be the final instar (Fig. 9) is heavily sclerotized, and the epistoma, pleurostomata, and hypostomal spur are fused with the stipital sclerite to form a continuous arch. The inferior mandibular processes are prominent. The labral sclerite appears to have a second arm which lies behind the mandibles. Three valcuoles occur on the labral sclerite. Both maxillary and labial palpi consist of a circle with a single sensorium in each. Four pits are located above the palpi, the exterior two of which are joined in each instance. The silk press is small. Four setae are located near the inner edge of the labial sclerite and one on each side of the cephalic structure between the mandibular process and the hypostomal spur. The antennae are cone-shaped, each with a complete antennal sclerite.

Ichneumonidae
Gelis tenellus (Say)
Figs. 3, 20, 34, 35

Gelis tenellus acts both as a primary and a secondary parasite, thus the cephalic structure is found in conjunction with other cephalic structures in the same host case. When secondary parasitism occurs *A. pumila* is the most common primary host. The parasite emerges through a small irregular hole cut in the side of the host case. A thin silk cocoon is found within the case. The remains of the last larval instar are compacted with the host remains and the meconium at the end of the case.

The atrium of the spiracle (Fig. 20) is composed of four horizontal sections and opens into a stalk with seven annulations and a closing apparatus. The spiracles appear funnel shaped. The epistoma is complete, although it appears incomplete because the dorsal portion is unsclerotized. The superior and inferior mandibular processes are well developed. The lacinial sclerite is present. The stipital sclerite does not appear to join with the hypostoma because its exterior portion is not sclerotized. The silk press is large with two ridges dividing its lower portion (Fig. 3) and two pits near its apex. The labral sclerite is well developed. The maxillary and labial palpi each have two almost equal sized sensoria. Setae are numerous within the cephalic structure. Antennae are each about two and one-half times as long as the width at their bases.

Gelis tenellus is perhaps the largest of the Wisconsin parasites of *C. laricella*. It is light orange with areas of reddish brown scattered over the body surface. Body setae are almost completely lacking. The antennae each have 19 segments. There are five tarsal segments and the setae on the legs are very fine. The wing surfaces are covered with small setae but their margins are not fringed with them. Two dark bands of color cross the forewings. The stigma is darker brown than the wing bands. No males of this species are known. There are reports of a wingless form, however, it was not found as a parasite of the larch casebearer in the study.

A detailed life history of this parasite was published by Muesebeck and Dohanian ,1927) using larvae of *Apanteles,* on which *G. tenellus* was a hyperparasite. The large egg was deposited singly within the cocoon of the host on the external surface of the larva. Host feeding was common and often all body fluids were withdrawn from the larva and no egg deposited. Several eggs may be deposited on the same host but only one larva matured. Because of their large size, only a few fully developed eggs were found in the uterus at one time. The limit for oviposition was 6 to 8 eggs in a 24 hour period. The total number of eggs deposited by one female was 76, which took from May 11 to July 1. The egg hatched in about 48 hours and the larva began to feed externally on the host. The insect had five instars. The first required two days, the next three a day each, and the fifth instar an average of seven days. The fifth instar larva fed for only one and one-half days. The average pupation period was 7.5 days. The total period from egg to adult was 22 days. The number of generations varied from 1 to 4 per year, with three most common. Hibernation was as a mature larva in the host cocoon. Some of the young from the same adult mature in 18 to 24 days, whereas, some do not reach maturity until the following spring. Females were produced parthenogenetically.

In *Hemiteles areator* (Panz.), the European species of *Gelis,* parthenogenetic reproduction resulted in males.

Ichneumonidae
Campoplex sp.
Figs. 4, 21, 36, 37

Two males and one female of *Campoplex* sp. were reared in 1964. The female was obtained by dissection from the host case. Emergence by the adult is through one small hole cut in the host case. A thick silk cocoon containing both the final larval skin and the meconium is found in the host case. The host skin is present at the base of the host case.

The atrium of the spiracle (Fig. 21) is small. The stalk contains many annulations and becomes progressively larger in diameter in a series of steps. No closing apparatus is present. The cephalic structure was illustrated from a single specimen which was slightly distorted during preparation. The epistoma, pleurostomata and hypostomata are fused to form an arch. The stipital sclerites are fused to the base of a wishbone-shaped labial sclerite. The superior mandibular processes are well developed. The inferior mandibular processes are represented by a groove in the base of the hypostomata in which the mandibles rest. The silk press is a large "U"-shaped structure which originates in the opening between the two arms of the labial sclerites and extends toward the tips of the mandibles. The maxillary palpi are egg-shaped with a divided sensorium in each. The labial palpi are rounded with two sensoria in each. Many setae are found wthin the cephalic structure (Fig. 4). The antennae are each about twice as long as the thickness of their bases and are flat-topped.

Campoplex sp. is a small black parasite with comparatively short wings in comparison to its body length (Fig. 36). There are 28 antennal segments and five tarsal segments. The legs are mostly yellow with areas of brown. The body has few short setae. The wing surfaces are covered with small brown setae but lack setae on the edges of either the fore or hind wings. They are not banded. The costal vein is broken just before the small stigmal area. The abdomen of the female (Fig. 36) is almost as wide as its thorax, whereas the male abdomen (Fig. 37) is visibly narrower than the thorax.

Eulophidae

Kratochviliana laricinellae (Ratz.)

Figs. 10, 17, 29, 30

Kratochviliana laricinellae is an internal, solitary parasite which forms a white silk cocoon. The larval skin, meconium, and host skin are present within the cocoon. A black pupal skin remains in the cocoon also. Emergence is through a hole cut in the host case. Location of the emergence hole is variable and is not an identifying character.

The spherical atrium of the spiracle (Fig. 17) is unsculptured. The stalk is nearly half as large as the atrium at the point of junction. It tapers to about one-third its original width at the closing apparatus which is short and narrower than the last segment of the stalk. The cephalic structure is much reduced (Fig. 10). The mandibles are large and appear to be the only part of the cephalic structure present, however, mandibular processes are present. The superior processes are well developed whereas the inferior processes consist of grooves in the hypostoma which serve as articulation points. A large silk press is present between the mandibles. The labial palpi each contain one sensorium. Three pits adjoin the palpi. The antennae are small, each slightly larger than the width at their bases. The antennal sclerites are large and well developed.

This brightly colored eulophid is primarily metallic green except for a metallic blue thorax. The sclerites of the thorax are bare and have many small pits. The abdomen has a single row of setae on the posterior edge of each tergite (Fig. 29). Each antenna is geniculate and composed of seven segments. The terminal segment is pointed and has a false ring. There are four tarsal segments on the white to pale yellow legs. The wing surfaces are covered with small white setae. The leading edges of the fore and hind wings are fringed with setae whereas the hind edges are bare. The male (Fig. 30) is smaller than the female and has a slightly narrower abdomen. The ovipositor of the female (Fig. 29) is not visible from above.

Detailed descriptions of the instars were made by Dowden (1941) and of the life history by Graham (1948). The egg was deposited in the body of the host larva. Host feeding by the parasite female was common. Many immature parasites died because they had insufficient food as a result of the extensive feeding on the host larva before egg deposition. Eggs hatched in about 48 hours. First instar larval development lasted two days with one day in each of the second and third instars. A last-instar larva took two days to complete its development after which it cut through the host skin and moved to the cleared area of the case. Pupation occurred in about 24 hours and about 8 to 10 days were spent as pupae before the adult emerged. Total developmental period from egg to adult took from 17 to 23 days.

Graham (1948) stated that *K. laricinellae* produced three generations per year. Hibernation took place in the host larval case within the full-grown larval stage of the host. Pupation took place in early May and the adult emerged 7 to 10 days later. It parasitized the overwintering larva of the casebearer which usually had been feeding for a week or so. The host larva died when the parasite egg hatched. The adults which produced the second generation emerged from mid-June to mid-July; the earlier ones parasitizing the larvae already parasitized by *A. pumila*, and the later ones the young needle-mining casebearers. Pupation did not take place until the end of August or the first week in September. Very little evidence was found to support Graham's theory of *A. pumila* serving as a support for populations of *K. laricinellae*. Several hundred cases were opened and the parasite remains examined. No evidence of *A. pumila* remains in the same case containing the remains of a successful emergence of *K. laricinellae* have been found. As the field samples were collected and examined throughout the spring period some evidence of this should have been found in the parasite remains if *K. laricinellae* was indeed dependent on the nonpupated casebearers containing larvae of *A. pumila*.

The adults producing the third generation emerged from mid-September to early October. This generation developed entirely within the needle-mining host larvae and the resulting adult parasites were very small. Emergence of the third generation usually coincided with the formation of the host case and the beginning of diapause. Development was rapid and the parasite larvae matured and entered diapause in about two weeks.

Pteromalidae

Capellia lividicorpus (Grit.)

Fig. 33

Capellia lividicorpus is not included in the key to the immature stages as the larval skins were inadvertently destroyed before illustrations could be made. The adult is dull purple with few body setae. The sclerites of the thorax are covered with many small pits. The antennae each have 10 segments. There are five tarsal segments on each leg. The wing surfaces are covered with small white setae and their edges are fringed with setae. The male is similar to the female, but has a small amount of yellow on the abdomen. This makes the male easy to confuse with the males of *H. phycidis* and *K. laricinellae*. The purple color of the thorax of *C. lividicorpus*, however, distinguishes it from the others.

The life cycle was investigated by Beacher (1947) using the pistol casebearer, *Coleophora malicorella* Riley, as a host. Copulation occurred shortly after the emergence of the insects. In general, a female required about one week to develop an interest in the host. After preliminary movements of the antennae over the case, the abdomen was curved downward and the tip applied to the point of the case where the ovipositor was to be inserted. The point of insertion was usually in the center of the case, the head of the female being directed toward the distal end. Thus, the thoracic region of the host larva was pierced, allowing the paralyzing agent to reach a vital part quickly. When the host larva remained quiescent for a few minutes, the true egg thrust occurred, and the ovipositor often remained inserted for over a minute. *C. lividicorpus* was an ectoparasite, and the eggs were deposited upon the integument of the larva. Several eggs were commonly deposited on a single host. The average number of eggs per female was 21, usually deposited over a ten day period.

Larval maturity was attained in approximately 11 days after eclosion, with the complete reduction of the host larva to a flattened, dried mass. Reports of ten parasite larvae reaching full growth on a single host and successfully emerging as adults were known. The mature larvae averaged 2 mm. long and 0.5 mm. wide. A fine white cocoon was constructed within the case of the host. The pupal stage usually lasted seven days. The complete life cycle averaged 20 days as follows: egg stage 36 to 48 hours; larval stage (three instars) 11 days; pupal stage seven days. At least two generations occurred annually on the pistol casebearer.

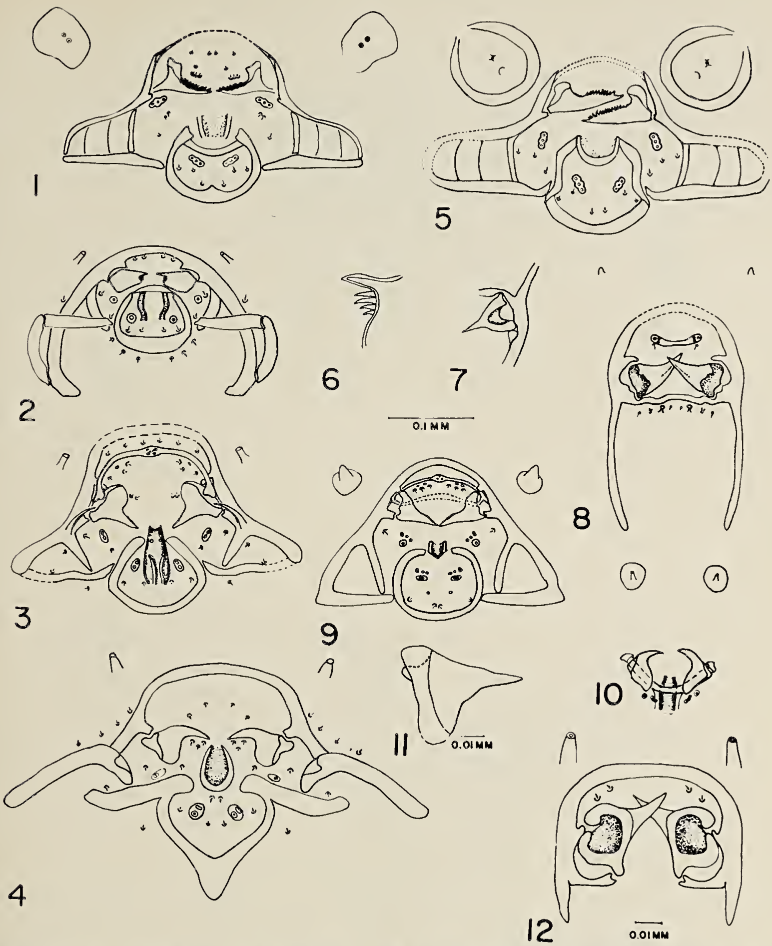
Pteromalidae
Habrocytus phycidis Ashm.
Figs. 11, 12, 18, 31, 32

This parasite was reared frequently from the different sampling areas. In all instances but one it was a solitary parasite. In that instance, two males emerged from the same case. A light brown pupal skin is found within the host case. No cocoon is apparent and the parasite appears free in the host case. The larval skin, meconium and host skin are compacted at the base of the host case. Emergence occurs through a hole cut in the side of the case.

The atrium of the spiracle (Fig. 18) is large and irregularly sculptured. The stalk is almost as wide as the atrium and has seven annulations before the large closing apparatus. The cephalic structure is reduced and very small. The epistoma, pleurostomata and hypostomata are fused into a single arch. The superior mandibular processes are reduced to ball-and-socket type pivot points (Figs. 11, 12). The inferior mandibular processes are greatly enlarged and extend for about one-third the width of the cephalic structure. The labial sclerite, labial palpi, maxillary palpi, stipital sclerites, silk press and labral sclerites are apparently lacking. Four setae occur along the epistoma. The antennae are long, about two times the width of the base. Antennal sclerites are lacking.

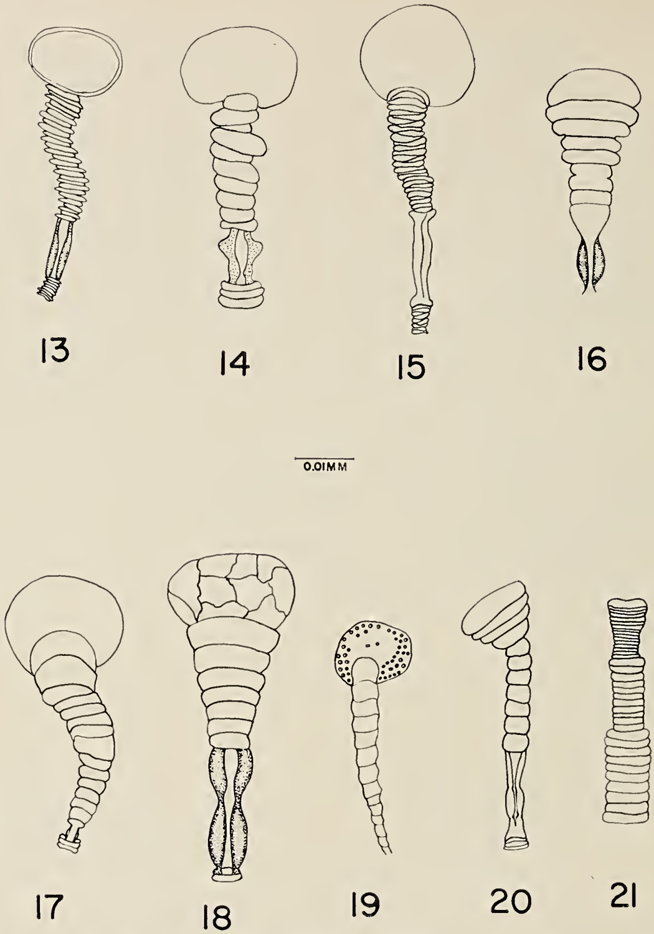
Habrocytus phycidis is a small metallic green parasite. The thorax is bare, but the sclerites are covered with many small pits. The antennae are geniculate and each is composed of 12 segments which include two very small segments between the second and fifth segments. There are five tarsal segments. The legs are light yellow-brown. The wing surfaces are covered with small white setae and both the fore and hind wing margins are fringed with setae. The abdomen of the female (Fig. 31) is pointed and dark green whereas the male (Fig. 32) has a rounded abdomen with an area of light yellow grading to dark green at the apex.

Clausen (1962) reported that the majority of species of this genus were external gregarious parasites of lepidopterous and coleopterous larvae and pupae. In all but one of the larch casebearers examined they have been solitary. Host feeding was very important in this group and detailed studies have been made of the formation of a feeding tube by the female to enable her to draw the fluids from the host. The female parasite pumped droplets of a paralyzing fluid into the body of the host. Doner (1936), found that the female of *H. phycidis* made repeated injections of the paralyzing fluid. This was done by stinging the host several times,



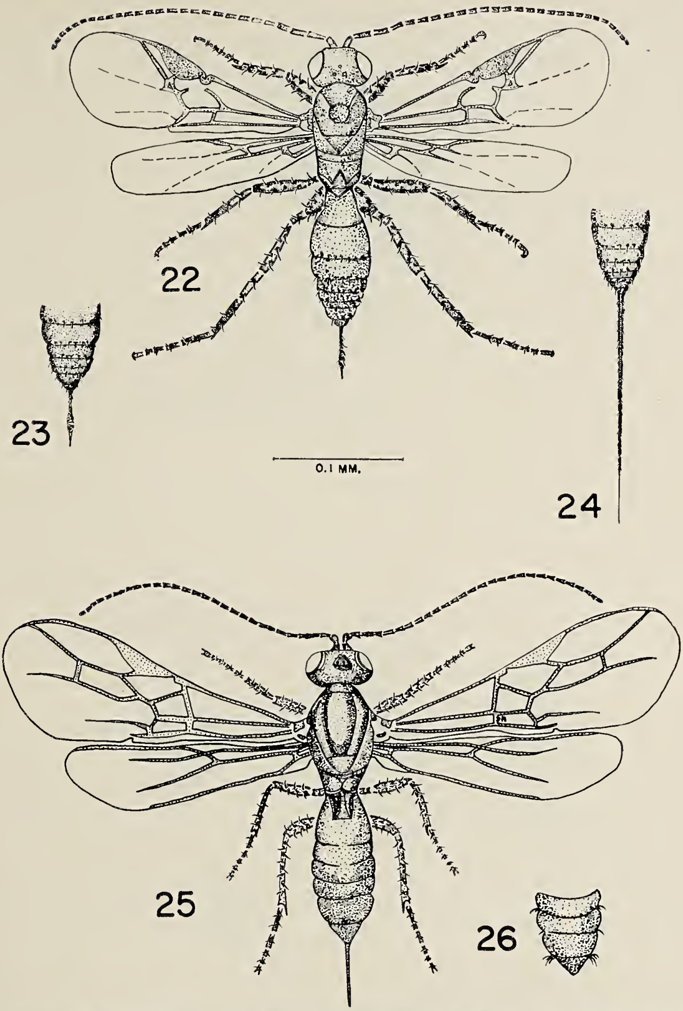
FIGURES 1–12. Cephalic structures of final-instar hymenopterous larvae. 1, *Agathis pumila* (Ratz.), cephalic structure, anterior view; 2, 6, *Bracon pygmaeus* Prov.; 2, cephalic structure, anterior view; 6, left mandible showing teeth; 3, *Gelis tenellus* (Say), cephalic structure, anterior view; 4, *Campoplex* sp., cephalic structure, anterior view; 5, *Agathis cinctus* (Cress.), cephalic structure, anterior view; 7, 8, *Spilochalcis albifrons* (Walsh); 7, left mandible showing points of articulation; 8, cephalic structure, anterior view; 9, unknown ichneumonid, cephalic structure, anterior view; 10, *Kratochviliana laricinellae* (Ratz.), cephalic structure, anterior view; 11, 12, *Habrocytus phycidis* Ashm.; 11, right mandible; 12, cephalic structure, anterior view.

leaving it, and later returning to re-sting it. The parasite usually then left for a second time and returned shortly to oviposit in the completely paralyzed larva. The number of eggs per female ranged from 38 to 59 and these were deposited usually over an 8 to 10 day period.



FIGURES 13–21. Spiracles of final-instar hymenopterous larvae: 13, *Agathis pumila* (Ratz.); 14, *Agathis cinctus* (Cress.); 15, *Bracon pygmaeus* Prov.; 16, *Spilochalcis albifrons* (Walsh); 17, *Kratochviliana laricinellae* (Ratz.): 18, *Habrocytus phycidis* Ashm.; 19, unknown ichneumonid; 20, *Gelis tenellus* (Say); 21, *Campoplex* sp.

Clausen (1962) outlined the life history of the group as being short, averaging three weeks from egg to adult. The incubation of the egg required from less than one to three days, the larval period 4 to 10 days and the pupal period 4 to 14 days. The number of generations per year was dependent on the availability of the host stages, and most species produced generation after generation as long as these were available. Hibernation of the majority of species was in the mature larval stages within the host cell, cocoon, or



FIGURES 22–26. Adult hymenopterous parasites of *C. laricella*: 22, 23, *Agathis pumila* (Ratz.); 22, female; 23, tip of abdomen showing length of ovipositor; 24, *Agathis cinctus* (Cress.), tip of abdomen showing length of ovipositor; 25, 26, *Bracon pygmaeus* Prov.; 25, female; 26, tip of abdomen of male.

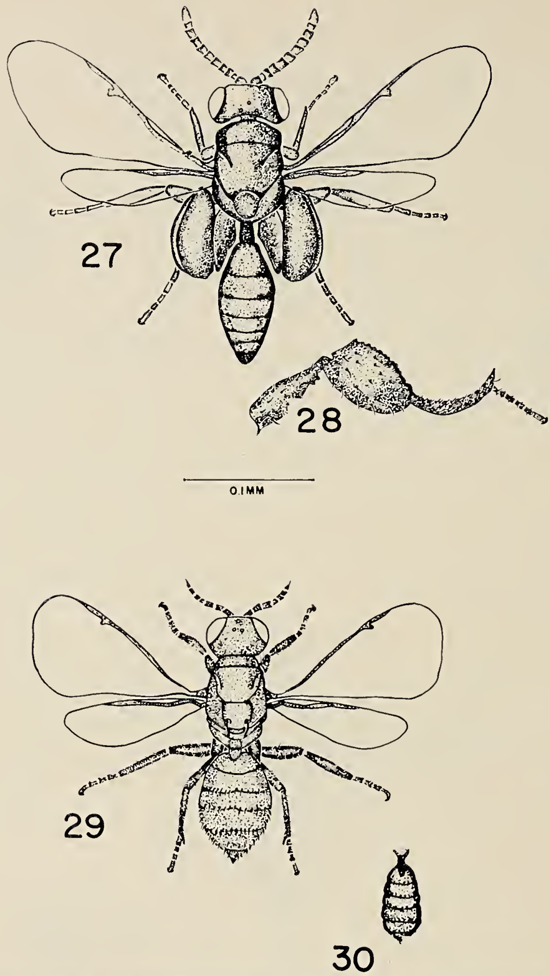
puparium. No descriptive studies were available on the immature stages of *H. phycidis*.

Chalcididae

Spilochalcis albifrons (Walsh)

Figs. 7, 8, 16, 27, 28

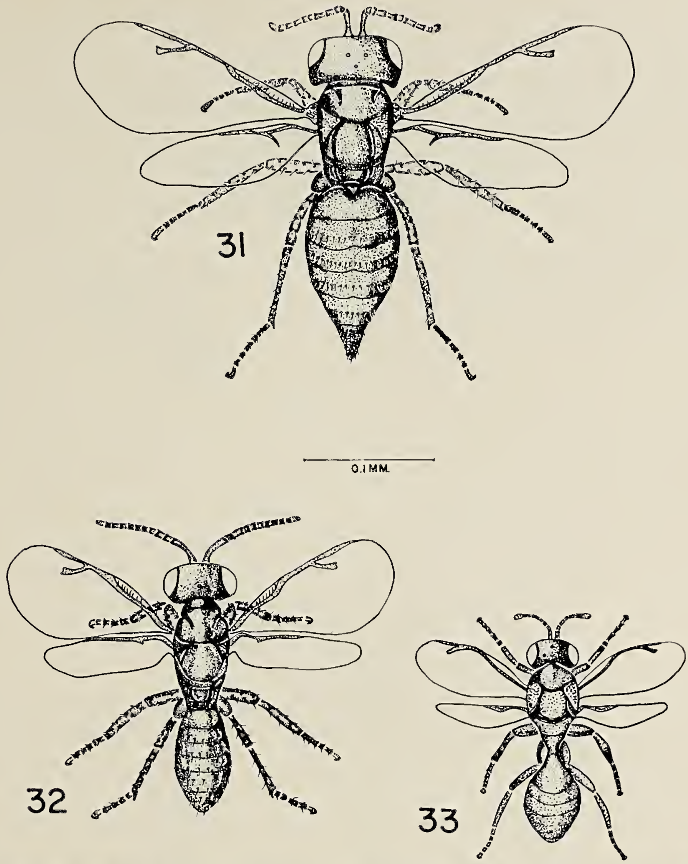
Spilochalcis albifrons is the only parasite of the complex which always emerges through the host pupal skin. The parasite pupal



FIGURES 27–30. Adult hymenopterous parasites of *C. laricella*: 27, 28, *Spilochalcis albifrons* (Walsh); 27, male; 28, hind femur showing enlargement and teeth; 29, 30, *Kratochviliana laricinellae* (Ratz.); 29, female; 30, abdomen of male.

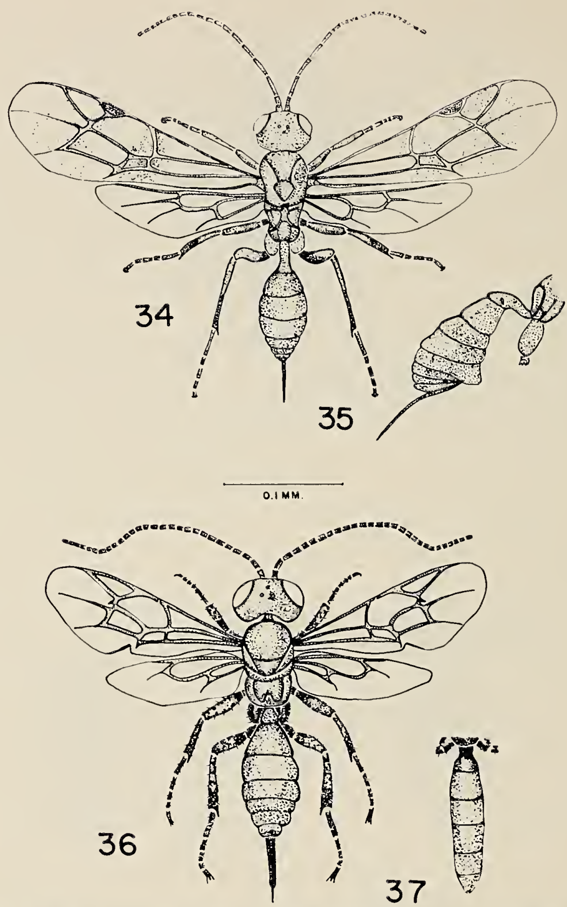
skin is dark brown and occurs next to the host pupal skin in the host case. The parasite is solitary. A thick silk cocoon is present. The larval skin is usually found tangled in the silk of the cocoon. The host meconium and skin are packed at the base of the case, and the parasite meconium within the cocoon.

The atrium of the spiracle (Fig. 16) is slightly smaller than the first annulation of the stalk. Seven annulations are present, and the fifth has a false segmented appearance. The last annulation is



FIGURES 31–33. Adult hymenopterous parasites of *C. laricella*: 31, 32, *Habrocytus phycidis* Ashm.; 31, female; 32, male; 33, *Capellia lividicorpus* (Gir.), female.

funnel-shaped and the closing apparatus joins the stalk of the funnel. The cephalic structure is reduced. The epistoma is incomplete in appearance but may be complete with the dorsal portion unsclerotized. The pleurostomata and hypostomata are fused to form two side pieces. The hypostomata are long, nearly more than half the total length of the cephalic structure. The labral sclerite has a group of vacuoles at each end. The superior mandibular processes are well developed. The inferior mandibular processes are joined and extend completely across the cephalic structure (Figs. 7, 8). The labial palpi appear as projecting knobs. Two sensoria are present in the area adjoining the labial palpi. Maxillary palpi could not be located.



FIGURES 34–37. Adult hymenopterous parasites of *C. laricella*: 34, 35, *Gelis tenellus* (Say); 34, female; 35, lateral view of abdomen of female; 36, 37, *Campoplex* sp.; 36, female; 37, abdomen of male.

This chalcid is readily separated from the remaining Wisconsin parasites by the presence of the much enlarged femora (Figs. 27, 28). The adult is black with areas of white or cream on various parts of the body particularly in the facial region. The antennae are geniculate and each is composed of 12 segments (Fig. 27, basal segment not shown). There are five tarsal segments. The tibia and tarsal segments are cream colored and the remaining portions of the legs are dark. The body is covered with fine setae.

Clausen (1962) reported that all known species were solitary and developed internally. Arthur (1938) described the mating behavior of *Spilochalcis side* (Walk.) a closely related species. Mating took place soon after the female emerged and was preceeded by a courtship. This included waving the antennae up and down and swaying the body by the male. Wing stroking by the male also occurred. Eggs were deposited 1 to 4 per host and hatched in 40 to 48 hours. One first instar larva usually killed the rest of the parasites present. Three larval instars were reported by Arthur. The larval period lasted 6 to 10 days, with emergence of the adults 20 to 25 days after the eggs were deposited. Clausen (1962) stated that, for the group, the usual number of larval instars was five rather than the three of Arthur's, these varying from the hymenopteri-form first instar larva to an oval larva in the fifth instar.

Summary

Some fifteen species of parasites of *Coleophora laricella* Hbn. have been reared in Wisconsin. Two keys have been prepared to aid in separation both of adult parasites and the parasite remains left in the host case. Nine species of parasites are included in each of the keys. Brief notes on the biology of each species, and illustrations and descriptions of the final-instar cephalic structures are also included.

Acknowledgements

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THE BEAVER IN EARLY WISCONSIN

*A. W. Schorger**

Wisconsin was noted among the French for the quantity and quality of its beaver. Perrot (1864:57), who came first to the Northwest in 1665, stated that as one went north to the Wisconsin River, the winters became long and cold. Here the beaver was best and the hunting season lasted longest. A memorandum of 1786 from the British traders (1892) at Montreal states that the Chippewa country south of Lake Superior was scarcely to be surpassed or equalled for its fine furs. Johnston (1960) was at Fond du Lac (Superior) in 1792 and thought that the region produced the best assortment of furs of any place on the continent. Beaver of the highest quality, however, came from north of Lake Superior according to Aigremont (1902).

The upper Misissippi district in the season 1734–35 produced 100,000 good beaver skins, worth 178,000 livres, and this in spite of the Indian troubles (Hocquart, 1906). Champigny (1902) expressed the opinion that Le Seur's request to develop mines on the upper Mississippi concealed an intention to mine for beaver. The number of Indian hunters frequenting Lake Pepin about 1766 was 2000 and each brought to trade 100 pounds of beaver (Carver, 1781:337). This is approximately 160,000 pelts. In 1774 about 130 canoes from Mackinac came to Prairie du Chien and departed with 1500 packs of various furs (P. Pond, 1908).

Green Bay (La Baye, Baye des Puants) was long the beaver emporium in the state. La Salle (1902), peaked at ecclesiastical competition, wrote that the Jesuits at the mouth of the Fox River held the key to the beaver country. There "a lay brother that they have, who is a blacksmith, with two companions converts more iron into beaver-skins than the Fathers convert savages into Christians."

In 1739 Green Bay produced only 110 packs of beaver, though ordinarily 300 to 400 packs (Innis, 1927:151). A few years later this post provided 500 to 600 packs of mixed furs and was farmed for 9000 francs. The post was worth 312,000 livres to Rigaud and Marin over a period of three years (1754–56); and in the time of the Senior Marin it netted a profit of more than 150,000 livres an-

*The author is Professor Emeritus of Wildlife Management, University of Wisconsin–Madison.

nually (Bougainville, 1908:183, 192). Todd and McTavish (1895), merchants of Montreal, estimated in 1794 that Green Bay, including the upper Mississippi and the south shore of Lake Superior. provided 300 packs; and Milwaukee 120 packs.

A government factory, or trading post, was established at Green Bay in 1810. Joseph P. Varnum, Indian agent at Mackinac, recommended the Bay on account of the valuable beaver pelts produced in the area (Peake, 1954:20). This is a far cry from reality at that time. During a period of four years the returns in beaver to the factory were: 1816, none; 1817, 13 pounds; 1818, none; and 1819, 2 pounds (Anon., 1834). The factories were never able to compete successfully with the private traders.

Fur Trade Annals

The arrival of Jean Nicolet at Green Bay in 1634 formed the first visit of a white man to Wisconsin. As a result of intertribal wars, no traders appeared in the state for nearly a score of years afterwards. The beaver trade then continued with few important interruptions. These were usually caused by Indian wars which were a plague to the French since they interfered with the hunting of beaver.

1654. Radisson and Grosseilliers are the first recorded traders. Defeat of the Iroquois in 1653 permitted Radisson to accompany the Ottawa to the St. Lawrence with a cargo of furs.

1656. Radisson and a companion returned to Wisconsin.

1660. Radisson and Grosseilliers built a trading post at Chequamegon Bay. Antoine Trottier with a party arrived at the bay. Return was delayed for three years by Indian wars. Insufficient furs were collected to meet expenses.

1668. Perrot came to Green Bay.

1669. The mission of St. Francis Xavier was established at Green Bay by the Jesuits who were active in the fur trade.

1673. Marquette and Joliet "discovered" the Mississippi though they were not the first to do so.

1679. The trader Duluth obtained a peace pact between the Indians gathered at Fond du Lac (Superior).

1678–80. La Salle had men at Green Bay to collect furs.

1685. Perrot left his command at Green Bay in autumn and built a temporary wintering post at Trempealeau. The following spring he built Fort St. Antoine in Pepin County.

1687. The mission house at Green Bay was burned by hostile Indians. Perrot lost his furs valued at $40,000.

1693. Le Seur built a post on the southwestern shore of Madeline Island.

1694. A post was established by Le Seur on the Mississippi, below the mouth of the St. Croix, on Pelee, now Prairie Island.

1689–1701. By royal decree there were few traders in the West. This was due in part to a surplus of beaver and in part to the influence of the Jesuits.

1706. Boisseau was operating at Green Bay without a license.

1716. Louvingy attacked the Fox village on Little Lake Butte des Morts. The truce agreement stipulated that the cost of the war would be paid for by the Fox in beaver.
1718. The French built a new military post on Madeline Island.
1727. A military and trading post was built on the west shore of Lake Pepin.
1731. Beauharnois sent Villiers to rebuild the fort at Green Bay. Linctot constructed a fort at Mount Trempealeau on the site of Perrot's old wintering post. It was maintained for five years.
1740. The Chippewa drive the Sioux from Lac du Flambeau and Lac Court Oreilles.
1759. Wolfe defeated Montcalm at Quebec.
1760. Montreal surrendered.
1761. Lieut. James Gorrell with seventeen men and two traders occupied the delapitated French fort at Green Bay.
1763. Following the massacre at Mackinac, the English army permanently abandoned Green Bay.
1765. The trader Alexander Henry arrived at Chequamegon Bay.
1779. The Northwest fur company was organized.
1784. The Mackinac Company was formed about this time.
1808. The American Fur Company was organized by John Jacob Astor.
1811. Astor formed, under the American Fur Company, the Southwest Company which absorbed the Mackinac Company.
1834. Astor retired from the American Fur Company which was then headed by Ramsay Crooks.
1848. The American Fur Company virtually ceased operation.

Utilization

The beaver formed one of the important foods of the Indians and was captured throughout the year. It was roasted entire and the French had to persuade them to discontinue this practise as the pelt was destroyed. Perrot (1864:99) relates that the Ottawa returned some prisoners to the Sioux in northwestern Wisconsin. They did not bring back many beaver pelts since the Sioux were accustomed to roast the whole beaver for eating.

Originally the pelt was of little value in the eyes of the Indians. At Chequamegon Bay they could not understand why the French would come so great a distance to obtain their well-worn robes (La Potherie, 1753:86). While Marquette (1903) was at Chicago in 1674, the Illinois were so eager for French tobacco that they threw beaver skins at his feet in order to obtain a few pieces of it. A chief at Green Bay gave Perrot (La Potherie, 1753, II:127) ten beaver robes for some theriac.*

The flesh of the beaver was eaten quite extensively by whites especially on trading expeditions. To some the flavor was unpleasant. Edibility resulted from long boiling or preferably roasting. Lahontan (1703, I:142) thought the flesh delicious in autumn and winter but it had to be roasted to taste well. The roasted fat tail was eaten eagerly by trappers. Thompson (1962:152, 209) wrote

*A mixture of many drugs used as an antidote to poison.

tersely: "His meat is agreeable to most although fat and oily; the tail is a delicacy." Among the provisions for his trip down the St. Louis River in Minnesota were four beaver tails. Hunger is a sauce blind to discrimination. Du Creux (1951) in 1664 thought it a moot question whether the beaver was a land or water animal. Rationalization permitted the French to eat beaver on meatless days. The faculty of medicine in Paris declared from its aquatic habits that the beaver was a fish, so the faculty of theology decided that it could be eaten on lean days (Charlevoix, 1744:142). The kidneys of the beaver were collected at a few posts. Perrault (1909–10:555) brought out a keg of them, from his post on the Red Cedar River, weighing 45 pounds. In 1754 there were shipped to France 1040 pounds of kidneys valued at three livres a pound (Innis, 1927:153).

Special glands in the beaver secrete a yellowish, unctous substance called castoreum. Its uses in medicine as given by Charlevoix (1744:145) represents the quackery of the age. In relatively recent times it was used as a fixative in perfumes. Its most valuable use was as a lure in trapping beaver. The amount collected was not large. The inventory of October 15, 1824, of all the returns assembled at Mackinac by the American Fur Company shows 83 pounds of castoreum. During the ten-year period, 1837–46, the total collection at La Pointe was 128.5 pounds with an annual variation of 4.75 to 26.75 pounds. On August 20, 1837, 11.5 ounces of castoreum were sold by the American Fur Company at Mackinac for $5.50. William Brewster, Detroit, was informed by the Company in March, 1839, that a price of $4.00 a pound was expected.

Though garments of beaver fur were worn quite extensively, particularly in Russia, the greatest use of the fur was in the manufacture of hats. Only the hairs of the undercoat (wool) were employed. The nature of the scales on beaver hairs gives them a high felting quality by interlocking. At first the hat was made entirely of beaver hair. According to Cadillac (1883) a satisfactory hat could be made by using one-third dry beaver wool and two-thirds of fat or semi-fat wool. These terms will be explained subsequently. The French for a long period enjoyed a monopoly in hat manufacture. In 1752 the wool sold in France at 18 shillings a pound and in England at 32 shillings. Beaver pelts were worth 6 shillings a pound in France and 11 shillings in England. One English manufacturer used 10 to 12 ounces of the wool in a hat for export and 7 to 8 ounces in one for domestic wear (Hume, 1803). In France it was estimated that 10 pounds of pelt would produce 33 ounces of wool which would make three and one-half hats, since at most 9 ounces of wool were used in a hat (Cadillac, 1883).

Hats were eventually cheapened by using a foundation of rabbit and other common fur hairs, and limiting beaver wool to the nap or surface (Lawson, 1943). About 1830 the silk hat came into fashion and the use of beaver declined rapidly. In January, 1836, the London agent of the American Fur Company wrote that the abundance of nutria had lowered the price of beaver; and in August of the same year that silk hats were in almost universal use (Nute, 1944:nos. 1168, 1865).

Hunting

Several methods for taking beaver were employed. The only trap used by the Indians prior to the arrival of Europeans was the deadfall which was baited with a branch of aspen or other suitable wood. This mechanism was used from the Atlantic Ocean to the Mississippi River (Le Clercq, 1691; Carver, 1781:185). The deadfall was of little use in winter, the season when the fur was most valuable, since at that time the beaver seldom appeared on land. Then the beaver had to be driven from its house. The early writers frequently garbled the procedure or omitted essential details. Having found the exit from the house, by cutting a hole in the ice, a net was placed in front of it. A hole was then cut into the house to drive out the beaver which was caught in the net, drawn to the surface, and dispatched (Hennepin, 1903:518). Before iron axes and spuds were made available by Europeans, the opening of a frozen beaver house was a laborious procedure for the Indian with his primitive tools.

The beaver was taken in nets in other ways. According to Le Jeune (1897.1:299) a hole was cut in the ice near the house into which a baited net was placed. On attempting to eat the bark of the wood, the beaver became entangled in the net, rose to the surface of the water and was killed with a club. This method entailed a long, patient, and often fruitless vigil on the part of the Indian. Also a hole was made in the house to drive the beaver into the adjacent pond. The dam was then broken down and a net placed in the gap to catch the beaver as it sought deep water when the pond drained (Perrot, 1864:52). Carver (1781:185) states that when a house was broken into the beaver sought the deepest water in the pond. Here a net had been set in which the beaver became entangled.

The use of nets was original with the Indians who made the twine of various bast fibers. In northwestern Wisconsin, about 1662, the Sioux stretched beaver nets with attached bells in a rice marsh where the Hurons were hidden. When the latter attempted to reach dry land, the Soiux were warned and captured them

(Perrot, 1864:89). Traders carried twine for making nets. Duluth (1902) gave an Ottawa some twine with the reminder that to keep the Indians from dying of cold and hunger the French supplied them with guns, axes, and twine.

Another method of capture was to cut a hole in the ice and drive stakes to form a ring within which fresh aspen was placed. One of the stakes was withdrawn to permit entrance of the beaver. When the beaver entered the enclosure the stake was inserted in the gap, forcing the beaver to rise eventually to the surface where it was killed with a club or a spear. Grant (1860) mentions that a board closed the entrance after a beaver entered. The method was practical only in February and March by which time the beaver had tired of his stale food.

Some beavers lived in bank burrows in lieu of houses. There were also escape burrows around the ponds if the banks permitted. The Chippewa name for a burrow was *o-wazhé,* corrupted to "wash." Before the steel trap came into use most of the beavers were taken from washes. Henry (1921:127–28) wrote of his hunting experiences with the Indians: "Breaking up the house, however, is only a preparatory step. During this operation the family make their escape to one or more of their washes. These are to be discovered by striking the ice along the bank, and where the holes are a hollow sound is returned. After discovering and searching many of these in vain we often found the whole family together in the same wash. . . . From the washes they must be taken out with the hands; and in doing this the hunter sometimes receives severe wounds from their teeth."

The presence of a beaver in a wash could sometimes be detected by the motion of the water at the entrance or by the muddy appearance of the water after the beaver had entered, following exodus from the house. The burrow rose from its under water entrance to a dry chamber near the surface of the ground in which was a small opening for the admission of air. In order to secure the beaver the entrance to the burrow was closed with stakes and the burrow opened at the chamber. If the beaver remained above water it was killed with a club; and if submerged, it was withdrawn with a crooked stick or by hand (Le Jeune, 1897.1:301; Morgan, 1868:238). The Indians of western Manitoba had a peculiar breed of dogs with an extremely keen sense of smell. They were used to detect the thinnest places in the beaver houses and the air openings of the burrows (Thompson, 1962:153). The Chippewa along Lake Superior also used dogs for detecting inhabited washes (Grant, 1860).

Many beavers were taken with spears. Le Jeune (1897) was requested by the Indians to furnish them with cord which was to be attached to spears with barbed iron points. The Indian held the cord until the diving beaver became so exhausted that it could be drawn in. The father of W. W. Cooke (1940:294) speared beaver in Buffalo County. He would follow a stream with his dog which was so highly trained that he would come to a point at the air opening of an occupied wash. Cooke would go to the edge of the stream and locate the exit. On a signal the heavy eighty-pound dog would rear and come down on the ground at the air hole. The earth was usually so thin that it caved in. The beaver would break for the stream and was speared easily.

Beavers were sometimes shot. At dusk when they came out to feed or work on their dams, the hunter allowed his canoe to drift silently down stream (Henry, 1921:125). The hazard lay in securing a beaver which had been killed since it sank quickly to the bottom. The trade goods shipped to Milwaukee in 1821 for James Kinzie (1888) contained 112 pounds of beaver and duck shot invoiced at $22.40. As long as a demand existed for beaver for making hats, the value of the skin was not decreased by the perforations produced by shot and spear. After the hair was removed, the "leather," or skin proper, was made into glue.

The most effective way of taking beaver was with the steel trap which was in general use by 1750 (Schorger, 1951:178). Pierre Grignon who traded at Green Bay from 1763–95 always kept a blacksmith to make traps (Grignon, 1857). All that was necessary to catch a beaver was to place in the water a trap beside which projected a stick having castoreum on the end. The discoverer of this efficient lure remains unknown. Strangely the Indians learned its use from the whites. Many aromatic substances were used as a substitute for castoreum and were frequently mixed with it. In Trempealeau County the Indians sometimes used castoreum but camhpor would also serve (Bunnell, 1897:197). Cinnamon, cloves, and oil of juniper were used in the Lake Superior region. The government factories, of which there was one at Prairie du Chien and one at Green Bay, carried in stock for this purpose cinnamon, nutmeg, cloves, ginger, allspice, and mace (Peake, 1954:60).

The beaver dams were sometimes opened and a trap set in the channel. Regarding the efficiency of this method in Dunn County, Cartwright (1875:240) wrote: "There Mr. Putnam tried the old but fatal plan of cutting down the dam to catch the beavers. He did let them out; but he caught only two from the four or five dams which he cut into."

The steel trap became indispensable and competition in the nineteenth century between traders caused them to loan rather than sell traps to the Indian. If the trap was not returned he was charged five dollars for it on the books. Newhouse (1874) summed up the importance of the trap by stating that trapping for furs took place in advance of civilization. The trap preceded the axe and the plow and caused the bear and beaver to give way to settlement. In his opinion it would not be inappropriate, accordingly, for Wisconsin to have a steel trap in her coat of arms.

Grades of Pelts

The Indians captured beavers at all seasons. Those taken in summer for food might or might not be skinned. The poorest pelts were taken at this season. The quality improved through fall, winter, and spring. The pelts were not fully prime until spring, the best being obtained between the first of February and the first of April, depending on latitude and altitude. In order to keep the goodwill of the Indians, it was necessary for the trader to buy all the skins presented, and this forced the establishment of several grades (La Potherie, 1753, I:269).

There is some inconsistency as to the grades among the early writers. Lahontan (1703, II:70) defines hazily five grades: (1). Winter beaver, called Muscovite, valued at 4 livres and 10 sous per pound. (2). Fat beaver, the long hairs of which have fallen out while being worn by the natives and valued at 5 livres. (3). Soft beaver, that is beaver taken in autumn, worth 3 livres and 10 sous. (4). Dry or ordinary beaver, 2 livres. (5). Summer beaver valued at 3 livres.

Six grades are given by La Potherie (1753, I:267–69). The first is fat winter beaver *(gras d'hiver)* with a fine thick undercoat and long guard hairs. Six or seven skins were sewed together to make a robe. The sweat from the Indian's body and the bear's grease from his soiled hands turned the undercoat yellow. Handfulls of the grease were taken to eat, some of which fell on the guard hairs and gradually reached the undercoat. The chief source of grease was probably the bear oil which the Indians applied liberally to their bodies especially in winter.

The second grade was the half-fat winter beaver *(demi-gras)*. Due to pressing needs the natives sold these robes to the French when they were only half-fatted. It was necessary, however, that they be as supple as the fat robes. The third grade was the summer fat. The robes had large guard hairs but a thin undercoat. The fourth grade was the soft beaver *(veule)*. The robes were of fine quality but since they had been worn very little, the undercoat was only slightly greased. The pelts were well prepared and the price was the same as for the fat winter beaver. The fifth grade was the dry winter beaver *(sec)*. The skins were not used for robes on account of the holes made by shot or spear. The skin was very thick and badly prepared. The sixth grade was the Muscovite for which grade the beavers were caught in traps. This was a fine fur with long guard hairs. There was a large commerce with Russia in this grade. The Russians combed out the undercoat, leaving only the long guard hairs. The wool was sold to hatters.

Two kinds of pelts are mentioned by Charlevoix (1923:146), the green *(vert)* and the dry *(sec)*. The green pelt was one which had been worn by the Indians, hence was equivalent to the fat pelt. The leather side was scraped, then rubbed with bone marrow to make the pelt supple before the robe was made. He states that the robe was worn with the hair side next to the body and was never removed day or night; also that the long guard hairs soon fell out. This is doubtful. If the guard hairs fell out, the ampulla, or base of the hair, must have been cut by too severe scraping in removing the flesh and fat adhering to the skin. In this case the hairs of the undercoat would fall out also.

The values in trade of *gras, demi-gras, sec (autrement bardeau)*,* *veule,* and Muscovite pelts were argued by Cadillac (1883.1). He thought that the commerce in fat beaver should cease. Properly, *veule* was only a dry beaver which had been scraped, cleaned, and sewed into a robe. The leather was white, light in weight, and thinned to the point where the hair could still be held fast. In the half-fat the leather is greased inside and out, is more worn, dusty, and matted than the *veule* and smells of the Indian. It is dirty but not as much so as the *gras*.

Eight grades are given by Dobbs (1744:25) whose information came from French sources. They follow:

"The first is the fat Winter Beaver, kill'd in Winter, which is worth 5s. 6d. per Pound.

"The second is the fat Summer Beaver killed in Summer, and is worth 3s. 6d.

"The third the dry Winter Beaver and fourth the Bordeau, is much the same, and are worth 3s. 6d.

"The fifth the dry Summer Beaver is worth very little, about 1s. 6d. per pound.

"The sixth is the Coat Beaver, which is worn till it is half greased and is worth 4s. 6d. per Pound.

"The 7th the *Muscovite* dry beaver, of a fine skin, covered over with a silky Hair; . . . This is worth 4s. 6d. per Pound.

"The eighth is the Mittain Beaver, cut out for that Purpose to make Mittains, to preserve them from the cold and are greased by being used, and are worth 1s. 9d. per Pound."

His grades are poorly defined and he confused *bardeaux* with Bordeaux. The English used only coat (fat) and parchment (dry) beaver in their data on exports in the early part of the eighteenth century (Dobbs, 1744:199).

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*I have been unable to find the meaning of *bardeau* as applied to the beaver pelt.

Most of the beaver pelts produced were dry. For example in 1723, Canada exported 649 packs of dry beaver, 330 of fat, 2 of soft, and 20 of Muscovite (Innis, 1727:150). These grades fell into disuse in the latter part of the eighteenth century in Wisconsin. The pelts were then graded as No. 1 and No. 2. I have not discovered the difference. Porlier (1911) shipped: "No. 1. 100 Beaver weighing 108 lb.; No. 2. 57 Beaver weighing 78 lb." Both parcels are stated to have been of the best quality. The No. 2 beavers were the heavier, hence the largest; so that the difference in grades does not appear to have been based on size.

Weight of Packs and Pelts

Beaver pelts were compressed into packs for economy of space and ease of handling. Poor grades of bear skins were commonly used as covers. Four methods of compression were used (Russell, 1948). At small and remote posts a pole was employed. One end was fastened to the ground and pressure was applied by the weight of a man on the other end of the pole. The wedge press consisted of a frame of four posts driven into the ground, and provided with cross pieces beneath which were placed the furs covered with slabs of wood. Pressure was obtained by driving wedges between the slabs. Large trading posts having easy shipping facilities, such as Mackinac, used a heavy metal screw press. This press was superseded by the simple and efficient jack.

The weight of a pack of furs is usually given as 90 to 100 pounds. Chittenden (1904) states that a pack weighed 100 pounds and contained 80 beaver pelts, which would be 1.25 pounds per pelt. Larpenteur (1933) gives 100 pounds for a pack containing 60 average pelts, or 1.66 pounds a pelt. A weight of 100 pounds is also mentioned by Henry (1921:197). The packs of beaver taken along the Minnesota River in 1822 weighed 100 pounds and contained 80 skins; again 1.25 pounds a pelt (Neill, 1852). Harmon (1922) in 1801 had his furs in packs weighing 90 pounds each. According to Morgan (1868:228) an average pelt from the Upper Peninsula of Michigan weighed 1.5 to 1.75 pounds.

Extensive data on the packs of beaver collected by the Northwest Company at the Fond du Lac post in 1804–05 are given by Pike (1895). Four packs of mixed large and small pelts averaged 91.5 pounds in weight and contained on the average 69.5 skins weighing 1.32 pounds each. He lists the weights of 115 packs. If the highly abnormal weights of 72 and 127 pounds for two packs are rejected, the average weight of a pack is 91.5 pounds.

The following data were compiled from 133 invoices of the American Fur Company and its agents of beaver taken in the upper Great Lakes region, principally in Wisconsin. A total of 25,630 pelts weighed 29,545 pounds, or 1.15 pounds each. All lots weighing less than a pound per pelt were rejected as young or "cubs." Their average weight was 0.88 pound. The heaviest lot consisted of 416 pelts having an average weight of 1.4 pounds, shipped by Jacques Porlier in August, 1821. Two apparently especially selected skins weighed two pounds each. It may be accepted that the average pack of Wisconsin beaver pelts weighed 91.5 pounds and contained 80 pelts of 1.15 pounds each.

Large beaver, weighing 80 to 110 pounds, have been caught in the state (Schorger, 1953; Jackson, 1961:193).

Prices

Originally the unit of value at the trading posts was a beaver pelt or *plus*, pronounced plew. Not only were trade goods priced in beaver pelts but furs other than beaver as well. In the Fond du Lac region in 1820, a large prime beaver pelt was worth two otter skins, and three of marten or mink (Doty, 1876:205). The cost of goods at the posts varied considerably but was regulated largely by the distance that the supplies must be transported. Examples of the rate of exchange are given in Table 1.

English blankets for the Indian trade varied in size and weight and were classified as 2, 2½, 3, 3½, and 4 point (Elliott, 1900). The points were woven into the blanket. A black strip four inches long represented one point, and a strip two inches long one-half of a point. A 2½ point blanket was six feet and three inches long, five feet and two inches wide, and weighed seven and one-half pounds (Peake, 1954:56). A 3 point Northwest or Mackinac blan-

Table 1. Rate of Exchange of Full Beaver Pelts For Goods

Year	Place	Blanket Kind	Blanket No. Pelts	Gun No. Pelts	Reference
1689	Albany	White or Red	1	2	Anon. (1855)
1689	Montreal	White or Red	2	5	Anon. (1855)
1776	Fort des Prairies, Saskatchewan	White	8	20	Henry (1921:303)
		Stroud	10	—	Henry (1921:303)
1804	Lac du Flambeau, Wisconsin	2½ Point	3	10*	Malhiot (1910:221, 222)
1820	Fond du Lac, Wisconsin	2½ Point	2	5	Doty (1876:205)

*Inventory value.

ket was six and one-half feet long, five and one-half feet wide, and weighed eight and one-half pounds. A 3 point American blanket, e.g., was inferior in size, weight, and quality.

In 1820, according to Doty *(l.c.)* a plus (or pound) was estimated at $2.00 and a large prime beaver skin was worth two plus. His data have been adjusted to full skins in the above table. Turner (1889, 1891) was informed by Andrew J. Vieau that a plus was a pound of pelt worth $1.00 in his day. Vieau's trading experience was in the period 1834–50 and was confined to Milwaukee and a few places north of this city, an area where the beaver was close to extinction. The values given by Malhiot *(l.c.)* for his post at Lac du Flambeau in 1804–05 are somewhat perplexing. He carried a gun at ten plus and a 2 point blanket at two plus in his inventory. The blanket was traded at three plus. His plus must have been a large skin weighing two pounds for in his return for December 23 he lists 30 beaver skins, evidently small, at 16.5 plus. Traders at Green Bay in 1810 charged $10.00 for a 2½ point blanket (Peake, 1954:20).

It is difficult to follow the early prices in currency of beaver since it is frequently impossible to determine if the price was based on the whole skin or the pound. The hat manufacturers were interested only in the weight of skins, so that selling beaver by the pound became an early custom. A good example of confusion is to be found in the tables in Innis (1927:153, 154). In 1754 a skin was priced at four francs, and the following year the price is four francs per pound. In the Canadian trade the average beaver skin was considered to weigh one and one-half pounds. Where weight is not stated I have assumed (Table 2) that the price is per pound. In Table 3 all prices are per pound.

TABLE 2. PRICE OF BEAVER PER POUND

YEAR	PLACE	CANADIAN CURRENCY	DOLLARS	REFERENCES
1635	Albany		1.50[1]	Morgan (1868:243)
1681	Montreal	4 livres, 10 sols[2]	.75	Du Chesneau (1855)
1681	Albany	8 livres	1.33	Du Chesneau (1855)
1699	Montreal	3 livres 7 sols 6 den.	.56	Cadillac (1883:148)
1738	Montreal	55 sols	.46	Salone (1906)
1744	Montreal	4 livres[3]	.67	Salone (1906)
1754	Quebec	4 livres	.67	Innis (1927:154)
1799	Montreal	12 shillings[4]	2.88	Morison (1910)

[1]A skin sold for $2.25 making $1.50 per pound.

[2]Canadian livre, or shilling after the conquest of Canada, was worth 16.6 cts. There were 20 sols to the livre and 12 deniers to the sol. One English shilling = 1s. 4d. Canadian.

[3]Increase in price attributed to war with the English.

[4]Sterling.

The prices in Table 3 have been taken from the voluminous papers of Wisconsin fur traders in the Wisconsin Historical Society library and from those of the American Fur Company.

There was a financial crisis in England and the United States in 1837 and the American Fur Company did not know what to do with its beaver. About this time the Northern Outfit of the Company at La Pointe issued "beaver money" (Fig. 1) with which the trappers were paid (Nute, 1928). The certificate was payable in merchandise only. Under normal conditions two profits were obtainable, one from the merchandise, the other from the furs.

TABLE 3. PRICE PER POUND PAID TO WISCONSIN TRADERS

YEAR	DOLLARS	TRADERS
1811	3.00*	Pierre Grignon
1813	2.50*	Pierre Grignon
1814	3.34*	Jacob Franks
1815	3.50	P. and A. Grignon
1816	3.50	Franks and Co.
1820	4.00	Lawe and Grignon
1820	3.50	Porlier and Rouse
1821	4.00	Lawe and Grignon
1824	3.00	Suggested buying price Stuart to Abbott Aug. 18
1825	4.38	Lake Superior beaver } Prices paid by Am. Fur. Co.
1825	3.75	Upper Miss. beaver } Crooks to Astor July 29
1827	4.00	La Bulle (Wausau) Post
1840	4.00	Dec. 19. Suggested buying price Crooks to Juneau
1844	3.00	Dec. 25. H. L. Dousman to A. Bailly
1845	2.25	July 23. Dousman's offer for Ermatinger's beaver

*Prices in livres changed to dollars.

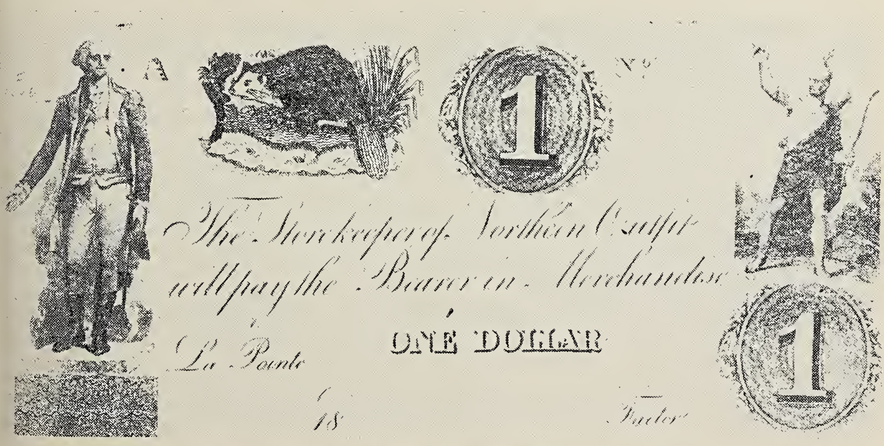

FIGURE 1. Beaver Money used at La Pointe, Madeline Island.

The Wisconsin traders in the first half of the nineteenth century rarely made a profit, many continuing to sink deeper into debt. The main reason why the Company continued to advance credits was that most of the traders had acquired land which had grown in value and could be put up for security. In 1844 Solomon Juneau (Nute, 1955: no. 14,187) at Milwaukee was bankrupt with $20,000 of debts. John Lawe (Nute, 1944: no. 7,883), with forty-two years of experience in the Indian trade, could lament that no one ever heard of a rise in price of furs. Accustomed to dealing only in furs and with no other means of support, the traders accepted with resignation a fate improverishing and inescapable. The Company was not free from the line of least resistance. Time and again it was determined to close an unprofitable post, yet the trader was continued in employment for years afterward.

Decrease of the Beaver

Few species of mammals can withstand continuous and indiscriminate trapping. There is precious little evidence that the Indian practised conservation in spite of Lahontan's (1703, II:161) statement that after breaking down a dam the Indians spared a dozen females and half a dozen males for reproduction. It would be an unusual pond that even had an initial population of eighteen beavers. Indians were directly responsible for exhaustion of the beaver as nearly all the pelts were taken by them.

Only a few Indian tribes were of importance in taking beaver in Wisconsin. The Chippewa hunted the south shore of Lake Superior and bartered their furs at Fond du Lac and La Pointe. In 1757 the Menominee, Sauk, Fox, Winnebago, Mascoutin, Kickapoo, Prairie Sioux and Lake Sioux came to Green Bay to trade (Bougainville, 1908:183). It is sometimes stated that the Sioux occupied lands west of the Mississippi and were not residents of Wisconsin. In the early days, the Sioux held the country immediately east of the Mississippi and never relinquished in spirit their rights to this borderland, especially the privilege of hunting. In the census of 1821, the number of Sioux men, women, and children residing east of the Mississippi is given as 1,182 (Cass, 1911). As late as 1850 Grignon (1914) traded with the Sioux for the furs which they had obtained up the Trempealeau River.

Beaver were so scarce in the Mackinac region by 1700 that the Indians went 200 leagues to hunt them. Between October and May a good hunter could capture 50 to 60 beavers, more or less (Cadillac, 1883). This means that he would average only one beaver in four days. Morgan (1868:243) wrote that an Indian family of four effective persons would take 75 to 150 beavers in a season on the south shore of Lake Superior in well-stocked beaver territory, and that 50 to 100 were not uncommon. This statement might have applied to the Upper Peninsula of Michigan, but doubtfully to Wisconsin. The winter of 1870–71, Cartwright (1875:272) and a companion caught 73 beavers in Marquette County, Michigan.

By 1793, according to Dickson (1923; Doyle, 1923), very few beavers were taken east of the Mississippi or on the streams which flowed into it. The land of the Menominee on Green Bay was almost exhausted of game. These Indians accordingly spent the winter in part on the upper Wisconsin, but chiefly on the upper Mississippi where they captured large numbers of beaver. They excelled all the other Indians in art. The Winnebago, Sauk, and Fox hunted chiefly deer, raccoon, and bear. Furs at Fond du Lac (Superior), which was once a highly productive region, had dwindled to a trifle by 1807 (Monk, 1923). This year, at Prairie du Chien, Dubuque (1910) outfitted a party of eight men to trap beaver on the Missouri. The Fond du Lac Indians hunted south to Pine Lake, Polk County, and in 1820 had but few beavers in their territory (Doty, 1876:201). Brunson (1843) traveled overland from Prairie du Chien to La Pointe. The only sign of beaver found was between the headwaters of the Black and Chippewa rivers.

The statement of Lanman (1847) that the beaver was extinct south of Lake Superior is not true. In the 1880's it was supposed to be close to extinction in the state (Strong, 1883; Paquette, 1892). It was sufficiently uncommon at that period that the trapping of one, or the presence of its dams, was certain to receive publicity. In 1912 it was still to be found in most of the northern counties (Cory, 1912). The estimate of Seton (1929) that in 1925 only 100 beavers remained in Wisconsin is much too low since 2,208 beavers were trapped in the season 1933–34. The recovery of the beaver under protection has been remarkable as 14,232 were trapped in 1958, and 9,806 in 1962. These figures were not approached at any time during the nineteenth century.

I have tabulated the copious data on the shipment of beaver from Wisconsin in the nineteenth century to be found in the fur papers in the Wisconsin Historical Society without being able to find consecutive quantitative data for any one post extending over a period as short as ten years. Henry (1921:196) obtained 150 packs at Chequamegon Bay in the spring of 1766. The return in 1832 at adjacent La Pointe, under Lyman F. Warren, was down to 250 pelts. These came from the seven posts on the St. Croix, Lac Court Oreilles, Lac Chetec, Chippewa River, and Lac Vassale* (Allen, 1834). The shipment of beaver from Green Bay declined from 535 pounds in 1813 to 198 pounds in 1836, but in neither case is possi-

*Corruption of Vaseux or Mud Lake, Town of Oakland, Burnett County.

ble to know the extent of the area from which the furs were collected. The last shipment of beaver from Milwaukee which I found was 21.5 pounds in 1822.

If the returns from a post were poor, the trader had an excuse whether valid or not. There was too much snow or none, high water, severe competition from rival traders, and the Indians were starving or ill. In March, 1835, Solomon Juneau wrote from Milwaukee that the Indians were so discouraged by the arrival of so many settlers north of Chicago that they refused to hunt. Then on Nov. 23, 1836, Ramsay Crooks wrote that the progress of civilization will break up all of the American Fur Company's trade south of the Fox and Wisconsin Rivers, worth $25,000 annually.

Distribution of the Beaver

The statement (McLeod, 1946; Lapham, 1946) that formerly the beaver occurred on all the waters of the state is undoubtedly correct. As demonstrated below it has been possible to show the early presence of the beaver in nearly all of Wisconsin's counties. I am indebted to Walter J. Zelinske and George J. Knudsen of the Wisconsin Conservation Department for information on the present and recent status of the beaver in certain counties. The recent presence of the beaver is good presumptive evidence that it occurred in primitive times. Numerous streams and lakes bear the name Beaver from the former presence of this animal (Fig. 2).

Adams.—Beavers were numerous in the early days of settlement (Cole and Smythe, 1919). In the fall of 1843 Kingston (1879) and a companion descended the Wisconsin River from Grand (Wisconsin) Rapids. Fresh sign of beaver was noted on the east bank below the mouth of Yellow River, hence in the town of Quincy.

Beaver Pond is in the eastern part of the town of Jackson.

Ashland.—Lapham (1858) listed the beaver among the mammals inhabiting the vicinity of Ashland. In 1878 Joe Harper of Butternut caught an old beaver which had lost a front paw (Ashland, 1878). According to McManus (1920) the headwaters of the Potato River formed "a vast region of beaver dams." Some beaver were to be found in 1920.

Beaver Lake, town of Morse, two and on-half miles SE of Mellen; a second Beaver Lake, one mile SW of the city of Clam Lake; a third Beaver Lake, western part of the town of Marengo; Beaverdam Lake, seven miles S of Marengo; Beaver Creek rises two miles W of Butternut and flows S into Butternut Creek.

Barron.—Surprisingly to some inhabitants, several beavers were caught in the county in 1881 by J. M. Parkhurst of Prairie

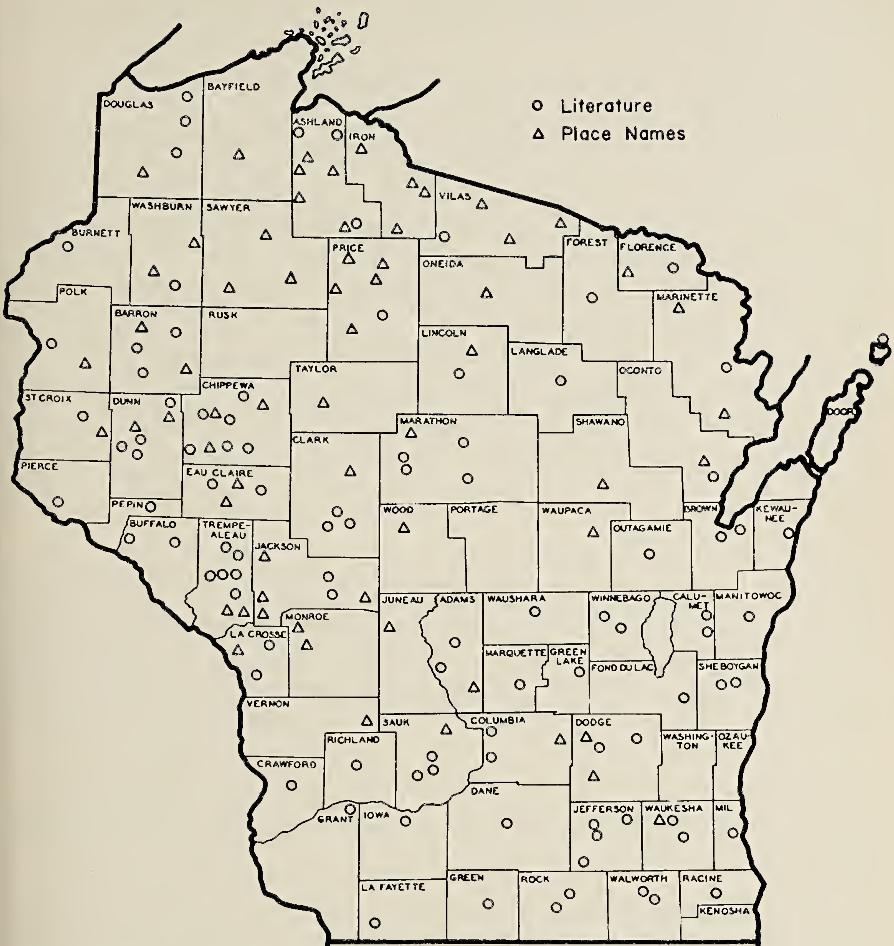

FIGURE 2. Early Distribution of the Beaver in Wisconsin.

Farm (Barron, 1881). The following year a few beavers were still being captured near Rice Lake and their old dams were common (Butler, 1882). An old and crippled beaver was caught in Hay River by Mr. Harris of Barron in 1892 (Barron, 1892).

Beaverdam Lake, edge of Cumberland; Beaver Creek, town of Dovre, flows NW into Tenmile Lake.

BAYFIELD.—In 1885 a colony of beavers was building a dam on a stream a few miles from Bayfield (Bayfield, 1885). Nineteen beavers were taken in March, 1921, by W. T. Gray, mostly in this county (Jackson, 1961:193), a good indication that the beaver was fairly common.

Beaver Lake, seven and one-half miles N of Drummond.

BROWN.—When Nicolet (1898) visited the Winnebagos at Green Bay in 1634 at least six score beavers were served at one feast. This is probably an exaggeration like his four to five thousand curious male visitors, but it indicates that the beaver was common in the region. Perrot (1864:279) was in the Great Lakes region from 1665–70. At the Potawatomi village on the eastern shore of Green Bay near Point Sable, the Indians gave him five beaver robes to dispel the ill-will which they had created in him. They did not wish to hunt beavers as they were few, preferring to seek other game to satisfy the needs of the body. Lahontan (1703, I:139) was at Green Bay in 1689 when he was served a roasted beaver tail. He saw in the Indian village ten or twelve tame beavers which came and went at will.

BUFFALO.—W. W. Cooke (1940:295) came with his parents in 1856 to a homestead five miles from Gilmanton. Beavers were in all the streams and two dams flooded part of the farm. His father took them by spearing. They were pleased if $1.50 was received for a pelt. In the fall of 1860 two trappers returned to Viroqua with 69 beaver pelts obtained on Beef River (Slough) in a period of six weeks (Viroqua, 1860).

BURNETT.—The winter of 1803–04 Curot (1911) collected three packs of beaver at his trading post where the Yellow River leaves Yellow Lake.

CALUMET.—Old beaver sign has been found in the towns of Charlestown and Brillion. At present there is a colony in the town of New Holstein *(In litt.,* Warden K. L. Reichenbach).

CHIPPEWA.—The fall of 1858 Cartwright (1875:241) and two companions caught beavers on Mud, Elk, and O'Neil creeks. Trappers in the fall of 1886 were taking four to five beavers nightly at various places on Duncan Creek eight miles above Chippewa Falls. The animals were also quite numerous on this creek near Bloomer (Chippewa Falls, 1886). Several beavers were taken on the same stream a year later by J. L. Stevens. A substantial dam had been built within a mile of Bloomer (Chetek, 1887). A fine beaver caught on Paint Creek, which flows into Lake Wissota, was exhibited in Chippewa Falls (Chippewa Falls, 1888). At this time a number of beavers was taken by a Minnesota hunter in the woods north of Chippewa Falls (Shullsburg, 1888). On October 25, 1891, Frank Hunter on Duncan Creek trapped a beaver weighing 68 pounds (Chippewa Falls, 1891).

Beaver Lake, ten miles NE of Bloomer; Beaver Creek, town of Wheaton, flows E into the Chippewa River near Chippewa Falls; another Beaver Creek, a small stream flows N and enters Fisher River eight miles NE of Cornell.

CLARK.—Manly (1927) trapped on the upper Black River the winter of 1843–44. He stated that the beavers living in the banks could not be secured until the ice went out in the spring. At this period the beaver was abundant (French, 1875.1). In 1874 a beaver minus one leg was killed on the Black River above Neillsville (Neillsville, 1874). A beaver dam was discovered in 1886 on O'Neill Creek a short distance east of Neillsville (Milwaukee, 1886). Two beavers were killed "near the mound" west of the Black River in the fall of 1889 (Neillsville, 1889).

There is a town of Beaver.

COLUMBIA.—E. F. Lewis settled in 1849 on Section 16, Town 13N, Range 7E on Beaver Creek, so-called because beavers had built a dam across it (Lewis, 1920). The stream is now called Big Slough. A beaver dam at Dorward's Glen, town of Caledonia, was still visible in 1896. Dorward (1901) saw it first about 1864.

Beaver Creek rises nine miles N by E of Columbus and flows into Beaver Dam Lake.

CRAWFORD.—During the 1959 season, 195 beavers were trapped in the county (Bersing, 1959).

DANE.—In 1836, according to Tenney (1877), the beaver had not yet been exterminated in the town of Madison. At present it is fairly common in the western part of the county.

DODGE.—Beaver Dam Lake and the city of Beaver Dam owe their names to the beaver. Prior to construction of the dam, the lake was a large marsh (Snyder, 1902). W. H. Murkley stopped at Beaver Dam in the spring of 1849 and reported that he saw beavers working on a dam (Beaver Dam, 1924). In 1843 Lapham (1925) visited Solomon Juneau's trading post on the Rock River, which according to the surveyor's description was near Mayville. Beavers were present until about 15 years previously.

Beaver Dam Lake is in the NW part of the county. The portion of Beaver Creek draining this lake flows S into the Crawfish River, town of Shields. On the map of Cram (1839) Beaver Creek bears the Algonquian name of the beaver, Ahmic.

DOOR.—As late as September 14, 1905, a beaver was shot at Washington Harbor, Washington Island (Sturgeon Bay, 1905).

DOUGLAS.—At intervals the Brule was a famous stream for beavers. In 1680 their dams were numerous (Duluth, 1886). Henry (1921:188) spent the winter of 1765–66 at Chequamegon Bay where he advanced goods worth 3000 plus to the Indians who went to Fond du Lac to hunt. When they paid their credits in the spring he obtained 150 packs of beaver weighing 100 pounds each. Even if it is assumed that on the average a pelt weighed as much as one and one-half pounds, he obtained 10,000 skins!

The water was so low at the headwaters of the Brule in 1767 that Carver (1781:81) had to close several old beaver dams, broken down by hunters, to raise the water sufficiently to float his canoe. In 1840, at the proper season, the Chippewa went to the Brule for "the beaver and otter that exist along its whole course. There are indications of its once having been abundantly stocked with these animals; but the trappers have made such havoc among them of late years, that the stock has become very much reduced" (Cram, 1841). Writing of the Brule in recent years, McManus (1920:136) stated that it had many ponds formed by beaver dams.

Beaver Creek, flowing S, enters the St. Croix about nine miles W of Gordon.

DUNN.—Perrault (1909–10:547, 555) built a post on the lower Red Cedar River and during the winter of 1788–89 traded for 14 packs of beaver of 90 pounds each. From his rough map his post could not have been much farther up the river than Menomonie. On one occasion he camped down the river at the *petit rocher,* near the post, where a deer pursued by wolves jumped from a cliff and broke its legs on the ice of the river. His rock corresponds with the Pinnacle midway between Downsville and Menomonie. Furthermore this is the only elevation sufficiently close to the river for the tragedy to have occurred.

The winter of 1857–58 Cartwright (1875:240) and a companion trapped beaver on Pine Creek, town of Sand Creek. The fall of 1858 he and two companions caught beavers on Gilbert and Wilson creeks. Writing of the "Big Woods" a "Pioneer" (1884) stated: "A notable feature to the eye of the observer, along the small streams, is the great number of old beaver dams, showing that at one time these animals must have been very numerous here." A few still lingered. The Big Woods comprised the present towns of Eau Galle, Weston, Lucas, Stanton, Sherman, Sheridan, and parts of others.

Big Beaver Creek flows SE into Hay River four miles NW of Wheeler; Little Beaver Creek flows into Big Beaver; Beaver Creek, rising in the town of Auburn, Chippewa County, flows W into the Red Cedar three miles S of Sand Creek. The Beaver River on Perrault's map *(l.c.)* appears to be the present Hay River.

EAU CLAIRE.—The fall of 1866 Charles Martin trapped several beavers in the town of Bridge Creek (Bartlett, 1929). The Slayton brothers of Augusta took four beavers during their hunt the winter of 1867–68 (Dodgeville, 1868). On January 22, 1877, a beaver was killed on the upper Eau Claire River (Eau Claire, 1877). Three large beavers were trapped in 1883 by Herman Heckern on Seven Mile Creek about seven miles east of Eau Claire. They were then quite rare; however fifteen years previously they were plentiful (Eau Claire, 1883). In the fall of 1886 a party of hunters captured 40 beavers on Muskrat Creek, town of Wilson (Delevan, 1886).

Beaver Creek enters the Eau Claire River from the E seven miles E of Altoona; another Beaver Creek flows N into Otter Creek at Brackett.

FLORENCE.—A black beaver was caught by Paul Miller on Pine River, town of Commonwealth (Florence, 1886).

Beaver Pond, town of Long Lake.

FOND DU LAC.—Beavers had not been seen for many years in the town of Osceola until the fall of 1872 when four were killed by W. Tomkins (Fond du Lac, 1872).

FOREST.—The county produced 296 beaver pelts in 1959. Insofar as known, the beaver was never exterminated.

GRANT.—At Muscoda, the fall and winter of 1845–46, Robert and William McCloud bought beaver and other furs, fur-bearing animals being numerous (Butterfield and Ogle, 1884). There is now a considerable population of beaver in the county. The take of beaver in 1959 was 202.

GREEN.—According to Jackson (1961) there were remains of beaver dams and ponds as late as 1900.

GREEN LAKE.—When Perrot (La Potherie, II:109) came to the Indian village at the site of modern Berlin there was a mixed population of Mascoutin, Miami, and Kickapoo. He gave the women knives for skinning beaver and cutting meat. The Miami told him that they had no beaver pelts because up to that time they were accustomed to roasting the entire animal. As late as 1847 the Indians were busily engaged in trapping beavers and muskrats (Acme, 1890).

IOWA.—Fifteen beaver were trapped in 1959. Most of the beaver occur along the Wisconsin River and the streams flowing into it.

IRON.—Beaver Pond, town of Gurney, two miles SW of Saxon; Beaver Lake, six miles N of Mercer; a second Beaver Lake, six miles NE of Mercer; Beaver Creek, town of Sherman, flows N into west arm of the Flambeau Flowage.

JACKSON.—The creeks flowing into Black River had beaver dams at short intervals in 1841 (French, 1875). In January, 1887, Royal McGregor caught a beaver on Robinson Creek, town of Manchester (Black River Falls, 1887). The take in 1959 was 390.

Beaver Creek, town of Northfield, flows S into Pigeon Creek at York; a second Beaver Creek rises in the town of Bear Bluff and flows E; South Beaver Creek, rises in the town of North Bend, flows W.

JEFFERSON.—Hawkins (1940) thought that the beaver was exterminated prior to settlement. He mentions that several well preserved dams could still be seen near Milford. On one of the dams was growing an elm tree estimated to be 100 years old. The father of E. D. Coe (1908) settled on the west bank of Rock River, town of Watertown, seven miles from the city of Watertown, in 1839. The following winter about thirty Winnebago families camped near his home. Beaver was among the furs taken by them. During the archeological excavations at Carcajou Point, Lake Koshkonong, there were found split incisors of beaver which had been used for chisels (Hall, 1962). Thirty remains of the beaver at the Aztalan site on the Crawfish River were identified by Parmalee (1960).

JUNEAU.—Beaver Creek rises in the town of Kingston and flows S into the Lemonwier. The county furnished 398 pelts in 1959.

KENOSHA.—There were no beaver in the county in 1956.

KEWAUNEE.—There are no resident beaver at present. Warden Philip Hein has seen an occasional beaver in years past. He furnished a photograph of a beaver traveling along the Lake Michigan beach in May, 1950.

LA CROSSE.—The Sioux called the Black River Chabadebah or Beaver River (La Salle, 1902). The former presence of the beaver in Lewis Valley, town of Farmington, is mentioned by Sisson (1955). In 1881 a man living a few miles from La Crosse brought to town the pelts of seven beavers which he had trapped (La Crosse, 1881).

LAFAYETTE.—In April, 1894, W. H. Calvert shot a beaver on a small stream on his farm near Benton. Its length from tip to tip was three feet and nine inches. None other had been seen for many years (Dodgeville, 1894).

LANGLADE.—Beaver was formerly one of the principal furs taken in the county (Dessureau, 1922). It furnished 205 skins in 1959.

LINCOLN.—It was stated by Hoy (1882) that a few beavers persisted in this and adjacent counties. The take in 1959 was 268.

Beaver Lake, town of Skanawan, three miles SE of Tomahawk.

MANITOWOC.—Beavers, though rare, were present in the county in 1956.

MARATHON.—Having seen sign of beaver on the Eau Pleine River east of Colby, William Wilde set his traps, but secured only part of the foot of a beaver (Colby, 1886). The following year a beaver weighing about 70 pounds was trapped by J. W. Denney (Colby, 1887). In the fall of 1889 beavers had a new dam two miles up Little Rib River, town of Stettin. Several had been trapped. The editor (Wausau, 1889) stated that a few years previously the streams in the region were well-stocked with this animal which was now becoming scarce. He entered a plea for protection. Two years later two beavers were trapped on Little Rib (Wausau, 1891). In the early days, Michael De Jarden, a Chippewa, assisted his father in trapping beaver and other fur-bearers near Mosinee (Ladu, 1907).

Beaver Creek, town of Bern, flows S to join Black Creek two miles NW of Athens.

MARINETTE.—Stanislaus Chapeau (1831, 1835) wrote in 1831 from his post on the Menominee River that a rival trader had secured most of the beaver. In June, 1835, he informed John Lawe that he had 150 pounds of beaver.

Beaver Branch, town of Dunbar, flows S into KC Creek two miles NW of Dunbar; Beaver Creek, Town of Beaver, flowing E, enters the Peshtigo seven miles S of Crivitz.

MARQUETTE.—In 1680 Hennepin (1903:306) descended the Fox River from Portage and before reaching the lakes on this river broke down several beaver dams in order to get the canoes through. From Portage to Buffalo Lake the Fox is broadly margined by marsh, a condition rendering the construction of dams improbable. The dams were probably found between Buffalo Lake and Puckaway Lake. Beaver are still present.

MILWAUKEE.—Lapham (1855) mentions an old beaver dam at Milwaukee. It is shown on his Plate III on a streamlet which enters the Milwaukee River three and one-half miles north of its mouth.

MONROE.—One hundred beavers were captured in 1959.

West and East Beaver Creeks rise in the NW corner to form Beaver Creek which flows S into the La Crosse River at Sparta.

OCONTO.—A beaver weighing 48.5 pounds was caught in the fall of 1884 on the Pensaukee River, near Abrams, by George Lince (Oconto, 1884). A year later a black beaver, "a rare variety," was captured near C. B. Alford's logging camp (Oconto, 1885).

Beaver Lake, three miles N of Oconto Falls.

ONEIDA.—The county produced 280 beavers in 1959.

Beaver Lake, town of Cassian, about eight miles NE of Harshaw.

OUTAGAMIE.—There were few beaver colonies in 1956.

OZAUKEE.—According to Warden Albert W. Wilke, there has not been a beaver in the county during the past 75 years.

PEPIN.—Two beaver were trapped by W. B. Dyer on the Eau Galle, west of Durand, in October, 1885. A colony was reported to exist on this stream in the town of Waubeek (Durand, 1885). One was also trapped on the Eau Galle by Dyer in 1887 when they were considered quite scarce (Durand, 1887). Three years later a trapper came into Durand with the pelts of three beaver trapped on the Eau Galle. A fourth beaver was shot but lost (Durand, 1890).

PIERCE.—In 1659 Radisson returned to Montreal with a "great store" of beaver pelts obtained while living with the Indians on Prairie (Pelee, Bald) Island, at the northern end of Lake Pepin (Adams, 1961). The number of beaver pelts taken in 1959 was 108.

POLK.—Branches gnawed by beaver, along with the bones of extinct bison, were found in Mountain Meadow, Interstate Park, town of Osceola (Pond, 1937).

The North and South branches of Beaver Brook rise near the village of Turtle Lake and form Beaver Brook which enters the Apple River at Amery.

PORTAGE.—Beaver are present, 40 having been taken in 1959.

PRICE.—In 1897 Capt. Wiken had two colonies of beavers at his lake; and a large colony was at work on the Jump River one and one-half miles north of Prentice (Prentice, 1897).

Beaver Creek, a small stream in the town of Catawba, flows SW into the North Fork of Jump River three miles SE of Catawaba; a second Beaver Creek, rising in Ashland County, flows S and enters Butternut Creek three miles SW of Butternut; a third stream of this name, town of Flambeau, flows into Price Lake seven miles W of Lugerville; Beaver Lake, three and one-half miles SE of Fifield; and Beaverdam Lake, five and one-half miles E of Fifield.

RACINE.—West (1903) stated that the remains of beaver dams were still quite common.

RICHLAND.—During the 1959 season, 50 beavers were trapped.

ROCK.—At one time there were beaver dams in the town of Harmony (Janesville, 1869). Remains of beaver dams and ponds were still visible in 1900 (Jackson, 1961).

RUSK.—This is one of the best beaver counties. The harvest in 1959 was 348 beavers.

ST. CROIX.—The dams built of alders and the canals dug by the beavers on Sand Creek, town of Emerald, were described by John E. Glover (Hudson, 1874). The present population is low.

Beaver Creek, town of Springfield, flows NE into Tiffany Creek at Downing.

SAUK.—Canfield (1890) came to Sauk County with a government surveying party in 1842. He wrote: "I have seen from five to ten dams, within a space of half a mile, upon some small spring branch, and have often noticed where they have dammed large streams. It would seem as though the whole country had once been alive with them." When the first settlers arrived in the town of Westfield there was a beaver dam, about 200 feet in length, one and one-half miles east of Loganville (Baraboo, 1921). Cole (1922) stated incorrectly that the beaver was exterminated about 1820; however, an occasional old dam existed. A beaver weighing 50 pounds was taken along the south branch of Honey Creek, Town of Franklin, by Edward Tabor in 1859 (Baraboo, 1859). W. A. Canfield had a section from a tree 27 inches in circumference supposedly cut by the same beaver. Parmalee (1960) identified 19 remains of beaver from the Durst rockshelter, section 12, town of Honey Creek.

Beaver Creek, a small stream, enters Dell Creek 5 miles SW of Delton.

SAWYER.—This county produced 706 beavers in 1959.

Beaver Creek, town of Weigor, flows into Little Weigor Creek 2 miles N of Weigor; a second Beaver Creek, town of Winter, flows SW, entering Thornapple River 8 miles SW of Draper; Beaver Lake, town of Round Lake, 6 miles S of Teal Lake.

SHAWANO.—Beaver Creek, town of Belle Plaine, flows SW into the Embarrass River five miles N of Embarrass.

SHEBOYGAN.—The original government survey recorded beaver dams in the towns of Plymouth and Sheboygan Falls. Charles D. Cole bought beaver and other furs from the Indians at Sheboygan (Buchen, 1944). At one time there was a large beaver dam on the farm of W. Kuhlmey, town of Plymouth (Plymouth, 1901). There were no beaver among the fur animals caught by the Indians about 1870 (Gerend, 1920).

TAYLOR.—A Mr. Hinman exhibited chips from a birch tree felled by beavers near the headwaters of Black River (Kilbourn, 1869). In the fall of 1876 a trapper caught eight beavers in the county (Plover, 1877). The take in 1959 was 451 beavers.

Beaver Creek, town of Ford, flows into Johns Creek four miles SW of Perkinstown.

TREMPEALEAU.—Beaver Creek was so named by James Reed and Willard Bunnell on account of the numerous beavers on the stream. A Menominee Indian is reported to have taken 50 beavers during a hunt on Trempealeau River. In September, 1843, W. Smothers caught a few beaver on Pigeon Creek, and T. A. Holmes some on Elk Creek (Bunnell, 1897:238). James Reed was famous as a beaver trapper. He came to Trempealeau in 1840 and died on the Little Tamarack in 1873. Much of his trapping was done on the Trempealeau River and its tributaries. Pierce (1915) relates that in 1863 Reed stopped at his home with his pony on which was a large pack of beaver pelts and traps. In January, 1859, Reed came into Osseo with 25 beaver pelts (Madison, 1859).

The spring of 1850 Antoine Grignon (1914) traded with the Sioux Indians who had trapped on the Trempealeau River and had collected a fine lot of beaver and other furs. Beavers were still quite plentiful on Beaver Creek in 1862. Cut trees, chiefly ash, were to be found throughout the length of the stream (Galesville, 1862).

A beaver was killed by Andrew Benson in the mill pond at Whitehall in November, 1878 (Whitehall, 1878). In the spring of the following year Albert Spaulding caught a large beaver in the Trempealeau River at Independence (Arcadia, 1879). Two beavers, weighing 52 and 62.5 pounds respectively, were caught by A. Lawrence in the spring of 1887. He trapped nine during the season (Merrillan, 1887). Though formerly so numerous in Beaver Valley, it was considered to be extinct in 1917 (Curtiss–Wedge, 1917).

Beaver Creek flows SE to join the Black River three miles south of Galesville. Both Beaver Creek and its South Fork rise in Jackson County.

VERNON.—Beaver Creek, town of Greenwood, flows N into the South Branch of the Baraboo two miles S of Hillsboro.

VILAS.—At his trading post at Lac du Flambeau, Malhiot (1910) obtained about 100 beaver pelts the winter of 1804–05. The Lac Vieux Desert region was "tolerably well provided" with beaver in 1840 (Cram, 1841).

Amik (Beaver) Lake, seven miles W by S of the village of Lac du Flambeau; Beaver Lake, town of St. Germain, four miles NE of Big St. Germain Lake; a second Beaver Lake, town of Boulder Junction, seven miles N by E of the village of Boulder Junction; and Beaver Creek, town of Phelps.

WALWORTH.—The beaver occurred formerly in the town of Sugar Creek and their dams were to be seen at the lakes in the town of Troy (Western Hist. Co., 1882). Their works were still discernible in 1900 (Jackson, 1961). Lapham (1852) was informed by solomon Juneau that the last beaver killed in southern Wisconsin was on Sugar Creek in 1819.

WASHBURN.—In the vicinity of Long Lake old beaver dams existed on dry land showing where streams had disappeared (McManus, 1919).

Beaver Lake, town of Bass Lake, four miles SE of Stansberry; Beaver Brook, town of Beaver Brook, flows NW into the Yellow River at Spooner.

WASHINGTON.—Warden R. J. Lake has written that about 1929 beavers were planted in Moon Lake, town of Fond du Lac County: "The animals multiplied, moved to Manitowoc County, the Sheboygan Marsh, built dams on all branches of the Milwaukee River. They moved into Washington County and built dams at the outlet of Smith Lake and Little Dricken in the town of Barton, blocked off the drainage ditch in the Rockfield Swamp in the town of Germantown as well as Cedar Creek in the Jackson Marsh." The beavers were eventually trapped out because of damage to property. None remained in 1956.

WAUKESHA.—Unonius (1950) came to Pine Lake in 1841. The beaver was still present, but "was beginning to migrate from his small but carefully constructed house." The beaver had disappeared at Waukesha, but his works were still to be seen when Silas Chapman (1890) arrived in 1841.

Beaver Lake, two miles N of Hartland.

WAUPACA.—Beaver Creek, town of Bear Creek, a small stream, flows W into Little Wolf River eleven miles SW of Clintonville.

WAUSHARA.—William H. Boose of Wild Rose, has written to me that remains of old dams can still be seen in the vicinity of this town, and that he had personally trapped eight beaver in the county. George J. Knudsen *(in litt.)* found the beaver rare in 1956.

WINNEBAGO.—In 1670 stags, bears and beaver were abundant in the country embracing the junction of the Wolf and Fox rivers (Allouez, 1899.1). At the Menominee Indian payment at Lake Poygan in 1847, the Indians had for trade many furs, including beaver (Watertown, 1847). According to Overton (1932) beavers were once abundant and their dams were still visible. Many beaver teeth had been found.

WOOD.—While digging a trench, J. Lavigne found a hand-made beaver trap twenty inches in length under six feet of sand (Grand Rapids, 1885). A total of 363 beavers was taken in 1959.

Beaver Creek flows S and enters Yellow River five miles S of Marshfield.

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ARISTOTLE-GENERAL SEMANTICIST? OR KORZRBSKI-ARISTOTELIAN?

*Kenneth D. Frandsen**

Since scholasticism corrupted the brilliance of classical scholarship, the ancients have been suspect and many have agreed that the early contributions should be seen but not heard. Attractively displayed in the academic market place, the products of this attitude are the offspring of what Alfred Korzybski called the "great scientific revolution."[1] One of these products is labeled General Semantics, and Korzybski's insistence on a clean break with what he called "Aristotelian Semantic Clutches"[2] is exemplary of the strongest form of that kind of revolutionism. But Korzybski's formulation of a non-Aristotelian system seems clearly an echo of Hamlet's reply to Polonius signaling a confusion of subject matter and cause for dispute. Whether there is sufficient *cause* for a new system and what is its *matter* are two esentially separate questions.

When recast and directed to the general semanticist, the questions are (1) What is Korzybski's rationale or justification for the term, "non-Aristotelian?" and (2) What does he offer that cannot be found in Aristotle? The answer to the first of these two questions can be found in Korzybski's introduction to the second edition of *Science and Sanity*. Consider that rationale briefly, observing its generally semantic and semantically general implications.

Asserting that the two-valued Aristotelian system could not deal adequately with the electro-collodial, sub-microscopic levels of the functioning of our nervous system, on which sanity depends, Korzybski concluded that the formulation of an infinite-valued, non-Aristotelian system was an imperative necessity.[3] Thus Korzybski announces his two fundamental premises: (1) The Aristotelian system *is* two-valued, and (2) Sanity or insanity can be, in the language of one branch of contemporary psychological theory, "reduced" to physiological explanations.[4] He observes that "applied"

*Mr. Frandsen is Assistant Professor of Speech at the University of Wisconsin–Milwaukee.

[1]Alfred Korzybski, *Science and Sanity*, 3rd. ed. (Lakeville, Connecticut: The International Non-Aristotelian Library Publishing Co., 1948), p. 86.

[2]*Ibid.*, p. 94.

[3]*Ibid.*, p. xxx ff.

[4]For an explanation of "Reductionism" in contemporary psychological theory, see George Mandler and William Kessen, *The Language of Psychology* (New York: John Wiley, 1962), pp. 260–268.

Aristotelianism promotes artificial and, therefore, harmful splits such as "mind" and "body" or "space" and "time."[5] Finally, he notes the similarity between the primary goals of the Aristotelian and non-Aristotelian systems—the formulation of a general method for science and for life. The presumed difference between the two systems rests with the departure from "two-valued" orientations to "general, infinite-valued, process orientations." The specific proposal accompanying this departure is the use of extensional devices —indexes, dates, quotation marks, hyphens, and etc.

In short, Korzybski's argument appears to be: (1) Modern science has demonstrated that we live in a much more complex world than was conceived of by our ancestors; (2) Because our (Aristotelian) language behavior and symbolic processes are not appropriate to the complexity of our world, our nervous systems are adversely affected, resulting in insanity; (3) When our nervous systems are affected in this manner, our language behavior and symbolic processes become even more inappropriate to our complex world; and (4) If we change our language and thought patterns—pretraining the children and retraining the disturbed—we can both prevent and cure certain mental disorders by correcting the improper activity of our nervous systems.[6] Admittedly, this is a simplified version of a multi-faceted theory of psycho-physio-logical therapy, but it will provide a convenient and comprehensible notion of Korzybski's reasons for proposing to formulate a non-Aristotelian system.

Reserving for the moment Korzybski's obvious alliance with the "reductionists" regarding physiological explanations of behavioral phenomena and recalling his premises concerning the characteristics of the Aristotelian system, consider the second question: What is there in Korzybski's system that renders it *non*-Aristotelian? To answer this, we should first determine what Korzybski means by the term, "System." His use of the word, system, carries at least two implications. It is a term for a set of "this-is-the-way-things-are-and-you-can't-prove-they're-not" statements, such as the negative premise concerning the non-identity of words and things and the assertions about what exists "inside our skins," and it is a term for a set of prescribed, symbolic antidotes for our apparent, linguistic maladies—extensional devices, consciousness of abstracting, etc.

System, as used by Korzybski, refers to a collection of observations and hypotheses about living, thinking, knowing, and talking. To be a non-Aristotelian system, then, it must go beyond or add

[5]Korzybski, pp. xxiii–xxxv.

[6]*Ibid.*, pp. xxix; 469–536 et passim.

something new and original to Aristotle's collection of observations and hypotheses about living, thinking, knowing, and talking.

On the surface, it might appear that a simple comparison of the two sets of observations and hypotheses would provide a useful answer to the question. Such an approach, however, provides only an incomplete understanding of the relationships between the two systems. A comparison of this sort would be vitiated by the fact that the documents which constitute the so-called "Aristotelian Corpus" are fragmentary, somewhat disorganized, often repetitious, sometimes internally inconsistent lecture notes which probably spent their first three hundred years in the worm infested, mouldy cellars of Asia Minor and Rome. Furthermore, the responsibility for integrating these documents into what was thought to be a unified and consistent body of doctrine, a "system," rests not with Aristotle himself but with the Greek, Syriac, Arabic, Jewish, and Latin–Christian phases of the whole "scholastic enterprise."[7]

Korzybski's itemized list of fifty-two "orientations," appearing in the introduction to the second edition of *Science and Sanity,* provides such a comparison.[8] Presented in tabular form, the two sets of observations and hypotheses are labeled "Aristotelian" and "New General Semantic Non-Aristotelian," and dated 350 B.C. and 1941, respectively. In view of the origin of the so-called Aristotelian system, this use of the extensional device known as dating is false-to-facts. The point is that Aristotelian system 1941 is *not* Aristotelian system 350 B.C. and either system could be called non-Aristotelian when compared with the other.

Rather than examine Korzybski's General Semantics to discover what makes it non-Aristotelian, it seems more appropriate to re-examine Aristotle's orientations to discover what they *are* and not what "scholasticism" has made them. In the course of one re-examination of this type, Randall clearly identifies in the fabric of Aristotelian thinking two central strands that place Aristotle squarely on the side of the general semanticists and in direct opposition to his scholastic editors. The first is his persistent concern for precise talking;[9] the second, his thoroughgoing philosophy of process which prompts Randall to call him the outstanding *functionalist* in the Western tradition.[10]

For Aristotle, what can be said about things is vastly different from the things themselves. This is the same principle that Korzybski illustrates in the map-territory analogy. Aristotle's treat-

[7]John Herman Randall, Jr., *Aristotle* (New York: Columbia University Press, 1960), pp. 22–31.
[8]Korzybski, pp. xxv–xxvii.
[9]Randall, pp. 34–58.
[10]*Ibid.,* pp. 65–67.

ment of entities *(ousiai)* as objects of rational discourse in Books Zeta[11] and Gamma[12] of the *Metaphysics* is consistent with the general semanticists' distaste for "identification behavior." But *ousiai* are also entities in process. It is this "process orientation" concerning the things we talk about that indicates Aristotle's point of view.

The Aristotelian process orientation is closely linked with functionalism, or the "organism-as-a-whole" orientation that permeates the works on biology. Chapter five of Book One in the work, *On the Parts of Animals,*[13] and the entire treatise, *On Life,* are particularly representative of this point of view. It is clear from these works that, for Aristotle, "Living organisms and their parts are to be understood in terms of how they act and operate *as a whole.*"[14] This facet of the Aristotelian system is far removed from the elementalism reflected in the scholastic interpretations.

Obviously, there are clear parallels between the central strands of Aristotelian and General Semantic thinking. Because of these parallels, the use of the term, "non-Aristotelian," is not only meaningless but unnecessary. The abuse of the Aristotelian system and the heralding of a non-Aristotelian system might be defended on the basis of the superficial distinction between Aristotle's operational behaviorism and Korzybski's physiological reductionism. However, the significant fact is that Korzybski's system is probably more Aristotelian than the system or systems he criticized. Korzybski attacked the "Platonic left-overs" as manifested through scholasticism and not the mature nor the whole Aristotle. Aristotle provides a system that, as Jaeger so conclusively demonstrates, "remains provisional and open in every direction."[15] Korzybski's contribution consists of concrete suggestions for talking-living which are neither "anti" nor "non" Aristotelian but flow naturally from the results of Aristotelian inquiry.

[11]Ch. 3. 1029a 27, 28.

[12]Ch. 4: 1006b 6–10.

[13]See *De Partibus Animalium* I, Ch. 5: 645b 15–20.

[14]Randall, p. 235 (italics mine.)

[15]Werner Jaeger, *Aristotle: Fundamentals of the History of His Development,* trans. Richard Robinson, 2nd ed. (London: Oxford University Press, 1948), p. 374. Cf. Martin Gardner, "General Semantics" in *Fads and Fallacies in the Name of Science* (New York: George P. Putnam & Sons, 1952).

TWO RARE INCUNABULA IN MILWAUKEE

*Alan D. Corré**

Alverno College in Milwaukee owns two rare incunabula which apparently have not previously been noticed outside the walls of the College, since they are not included in Stillwell's 1940 census of American incunabula.

The first is an edition of the works of Horace with a commentary: *Christophori Landini Florentini in qu. Horatii Flacci libros omnes ad illvstrissimvm Gvidonem Feltrivm magni Federici dvcis filivm interpretiones*. It was printed in 1486 at Venice by Bernadinus, and contains 178 numbered leaves.

The text is printed 20 lines to 110 mm., and the commentary 20 lines to 80 mm. There are 57 lines to a page. The work is bound in boards with clasps. The bottoms of the first and last few pages are worm-eaten.

The colophon reads: Imp̄ssū Uenetiis p māgistrū Bernadinu de tridino ex mōteferrato Anno salutis. M.cccc.lxxxvi || a b c d e f g h i k l m n o p q r s t u x y. Vna q q lra de andictis p qternum unum se extendit dempta y. que qnternū signat.

The book is inscribed at the beginning: Rev. A. Michels, St. Joseph–Convent, Greenfield Park Milwaukee Wisc. South Seid (sic) Office.

I am informed that Father Michels was chaplain to the School Sisters of St. Francis in Milwaukee, who operate Alverno College. He apparently used to purchase books on his trips to Europe, and on his death they were added to the College library.

The last page bears a very faint Latin inscription in ink, including the date 1507 in medieval numerals.

Pieces of a parchment manuscript, apparently liturgical in nature, were used in the binding of the book. Only parts are visible, but phrases such as *Deus qui dedisti legem moysi in sumitate montis synai et in eadem loco paratos.* . are clearly readable. The blue and red inks used are not faded.

On the basis of the above details, we may identify this text with no. 8884 in Ludwig Hain's *Repertorium Bibliographicum* and H386 in Stillwell's 1940 census. According to Stillwell, only Harvard,

*The author is Associate Professor and Chairman, Department of Hebrew Studies, University of Wisconsin–Milwaukee.

Princeton and the Library of Congress, among libraries in the U.S. possess copies, and as of 1940 there were five more copies in private hands.

The other incunabulum, scarcely less rare, is the 1493 edition of Augustine's *Epistolae,* printed at Basel by Johannes Amerbach: *Liber Epistolarum beati Augustini episcopi hipponensis ecclesiae.* The pages are not numbered. The book consists of 4 blank pages / 394 leaves / 32 leaves of an *annotatio* / 4 blank pages.

The text is printed 20 lines to 85 mm. There are 52 lines to a page. The work is bound in boards (some leather remains) with clasps.

The colophon, which occurs before the *annotatio,* reads: Diui Aurelij Augustini Hipponēsis epi: Liber eplar: uigilanti accuratissimoq stu- || dio' emēdatar & impressar: Argumētorū quoq nouor praenotatiōe succincte & di- || lucide expositar: atq opa magestri Iohānis de Amerbach civis Basilien. pfectar: An- || no dni &c. xciij. Foelicita explicit.

The work was apparently closely studied as there are frequent Latin marginal notes in ink.

The title page is inscribed: Bibliotheca conventis S. Lucij Frum Minorum. . prope Heckingam. There are some other faint provenance notes.

This volume may be idenfified with Hain 1969 and Stillwell A 1127. These copies have been reported to the Bibliographical society, and will be listed in the forthcoming new census of incunabula in the U.S.

ICE-WEDGE CASTS OF WISCONSIN

*Robert F. Black**

Introduction

Ice-wedge casts are the fillings of sand or other material that replace former ice wedges. Ice wedges grow only in perennially frozen ground subjected to marked seasonal temperature changes and where atmospheric humidity is high enough to transfer moisture from the air and snow cover to open contraction cracks in the ground (Leffingwell, 1919; Black, 1952b, 1954 and 1963; Lachenbruch, 1962; Black and Berg, 1963 and 1964). Thus, true ice-wedge casts are diagnostic of permafrost and of cold humid climates. Many ice-wedge casts are easily confused with sand wedges (Péwé, 1959) which grow in cold arid climates or with casts of composite wedges (Black and Berg, 1964) that commonly represent humidities intermediate between those which produce sand wedges and ice wedges. Seasonal frost wedges (Black, 1952b) and solution phenomena (Yehle, 1954) are also easily confused with true ice-wedge casts, but obviously connote markedly different climates and ground conditions.

No criteria are known to distinguish true ice-wedge casts from all other features with 100 percent reliability. Nonetheless, comparison of detailed features of a group of wedge-shaped casts in polygonal pattern with those of sand-wedge or ice-wedge polygons in polar areas permits their correlation. Once seasonal frost and solution phenomena have been eliminated as possible origins, distinction between former sand wedges and ice wedges is based on the fabric of the fillings left behind. As sand wedges grow in increments annually of no more than a few millimeters in width, the criss-crossing bands or layers of sand oriented vertically are generally still retained. In contrast as ice wedges melt or sublimate away, material adjacent and overlying them is dropped into the void vacated. Such filling commonly goes mostly or completely across the width of the wedges and stratification tends to develop horizontally on top of the ice. As lowering of the ice surface con-

*The author is Professor of Geology, University of Wisconsin–Madison. Field work leading to this paper was supported in part by National Science Foundation Grant GP–2820, in part by the Research Committee of the Graduate School from funds supplied by the Wisconsin Alumni Research Foundation, and in part by the Wisconsin State Highway Commission. Printing costs in part were defrayed by the University of Wisconsin Geological and Natural History Survey.

tinues, continued slumping and infilling leave a jumbled heterogeneous deposit of the adjacent walls and overlying material that has distinctive fabric. However, when the overlying material is well-sorted sand, as in dunes, the filling has little fabric and is easily confused with normal sand wedges. Most of the casts of Wisconsin are of such type, but large inclusions of the walls and overlying material in many casts attest to former large voids. Most casts are, hence, believed to be true ice-wedge casts.

Since the fall of 1956, the writer has examined 20 localities containing ice-wedge casts and 2 other known localities are recorded here for completeness (fig. 1) (table 1). All are in

FIGURE 1. Index map of Wisconsin, showing localities with ice-wedge casts by numbers and generalized distribution of late-Wisconsinan drifts.

TABLE 1: LOCALITIES WITH ICE-WEDGE CASTS

1. St. Croix County, New Richmond quadrangle, SE ¼, SE ¼, sec. 4, T29N, R18W; excavation for military construction in till and kame.
2. St. Croix County, River Falls quadrangle, SW ¼, SW ¼, sec. 36, T28N, R19W; borrow pit in kame.
3. Pierce County, Arkansas quadrangle, NE ¼, NE ¼, sec. 30, T26N, R15W; road cut in till.
4. Barron County, Barron quadrangle, SW ¼, NE ¼, sec. 4, T33N, R12W; borrow pit in Cambrian sandstone.
5. Dunn County, Menomonie quadrangle, NE ¼, SW¼, sec. 15, T28N, R13W; road cut in lacustrine sediments.
6. Dunn County, Menomonie quadrangle, NW ¼, NW ¼, sec. 12, T27N, R12W; road cut in Cambrian sandstone.
7. Chippewa and Eau Claire Counties, Elk Mound quadrangle, SE¼, SW¼, sec. 36, T28N, R10W and NE ¼, NW ¼, sec. 1, T27N, R10W; road cut in kame and till.
8. Eau Claire County, Elk Mound quadrangle, SE¼, SE ¼, sec. 17, T27N, R10W; road cut in Cambrian sandstone.
9. Eau Claire County, Elk Mound quadrangle, SW ¼, SE ¼, sec. 16, T27N, R10W; road cut in till.
10. Eau Claire County, Osseo quadrangle, NE ¼, SW ¼, sec. 24, T25N, R7W; borrow pit in outwash.
11. Clark County, Fairchild quadrangle, NE ¼, NE ¼, sec. 4, T24N, R4W; road cut in kame.
12. Clark County, Fairchild quadrangle, NW ¼, NE ¼, sec. 10, T24N, R4W; borrow pit in kame.
13. Jackson County, Hatfield quadrangle, NE ¼, NW ¼, sec. 12, T22N, R3W; borrow pit in outwash.
14. Monroe County, Tomah quadrangle, NE ¼, NW ¼, sec. 7, T17N, R1W; borrow pit in chert rubble and Cambrian sandstone.
15. Portage County, Amherst quadrangle, SW ¼, SE ¼, sec. 7, T22N, R9E; borrow pit in till.
16. Outagamie County, New London quadrangle, SW ¼, SW ¼, sec. 31, T22N, R15E; road cut in till.
17. Columbia County, Portage quadrangle, NE ¼, NE ¼, sec. 33, T13N, R9E, borrow pit in till.
18. Richland County, Muscoda quadrangle, NW ¼, SE ¼, sec. 33, T9N, R1W; borrow pit in outwash.
19. Dane County, Cross Plains quadrangle, SW ¼, SE ¼, sec. 28, T7N, R7E; road cut in loess and Ordovician dolomite.
20. Rock County, Evansville quadrangle, SE ¼, NW ¼, sec. 18, T4N, R10E; borrow pit in kame.
21. Green County, Brodhead quadrangle, NW ¼, NW ¼, sec. 32, T3N, R9E; borrow pit in kame.
22. Green County, Monroe quadrangle, NW ¼, NW ¼, sec. 15, T3N, R7E; road cut in Ordovician shale and sandstone.

Paleozoic bedrock or in glacial drift dating from the Rockian advance of about 29,000 to 32,000 years ago to that of Cary age, perhaps 12,500–16,000 years ago. As of 1965, all but two localities (16 and 17) were confined to the area of pre-Cary drift of southwest Wisconsin—the northern and eastern counties were singularly free of such features. Brief mention of one locality, the first discovered (fig. 1, locality 2), was published early in this investigation (Black, 1957); information on it and 15 other localities was summarized in a report to the VIth International Congress on the Quaternary in Warsaw, Poland, 1961 (Black 1964). As that report is not widely available in Wisconsin and few details were included, those sites are again reviewed here with the newer ones.

This paper attempts to summarize the available information on the ice wedge casts of the state, and on the time and conditions of their formation. Hopefully, this information will spur others into looking more closely at exposures of unconsolidated materials and of bedrock for such features.

Just why such casts were not recognized earlier is not known. Former times of increased frost action and mass movements in the "Driftless area" of southwest Wisconsin have been recognized for decades, although the first review of periglacial or cold-climate phenomena did not appear until fairly recently (Smith, 1949). Smith discussed the products of frost weathering, solifluction, and frost heave which produced block streams, block fields, rubble zones, and talus. Up to that time no casts of ice wedges were recognized in the state. None of the features reviewed by Smith is diagnostic of permafrost conditions, yet permafrost features were recognized to the south in Illinois (Sharp, 1942; Horberg, 1949). There it is thought that sporadic permafrost existed briefly in a relatively narrow zone marginal to the Wisconsinan-age glaciers as evidenced by involutions and ice-wedge casts (Frye and Willman, 1958).

It is now clear that permafrost has existed in Wisconsin, and buried glacial ice survived perhaps 18,000 years in southern Wisconsin and even longer in northern Wisconsin—from the Rockian advance of about 29,000 to 32,000 years ago to Two Creeks time (11,000–12,500 years ago) in southern Wisconsin and until post-Valders time (perhaps 9,000 years ago) in northern Wisconsin (Black, 1964). The available casts indicate ice wedges that required only a fraction of that time to grow, and details of the events and climate of that long interval still remain shrouded in mystery.

Ice-Wedge Casts

Ice-wedge casts are most abundant in west-central Wisconsin and are rarer in south-central Wisconsin. Most casts are in stratified deposits of sand and gravel and in sandy till; none is in truly fine-grained silts normally considered most susceptible to "frost action". The casts are in sandy gravel kames (localities 1, 2, 7, 11, 12, 20 and 21) (fig. 1), in gravelly sand outwash (localities 10, 13, and 18), in sandy till (localities 1, 3, 7, 9, 15, 16, and 17), in rhythmically banded lake clay-silt-sand (locality 5), and in thin bedded rock (localities 4, 6, 8, 14, and 22 in sandstone and 19 in dolomite). More than 200 casts are known; 45 were mapped at one time in locality 2, and additional casts were exposed there as excavation proceeded. Casts were best displayed or were most numerous in localities 2, 4, 7, 10, 13, 14, 15, 16, 17, and 21.

With the exception of localities 19 and 22, all casts are composed of clean, yellowish well-sorted glacial sand in marked contrast in color and texture to the host material; at localities 19 and 22 the filling is loess and colluvium or till. The coarser sand fractions are generally well-rounded to sub-rounded grains of quartz with 10–40 percent of igneous and metamorphic rock and mineral fragments. The finer fractions are generally angular to subrounded grains of quartz with appreciable other minerals as well —typical glacial suites. Frosting of intermediate-sized quartz grains is common. In most instances wind seems responsible for transporting the sand considerable distance to its present resting place.

Most casts are 0.5–2.0 m high in vertical exposures and 0.2–2.0 m wide (normal to the strike of the wedge). The largest casts are 2–3 m wide; the highest 3–3.7 m. In all but localities 5, 6, and 22 the casts occur in groups where a wide range of sizes is observed. The strike of the casts is such that in localities 1, 2, 4, 7, 10, 13, 15, 16, 17, and 21 primary polygons 5–20 m in diameter in plan are outlined by wedges 0.4–2.0 m wide and 1.0–2.5 m high. Secondary polygons 2–5 m in diameter also were seen at localities 2, 7, and 15, outlined by casts of wedges 0.1–0.4 m wide and 0.3–2.0 m high. Excavations at localities 2, 15 and 16 demonstrated that true polygons in plan actually exist. The tops of all wedges (except possibly some of those of locality 16) are truncated by mass movements, and it is not known how large they might have been. No large amounts of the sand typical of the fillings were observed in any of the nearby colluvium, but comparison of casts in locality 16 with others suggests that one-quarter to one-half the original height and width have been removed.

Individual locations where ice-wedge casts have been found are outlined below. All widths cited are maximum measured normal to strike of wedges, not oblique widths showing in many excavations. Heights are true vertical measurements regardless of inclination of casts. Thus, they represent the depth of penetration and not the length of material penetrated. Isolated casts and typical examples of wedges in groups were excavated or augered into the walls to demonstrate their horizontal continuity. Colors are those of the Munsell Soil Color Chart, taken dry unless otherwise indicated. The National Research Council Grade Scale (1947) is used for textural classifications in the sand range. Those sizes in millimeters are:

Gravel	>	2.0	–
Very coarse sand		2.0	– 1.0
Coarse sand		1.0	– 0.5
Medium sand		0.5	– 0.25
Fine sand		0.25	– 0.125
Very fine sand		0.125	– 0.0625
Silt and clay	<	0.0625	–

Descriptions are more complete for the smaller numbered localities than for the higher numbered to avoid undue repetition. Differences are emphasized. Generally detailed descriptions of individual wedges and of samples of fillings are not attempted. At many sites casts are in host materials with stratification that is cut and upturned adjacent to the casts as from pressure effects within the former wedges. Only the striking examples are cited.

Locality Descriptions

Locality 1, St. Croix County

Thomas E. Berg discovered casts of six ice wedges in an artificial excavation about seven miles south-southwest of New Richmond. The writer examined them on August 13, 1958. The smallest cast was 10 cm wide and the largest 50 cm; the shortest was 50 cm high and the tallest 130 cm. Outlines of the cross sections of the wedges are shown in figure 2. The tops of all were cut off by mass movement of the surface soil and by plowing on a slope of 7° to the south. The casts were spaced regularly around the periphery of a semi-circular pit, at intervals of 2.3 to 2.9 m. The reddish yellow (5YR–7/6 to 7.5YR–6/6) well-sorted fine- to medium-grained sand stood out in marked contrast to the light reddish brown (5YR–6/4) poorly-sorted till and kame sand and gravel (5YR–5/4 and 6/4 to 5/6). See figure 3 for textural analyses of the wedge fillings (A, B, and C represent casts 1, 3, and 6 respectively) and host materials (D represents till or sandy col-

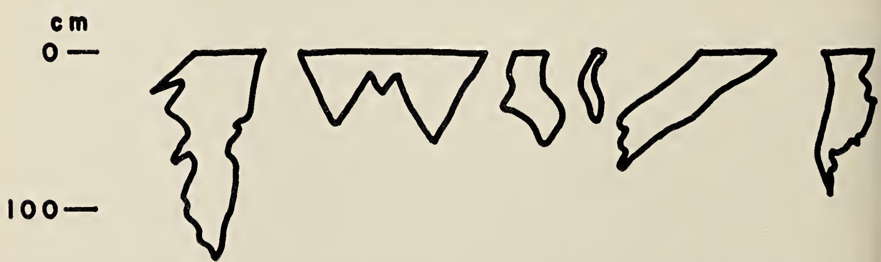

Figure 2. Cross sections of ice-wedge casts, Locality 1, St. Croix County.

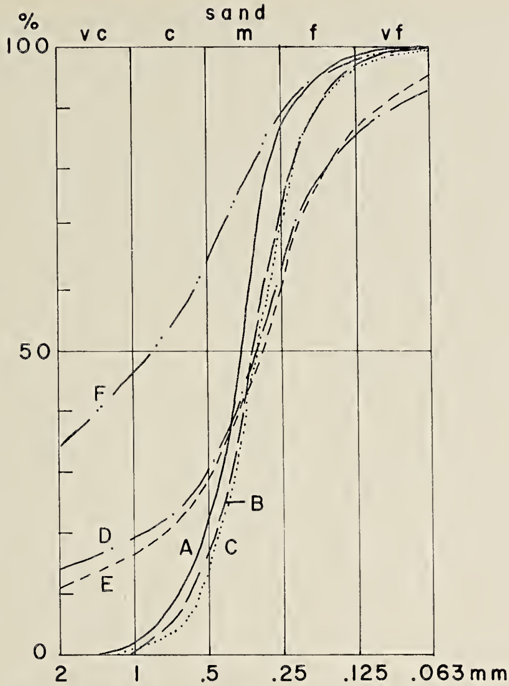

FIGURE 3. Size-grade analyses of some samples from Locality 1, St. Croix County.

luvium and E and F represent sand and gravel in the kame). The general section consists of:

1 m reddish brown gravelly sand and sandy till or colluvium,
65 cm gravel with pebbles up to 10 cm in diameter,
30 cm reddish brown sand from very fine- to coarse-grained,
30 cm gravel to bottom of excavation.

Stratification of the kame was upturned along the casts. Occasional blocks of dolomite and boulders of igneous rocks as large as 1 m in diameter are found on the surface and through the kame. A concentration of 2–3 percent of magnetite and 5–10 percent of igneous minerals other than quartz characterizes the silt and very-fine sand sizes of the wedge fillings and kame sand. Greater rounding and high quartz content characterize the median sizes in contrast to the greater angularity of the quartz in the silt and very fine sand sizes and the high igneous content in both the smaller and larger sizes.

The well-sorted and markedly frosted sand in the casts suggests emplecement by wind action. No suggestion of a source other than the local till and kame sand which it resembles in composition and degree of alteration was seen. As the deposit is on top of the highest hill for many kilometers in all directions, no source can be imagined for lacustrine sand other than that in a lake contained entirely by decaying ice.

Inclusions of till and clumps of coarse sand 2 to 3 cm across and irregular borders of the casts indicate slumping of the sides into a fairly large void—larger than the contraction cracks characteristic of sand-wedge formation. No trace of cracks outside the casts was seen. The implication is that these were ice wedges that were replaced by eolian sand.

Locality 2, St. Croix County

On February 6, 1957, the writer discovered numerous ice-wedge casts in a borrow pit at the junction of county roads M and MM, at River Falls. This locality contained the best-developed network of ice-wedge casts and has been the best exposed of any seen in the state. Figure 4 is a sketch in plan showing strike and width of the casts seen in 1957, and figure 5 shows typical cross sections of the casts. Fillings consist of clean, yellowish red or reddish yellow (5YR–5/6 or 6/6 to 6/8) medium-grained sand in

FIGURE 4. Plan view of ice-wedge casts along edge of borrow pit, Locality 2, St. Croix County, showing strike and width of the casts and strike and dip of the stratification.

marked contrast in color (figs. 6 and 7) and in texture (fig. 8) to enclosing reddish brown (5YR–4/4 to 3/4) poorly-sorted, dirty, gravelly sand kame deposits.

On June 28, 1957, when the pit was mapped (fig. 4), the south and east sides of the pit, about 100 m long, revealed 45 ice wedge casts. Wedges in primary polygons 5–10 m in diameter (fig. 4) were 0.4–1.2 m wide and 1.0–2.0 m high; wedges in secondary polygons 2–4 m in diameter were 0.1–0.4 m wide and 0.3–1.7 m high. Upturned bedding from pressure effects during growth of ice in the wedges was plainly visible adjacent to many casts. Colluvium was slumped into the top of several casts. The tops of all casts have been truncated by mass movement and deflation or by current action in a short-lived lake; a prominent stone layer crosses their tops. Loess up to 50 cm thick now covers the stone layer in which ventifacts are common. The borrow pit was worked sporadically after June, 1957, and the original group of casts was removed. Numerous additional casts have been exposed from time to time in plan and in section during stripping and as borrow from the excavation was removed. They showed features similar to the ones described, but slump of side walls and of large masses of overlying material into former large voids was particularly clear.

Size-grade analyses of 13 samples (not in fig. 8) of sand from the casts are shown in Table 2 as averages of individual sizes and

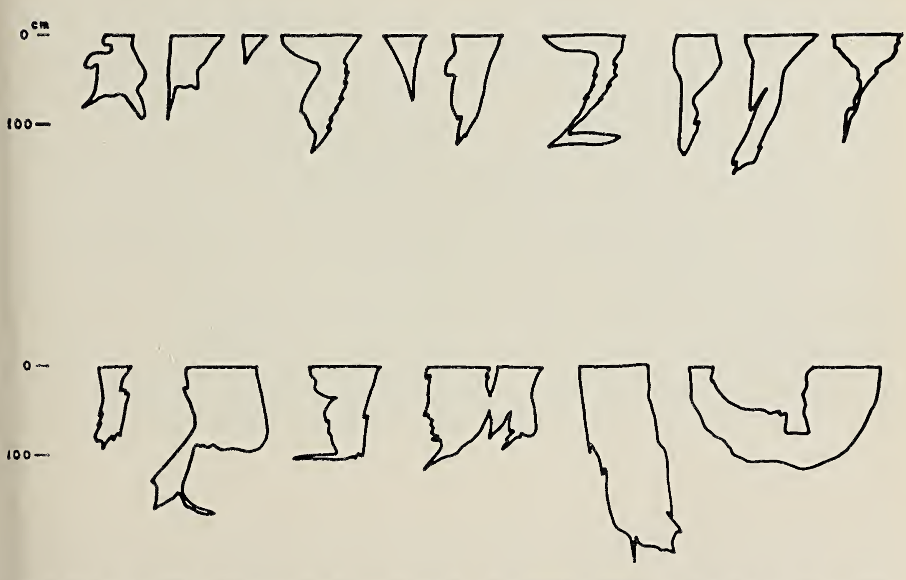

FIGURE 5. Cross sections of some typical ice-wedge casts, Locality 2, St. Croix County.

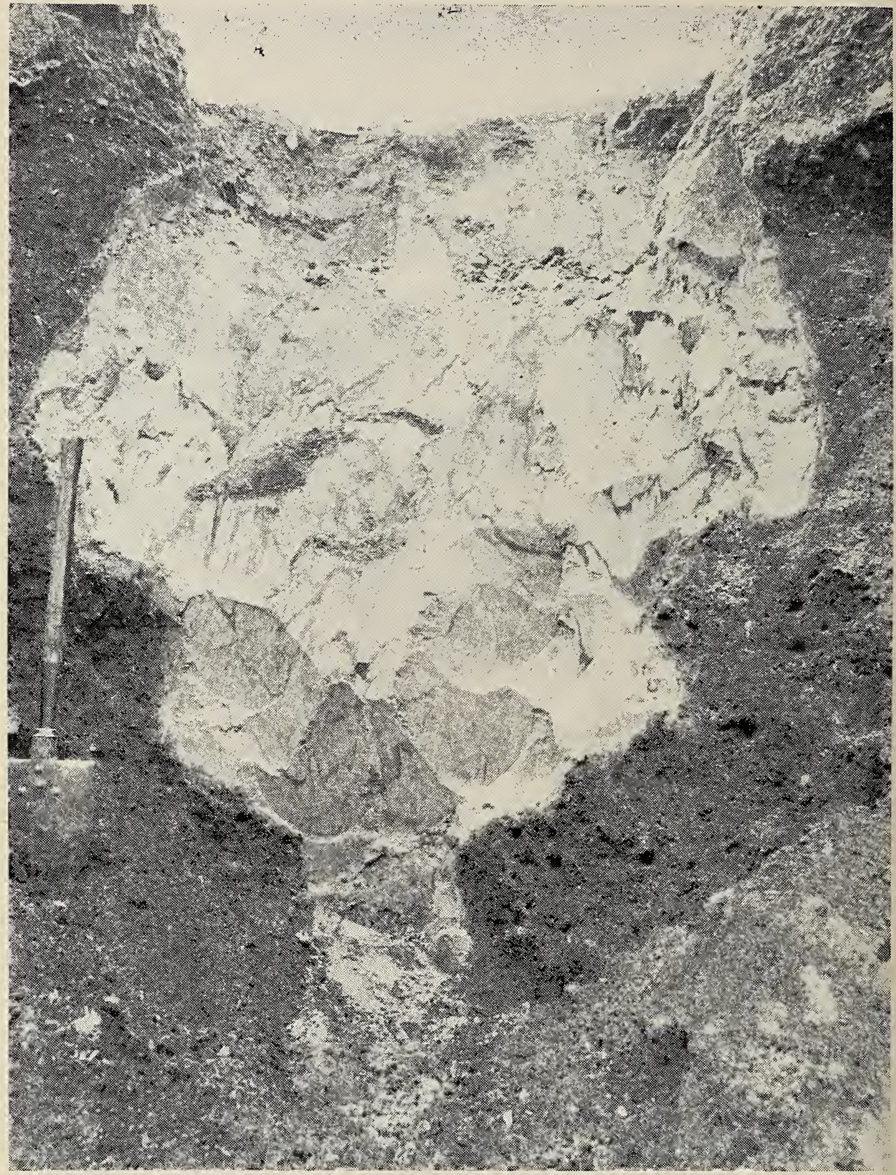

FIGURE 6. Typical large ice-wedge cast, Locality 2, St. Croix County. Shovel is 28 inches long.

as a range of individual sizes. Moreover, the small-size fractions of two samples of the host material are also shown. These data indicate the well-sorted nature of the sand filling which has a median size in the medium-sand range, and which on the

FIGURE 7. Ice-wedge cast with horizontal extension of the base, Locality 2, St. Croix County. Pick handle is 15 inches long.

average is symmetrically distributed around the median. In contrast the same size fractions of the host material are markedly skewed to the coarser sizes.

Binocular microscope examination of individual fractions of the samples from the casts shows that rounding of individual grains is greater in the medium-sand size and decreases toward fine and coarse fractions; more angular grains and more angularity of subround grains are noted at the extremes. Quartz dominates all sizes, on the average, but in some samples igneous rock fragments,

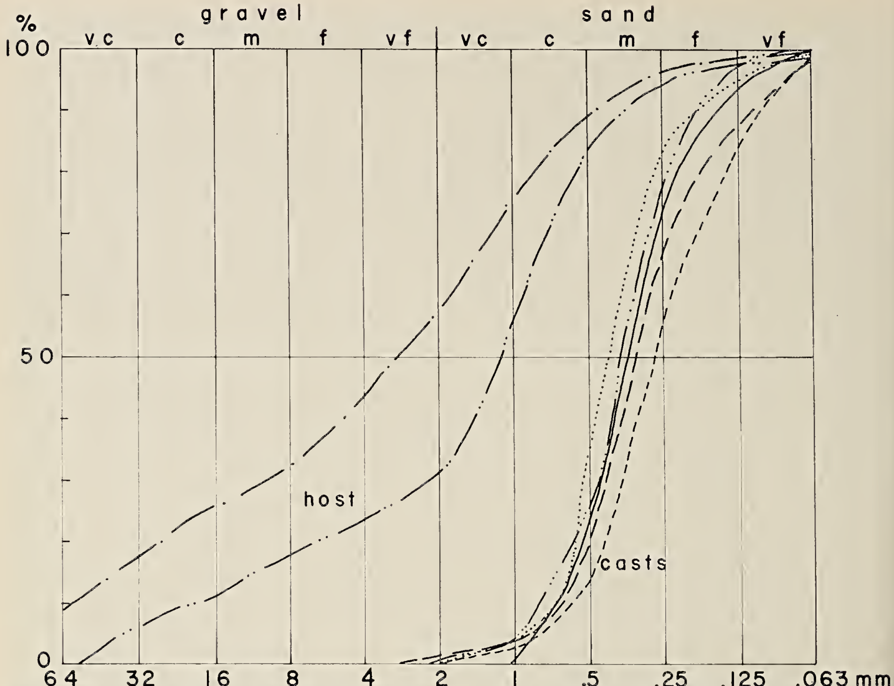

FIGURE 8. Size-grade analyses of some samples from Locality 2, St. Croix County.

quartzite, and siliceous metamorphic rock fragments make up all or most of the very fine gravel size. Various heavy minerals constitute an estimated 5–15 percent of the silt and clay and are 2–8 percent of the very fine sand. In contrast the same sizes from the host material contain less than 1–2 percent of heavy minerals.

TABLE 2

Sizes mm		Average of 13 Samples from Casts Percent	Range of Individual Samples from Casts Percent	Sand Portion of Host Percent	
2–4	v f gr.	0.8	0– 4.3	33.8	14.6
1–2	v c sand	2.1	0.1– 5.7	29.5	31.8
.5–1	c sand	20.4	9.5–32.8	20.4	34.6
.25–.5	m sand	50.3	38.6–60.5	11.2	12.9
.125–.25	f sand	20.6	10.8–29.9	2.4	3.0
.0625–.125	v f sand	4.3	1.0–13.5	1.4	1.5
<.0625	silt and clay	1.0	0.2– 4.3	1.4	1.7
		99.5		100.1	100.1

Rounding of grains in the host material is similar per size fraction to that in the casts. Igneous rock fragments in the coarser sizes make up an estimated 5–10 percent of the total. Iron and clay skins are common in the host material; iron staining in irregular bands or layers and some development of clay skins are present in the casts. All material is oxidized; dolomite fragments are rare in the coarser gravel and blocks of the host and absent in the fines.

The fine- to coarse-grained quartz sand is very similar in size, degree of rounding and frosting to the sand making up the St. Peter formation of Ordovician age which underlies the kame and crops out to the west of the kame. However, the igneous and metamorphic rock fragments and heavy mineral suite of the casts are markedly different from constituents in the St. Peter. The St. Peter formation has less iron and clay skins in this locality and is generally very pale brown (10YR–7/3).

In the casts of some wedges distribution curves of samples from the lower part of the cast, when compared with curves from samples from the upper part of the same cast, show a variation in skewness that is not explained. In most such pairs of samples, the lower samples are skewed to the coarser fraction whereas the upper samples are skewed to the finer fraction. This was not universally true and insufficient samples are available to pursue the matter further.

Whether destruction of the wedges took place beneath a shallow lake, as was postulated earlier (Black, 1957), and fillings came from the lacustrine sediments are still difficult to prove. The existence of the former lake seems clearly established from beach features and other deposits 10–15 feet above the level of the casts. However, similarity of the fillings with those of other localities believed to be due to wind work leaves one in doubt. Moreover, strong wind action is indicated by ventifacts in the stone layer which has slumped into some casts. The timing of wind work versus water work is also yet to be established.

Locality 3, Pierce County

On May 20, 1958, Aleksis Dreimanis (personal communication) saw three wedge-shape casts of sand in buff till near the break of the slope overlooking Plum Creek, one mile southeast of Waverly. He interpreted them as ice-wedge casts. The writer has not seen them, and details are lacking.

Locality 4, Barron County

On May 17, 1964, the writer examined four casts of former ice wedges cutting sandstone bedrock in a borrow pit 1.7 miles south of Barron, on Highway 25. This locality was recognized by John Foss, State College, River Falls. One cast was 3.1 m high and 60 cm wide; another was 1.4 m high and 85 cm wide (fig. 9). The other two were smaller. Curvature of the walls of the pit and the strike of the casts suggest that the larger pair initially joined as one wedge as also did the smaller pair. In the tallest cast 1.2 m of the lower part was filled largely with broken fragments of sandstone from the walls of the cast; the upper 1.9 m was filled with well-sorted reddish brown (5YR–5/4) sand of which 94 percent in the sample is fine- to coarse-grained; median size is 0.36 mm.

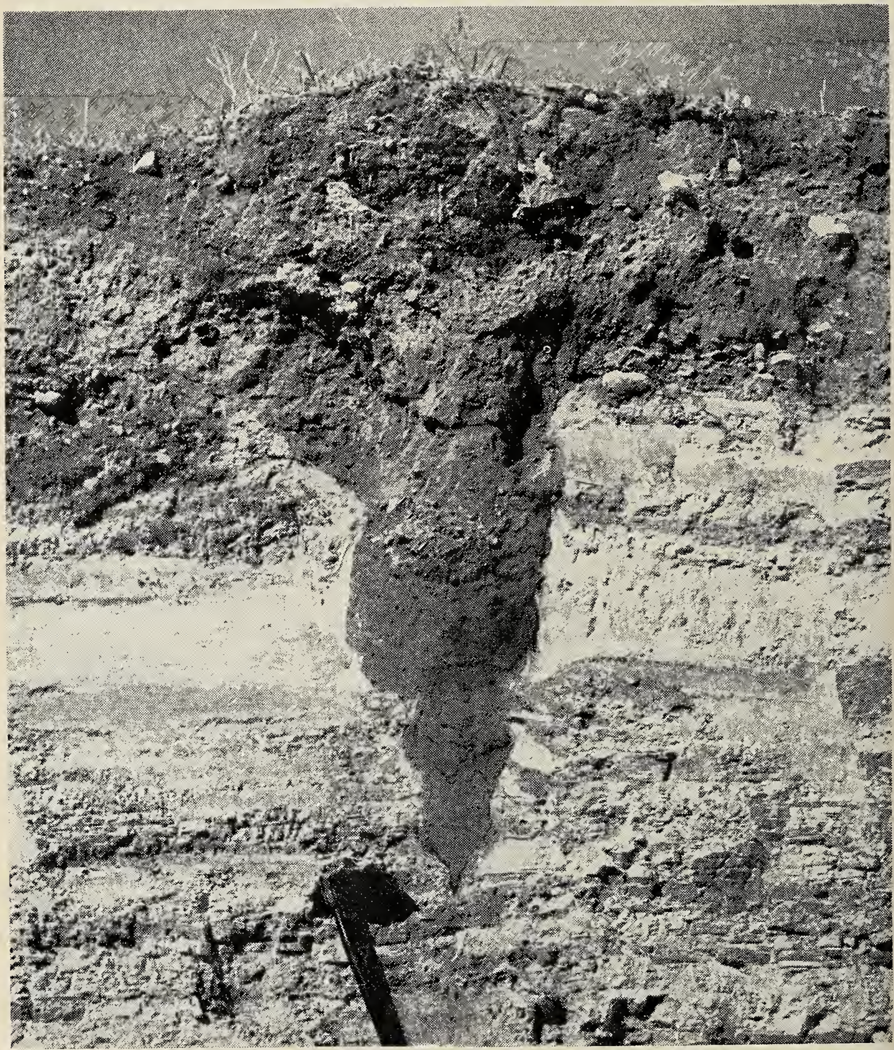

FIGURE 9. Ice-wedge cast penetrating Cambrian sandstone, Locality 4, Barron County. Folded shovel is 21 inches long.

Silt and clay make up only 2.1 percent. Occasional pebbles up to 1 cm are scattered throughout the cast. Although frosted quartz predominates, many varieties of igneous and metamorphic rocks and minerals are present in a typically glacial suite. Iron oxide and clay coatings are weakly developed, and mafic minerals are little weathered. Fillings of the other wedges are essentially identical, except that the upper part of the fillings consists of gravelly-sandy till or colluvium that has slumped *en masse* into the upper 30–40 cm. The till exposed in the pit contains boulders to 2 m of ventifacted Duluth gabbro; Lake Superior sandstone, red felsite, granite and many other rocks are present. Quartz grains of the size filling the wedges are not frosted but otherwise similar. Quartz in local Cambrian sandstone is finer grained, unfrosted, and more angular than the sand in the casts, and because of paucity of other minerals and rocks cannot have provided a significant source of the filling. The sandstone is white (10YR–8/2) and various shades of yellow and brown. Presumably wind played a significant role in frosting quartz grains, in sorting of sizes, and in emplacing them in the casts.

Locality 5, Dunn County

On March 28, 1959, the writer saw one coarse-sand cast of a supposed ice wedge in rhythmically banded, lacustrine clay-silt-sand exposed in a road bank of Interstate Highway 94, 2 miles north-northwest of Menomonie. The cast was 15 cm wide and 2.3 m high. The coarse-grained sand filling contained a typical glacial suite of minerals and was distinctly coarser than the enclosing lacustrine sediments. As the ground was still frozen at the time of visit, the cast could only be traced into the bank about 20 cm. The cast bisected the top of a small erosional knoll carved out of the lake sediments by streams established immediately after the draining of the lake. The well-bedded lake sediments were upturned adjacent to the cast.

Locality 6, Dunn County

On March 28, 1959, 6 miles east-southeast of Menomonie, the writer saw one fine- to medium-grained glacial sand cast 1.9 m wide and exposed vertically 1.3 m; the base was buried beneath frozen talus in Cambrian sandstone. The glacial sand is distinctly different in its mineral suite from that of the essentially quartz sandstone. No such glacial sand was seen in the vicinity. The cast was at the apex of a hill, but because of the frozen ground could not be traced horizontally.

Locality 7, Chippewa and Eau Claire Counties

Two miles west of Eau Claire, on the County Line Road, 0.4 mile east of Co. T, Thomas E. Berg recognized ice-wedge casts which the writer mapped and described on July 18, 1959. Outlines of 17 casts are shown in figure 10. The largest was 220 cm high and 110 cm wide; the tops of all casts were cut off at the base of a pronounced stone line which is multiple and inclined 10–12 degrees on the flanks of the knoll. The surface is covered with 40-80 cm of loess.

The casts of clean reddish yellow (commonly 5YR–6/6) well-sorted sand are in marked contrast with the gravelly sand kame and till (commonly yellowish red, 5YR–4/6 to 4/8). Sand in the casts has a median size of 0.2 to 0.3 mm whereas that of the host is 0.6 to 0.8 mm. Typical sorting is shown in figure 11. The coarser sand fraction of the casts has many frosted round to sub-round grains of quartz, but only rarely were similar grains seen in the host. Most grains in the host are commonly sub-rounded to angular. A large variety of rocks and minerals, typical of glacial suites, is present in both host and casts. The very fine sand size of the casts commonly has several percent of heavy minerals. Iron oxide and clay skins are much more abundant in the host than in the casts, but weathering of mafic minerals and rocks is highly variable from fragment to fragment.

Extended trends of wedges show they form primary polygons 5–8 m across and some secondary polygons 3–4 m across. Stratification in the kame is commonly upturned along the sides of the casts.

In August, 1965, numerous ice-wedge casts were seen about two miles northeastward, in the banks of the north-trending road in the center of Section 30, Township 28 North, Range 9 West. These have not been studied in detail but appeared very similar to the other casts at locality 7 just described.

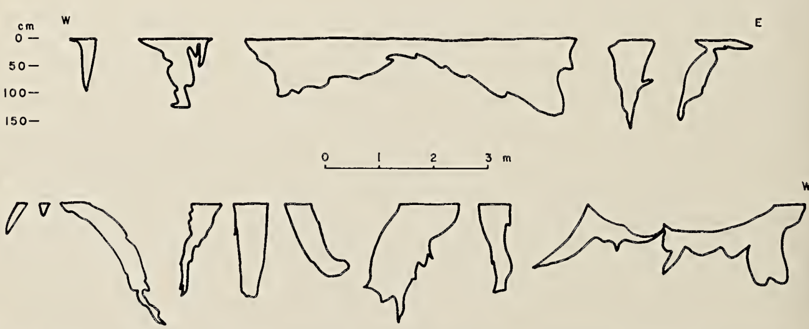

FIGURE 10. Cross sections of some ice-wedge casts, Locality 7, Chippewa and Eau Claire Counties.

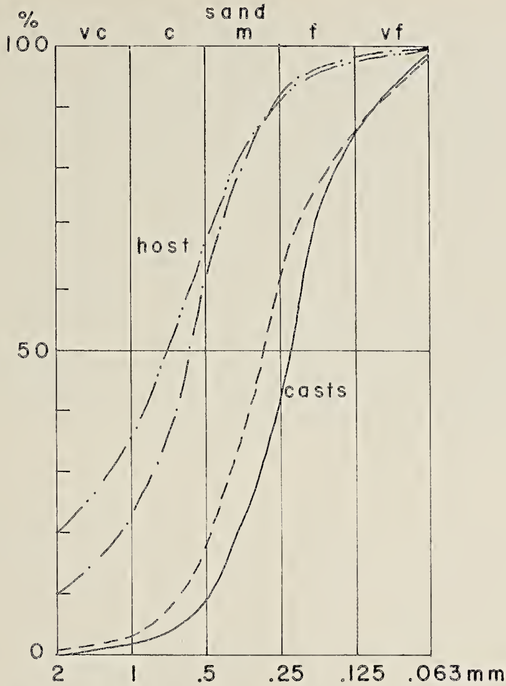

FIGURE 11. Size-grade analyses of some samples from Locality 7, Chippewa and Eau Claire Counties.

Locality 8, Eau Claire County

On March 28, 1959, the writer saw several ice wedge casts filling V-shaped notches in the Cambrian sandstone that outcrops at the apex of a rounded hill 5 miles west of Eau Claire on County Road E. The bedding of the sandstone was upturned in places along the casts from expansive forces in the wedges. Wedges 15–60 cm wide were as much as 200 cm high. Fillings consist of very fine- to coarse-grained, light brown (7.5 YR–6/4) sand similar to that in other casts in Eau Claire County, but more clay skins are seen. The textural distribution of a typical sample is:

	Percent
Fine gravel	1.6
Very coarse sand	1.6
Coarse sand	18.1
Medium sand	42.3
Fine sand	19.9
Very fine sand	13.0
Silt and clay	3.8

The gravel is sub-rounded fragments of the local sandstone; the sand fractions contained abundant (up to 10 percent) igneous rocks and minerals of a typical glacial suite, showing little or no weathering. Quartz in the larger sized fractions is sub-rounded to rounded, but angular in the smaller sized fractions. No frosted grains were seen but they may have been obscured by clay skins.

In contrast the local sandstone is pale yellow (5YR–7/3) with angular to sub rounded quartz of very fine to fine sand. Glauconite locally makes up a few percent of the total. Because of the difference in size of grains and of lithology, the sandstone can provide only a small part of the total filling. No till was seen in the cracks or on the bedrock on the hill. The upper few decimeters of the sandstone are locally much crumpled and contorted, supposedly from frost action and gravity movements.

Locality 9, Eau Claire County

On March 28, 1959, the writer observed 14 well-defined casts of ice wedges preserved in reddish-brown sandy till on dolomitic sandstone of Cambrian age, 4 miles west of Eau Claire, on County Road E. Widths ranged generally from 20 to 65 cm and heights from 1.8 to 2.2 m. Casts were speced commonly 3–4 m along the road. As the ground was frozen, no excavations were attempted beyond a few centimeters. Samples of the filling showed them to be well-sorted glacial sand similar to other localities in the county. A typical reddish-yellow (7.5YR–6/6) sample shows:

	Percent
Very coarse sand	0.9
Coarse sand	9.6
Medium sand	45.8
Fine sand	26.6
Very fine sand	15.9
Silt	1.2

Clay is absent. Igneous rock and mineral fragments make up 30–40 percent of the coarser fractions which are sub-rounded to rounded grains; the finer fractions are angular to sub-rounded grains. Frosting was not observed.

Again because of texture and lithology the local bedrock can have supplied only a small part of the filling. Slump and slope wash obscure details of the wedges, but pressure effects along the sides of the casts were seen especially where the till grades into bedded kame sands and gravels. The tops of all casts were at a marked stone line, and loess overlying was markedly different from sand in the casts.

Locality 10, Eau Claire County

On August 27, 1959, the writer found several ice-wedge casts of typical well-sorted yellowish glacial sand in a borrow pit in gravelly sandy outwash 5 miles southwest of Augusta. The largest cast was 130 cm wide and 105 cm high. Upturned strata were obvious adjacent to the sides of the casts. Spacing was irregular but for three casts which were uniformly 3 m apart. These have not been studied in detail.

Locality 11, Clark County

On July 17, 1959, the writer noticed several small ice-wedge casts in dirty sand and gravel in small crevasse fills and kames on Cambrian sandstone on Highway 10, 2.5 miles east of Highway 12. The typical yellowish well-sorted sand fills were generally about 30 cm wide and only 60–70 cm high. They were poorly displayed, and have not been studied in detail.

Locality 12, Clark County

Clarence Milfred, on November 30, 1964, informed the writer that he had seen several ice-wedge casts in a borrow pit of poorly-sorted drift 5 miles east-southeast of Fairchild. Wedge-shaped fillings of yellowish sand in the reddish brown drift seem typical, but the writer has not seen them.

Locality 13, Jackson County

On August 27, 1958, the writer saw three ice-wedge casts in relatively clean gravelly sand outwash, in a borrow pit 2 miles southeast of Hatfield. One wedge (fig. 12) was 45 cm wide and 1.5 m high; the other two were 15 cm wide and 1 m high. Their trends and spacing around the periphery of the pit suggest a polygon whose diameter is 15–30 m. Upturned strata along the flanks of the casts were common. Frost-stirred rubble lies on top of the casts and host and has slumped into the upper part of the casts. Fillings (10YR–7/3, very pale brown) are in marked contrast in color to the host (5YR–5/6, yellowish red), but texture and lithology differ only in details. A sample of the typically uniform sandy facies of the host contains 85 percent medium and coarse sand whereas the cast in figure 12 contains 75 percent in the same size range. The cast differs mainly in having almost no gravel and over 17 percent fine sand whereas the host has distinct gravel layers and less than 6 percent fine sand. Both are low in very fine sand, silt, and clay. Lithologically the coarser fractions of the host are dominated by igneous and metamorphic rocks and mineral fragments, but the same fractions of the cast are mostly well rounded to sub-rounded quartz and only 3–5 percent are typically glacial suites. Frosted grains are common in the cast but not the

FIGURE 12. Large ice-wedge cast in outwash, Locality 13, Jackson County. Folded shovel is 21 inches long.

host. The color difference is attributed largely to iron oxides and very minor clay skins on the surface of the larger grains in the host.

Although tree roots are utilizing the casts, they have played no role in making them. Excavation shows that the casts are distinctly linear, not circular features such as are produced by solution. Ground water effects subsequent to filling of the wedges, has left iron oxide zones traceable across both cast and host. However, stratification of the host does not carry through the cast.

Locality 14, Monroe County

Ronald H. Akers discovered numerous ice wedge casts in a borrow pit 2 miles west of Tomah and later studied the lithology of the sand and rubble host on the Cambrian sandstone into which the casts penetrated (Akers, 1964, p. 104–108). The writer examined them on July 5, 1963, and sketched the cross sectional outlines of the more exposed ones shown in figure 13. More than 30 casts are present along the walls of the borrow pit. The widest casts are 1.2–1.6 m; the highest 2–3 m. Widths decrease abruptly in the bedrock. The yellow to reddish yellow (10YR–7/6 to 7.5YR–7/6) well-sorted sand in the casts differs markedly in color and texture from the coarser yellowish red (5YR–5/8) sand in lenses in the overlying rubble. Sand in lenses in the rubble is typically medium to coarse, well-rounded quartz with some very coarse sand and gravel of chert and sandstone fragments; less very fine and fine sand and silt and clay are present. However, the casts are mostly fine to medium sand with about 10 percent each of coarse and very fine sand. Very coarse sand or gravel are rare. The larger grains are well-rounded and frosted quartz; the smaller are angular quartz. Fresh green glauconite makes up 1–5 percent of the smaller sizes of the casts but is absent or only a trace in the host sand. The local Cambrian sandstone is very similar to the finer fractions of the sand in the casts, including the glauconite, and presumably was the source. The host sand and rubble contain plagioclase, potash feldspar, and calcium-magnesium carbonate (Akers, 1964, table 16) and seem to have supplied relatively little of the filling for the casts.

Locality 15, Portage County

On May 31, 1958, more than 25 ice wedge casts were observed in a borrow pit in the Arnott moraine, 9 miles southeast of Stevens Point. The casts are as much as 1.8 m wide and 2.6 m high. They have been examined at different times during sporadic working of the pit, and cross sectional outlines of some were sketched (fig. 14). The reddish yellow to yellowish red (5YR–6/6 to 5/6) sand

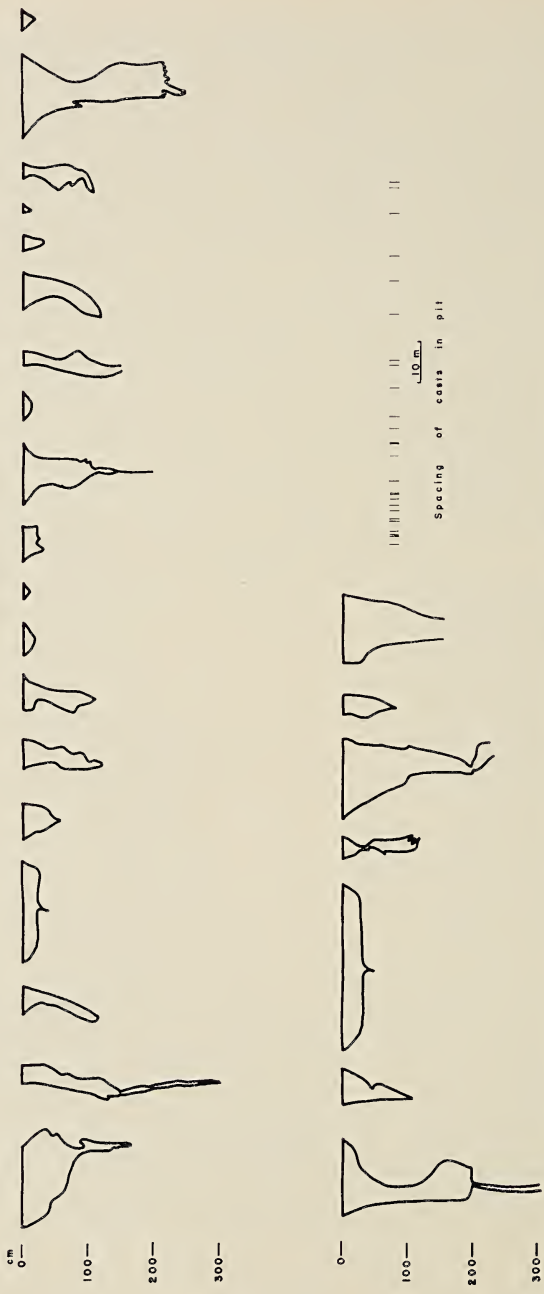

FIGURE 13. Cross sections of some ice-wedge casts, Locality 14, Monroe County.

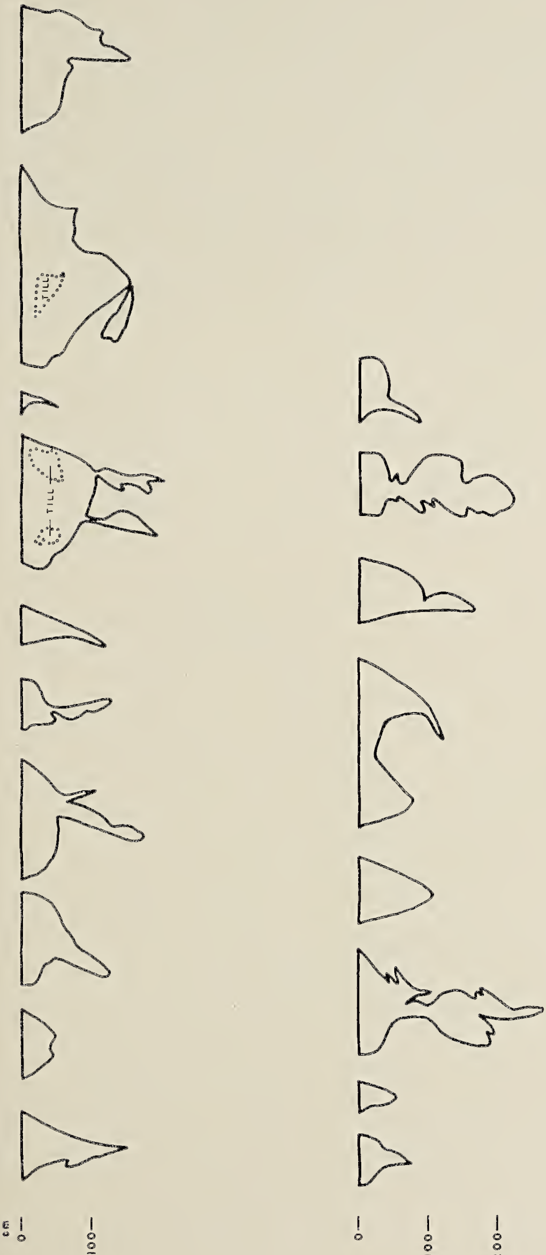

FIGURE 14. Cross sections of some ice-wedge casts, Locality 15, Portage County.

in the casts differs from the red to light reddish brown (2.5YR–4/6 to 5YR–6/4) sandy till of the host mostly in texture. Representative size analyses of four samples of the casts and two of the host are shown in figure 15. Gravel larger than 10 mm in diameter and numerous boulders of granite 1–2 m in diameter in the till are excluded from the curves. In the casts generally 80 to 90 percent of the sand is fine to medium; the curves are skewed toward the coarse fraction. Granules of angular disaggregated granite are common in the casts. Very little silt and practically no clay occur in either casts or host. The sand of the casts contains a typical glacial suite of rocks and minerals, but glauconite is common in the very fine fraction. Quartz is only 10–20 percent of the very coarse fraction; most grains are igneous rocks of wide variety. Quartz dominates the smaller fractions.

This pit contains pockets of sand in wedge-like form at depths that suggest roots of truncated casts. Their color, texture, and lithology are indistinguishable from those of the surface casts. Several are at a slight discontinuity in the till shown by a color change from red above to light reddish brown below and by slight

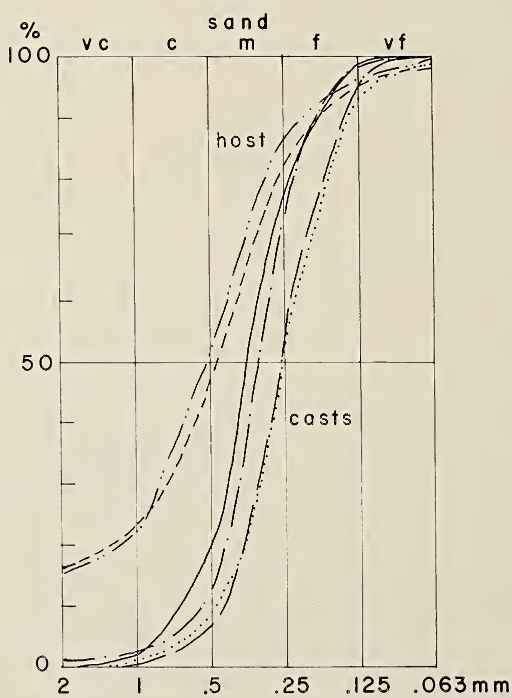

FIGURE 15. Size-grade analyses of some samples from Locality 15, Portage County.

differences in pebble counts. Textures (fig. 15) in the till and in the casts above and below are identical. However, it seems clear that the upper casts do not penetrate that discontinuity nor do they join or cut the lower casts. Too little information is in hand to pursue the problem of two generation of wedges; it remains a possibility for which much additional work needs to be done.

In 1958 one wedge cut in half a disaggregated granite boulder at a depth of 1.6 m. The width of the cast decreased abruptly from many decimeters in the till above to only a few centimeters within the boulder. It has since been removed.

The near surface wedges have all been truncated. Ventifacted stones are common.

Locality 16, Outagamie County

On November 7, 1964, Fred Madison showed the writer the tallest ice-wedge casts seen in the state, at the junction of County D and TT, 4 miles south of New London. Two wedges were 3.1–3.7 m high and 1.0–1.1 m wide. They were traceable from the face of the roadcut across the stripped upland for 5–10 m, and with a third wedge indicated a polygon of about 10 m diameter. Slump features on the sides and patches of reddish brown sandy till with flow structures crossed at least half the width of the two wedges, but the lowermost tip of one showed vertical foliation and separated crack fillings typical of an original sand wedge. The fillings of well-sorted very fine to fine sand were reddish yellow (7.5YR–6/6) to strong brown (7.5YR–5/6 to 5/8) in contrast to the reddish brown (2.5YR–5/4) till. Samples of the lower and upper part of the tallest cast and a third from the lower part of the adjacent wedge contain 61–67 percent fine, 19–27 percent very fine, and only 9–11 percent medium sand. Coarse and very coarse sand and gravel constitute together 1–4 percent. In contrast overlying sand several decimeters thick of eolian or lacustrine origin that seems to have slumped into the upper part of the wedges is slightly different. One composite sample contains 54 percent fine, 9 percent very fine, and 35 percent medium sand. The very coarse sand and gravel scattered throughout the casts is absent in the overlying sand and only 0.3 percent coarse sand is present. In all samples only 1–3 percent silt and virtually no clay are present. Typical glacial suites of rocks and minerals are present in all, but igneous rocks are less abundant, more rounded, and fresher and cleaner in the overlying sand than in the casts where they are typically very angular and corroded. It seems clear that the immediately overlying sand is distinctly coarser, more mature, and has not supplied as much of the filling as was thought on brief field examination. Appreciable glauconite in the finer sizes suggests a Cambrian sandstone source rather than the till host.

Numerous other casts are present in the vicinity of the junction of County D and TT and for 0.75 mile northward on County D, particularly on the west or Waupaca County side of the highway. All are smaller; some are 1.8–2.4 m high and 20 to 60 cm wide. Those to the north are truncated at a depth of 1–1.2 m. Several joined in polygonal network as seen in plan on the sloping road bank. They were not examined in detail nor sampled.

Locality 17, Columbia County

On June 13, 1961, the writer saw four ice wedge casts in the top of a drumlin 1 mile north of Portage. They appeared in the walls of a borrow pit in the apex of the rather sharp oval hill of reddish-brown sandy till. By April, 1962, the pit had been enlarged considerably but the same wedges could be identified and another new one showed up. The extensions of the four casts were smaller than those originally seen. One was 1.8 m high and 1.1 m wide; another was 1.5 m high and 70 cm wide (fig. 16); the other two were somewhat smaller. Spacing between three wedges in the southwest part of the pit was 3 m, but other walls 15 m long of the borrow pit showed no casts. Slump features and till masses extending diagonally across much of the width of two casts distinctly showed large linear voids existed that were not just oriented downhill. Mixed loess and colluvium 30–90 cm thick covered the top of the casts which are well-sorted reddish yellow (5YR–6/6) very fine to medium sand. The till host is light reddish brown (5YR–6/4), sandy, and with igneous boulders up to 1.5 m in diameter. Only a few percent of the sand in the casts is typical glacial suite of igneous rocks and minerals. That and the relatively high proportion of glauconite in the finer sizes suggest a Cambrian sandstone source.

Locality 18, Richland County

On October 4, 1964, two small casts of supposed ice wedges were seen in a gravel pit about 0.75 mile south of Eagle Corners. One was about 30 cm wide and 50 cm high; the other only 10 cm wide and 40 cm high. Both are filled with very clean reddish yellow, very fine to medium sand and are in brown silty-clayey sediments showing marked cryoturbations (?) nearby. The casts were dug out enough to demonstrate their linearity, but no detailed study has been done.

Locality 19, Dane County

One mile southwest of Pine Bluff, several wedge-shaped fillings of loess and colluvium in dolomite of Ordovician age appear along

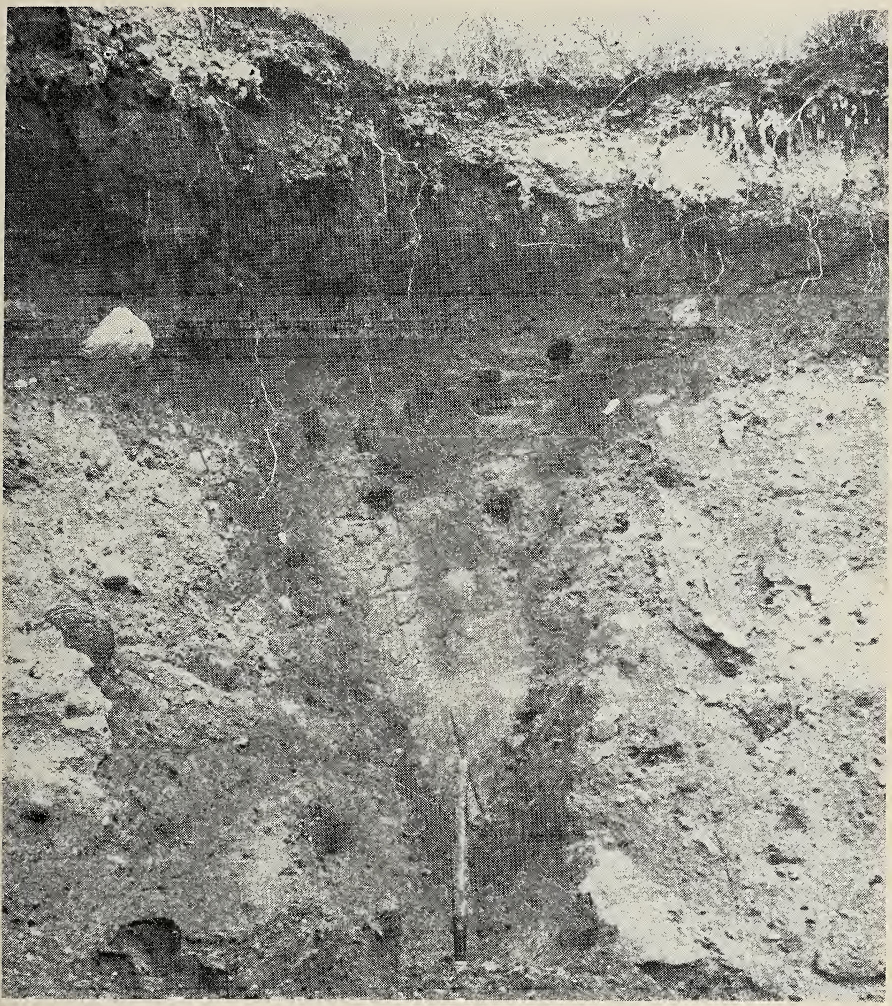

FIGURE 16. Ice-wedge cast, Locality 17, Columbia County. Exposed handle of shovel is 20 inches long.

the county road. These are typical and are cited as just one example of many such features that are to be found in thin-bedded rock in the state. Very locally pressure effects may be seen along the sides of the casts which generally are 30–100 cm wide and 60–120 cm high. Casts are spaced at fairly regular intervals of 3–4 m along the road. In many instances they seem to form polygonal patterns in plan. These particular casts have not been excavated more than a few decimeters and their origin is in doubt. It is thought likely that contraction cracking from cold and dissication would permit preferential solution and soil tonguing to operate. Subsequent wetting and drying of the filling then could produce the local pressure effects without the necessity of calling for ice wedge formation.

Similar wedge were reported earlier (Black, 1964, loc. 16) in Green County, but are not described here because of their dubious origin.

Locality 20, Rock County

Several casts of reddish yellow, clean, well-sorted, fine-medium sand are seen in the banks of a borrow pit in a dirty sandy gravel kame which rises 15–20 m above the surrounding lowland 3 miles northwest of Evansville. A stone line truncates the tops of each of the casts which are poorly preserved in the slumping bank. Several wedges have been discerned 30–60 cm wide and 40–100 cm high. Only two have been excavated as much as 2 m into the bank to establish their linearity. Slumping of the gravel into the wedges has left them very irregular. No detail work on them has been done, but they seem to be typical ice-wedge casts.

Locality 21, Green County

On April 14, 1962, the writer noted the truncated casts of four former ice wedges in a gravel pit in a kame about 2 miles southwest of Albany. Two casts on the east flank are especially striking although small; one is 40 cm wide and 115 cm high, and the other is 35 cm wide and 125 cm high (fig. 17). The well-sorted sand casts are reddish yellow with strong brown, iron-cemented streaks (7.5YR–6/6 to 5/6). The former was dug out along the surface for a distance of about 4 m and continued uninterrupted. Samples of the upper and lower parts respectively of the latter cast are 59 and 64 percent medium, 30 and 19 percent fine, and 8 and 12 percent coarse sand. Only traces of larger and smaller sizes are present. A typical suite of glacial sediments is present, but glauconite suggests the Cambrian sandstone influence in source also. In contrast the sand lenses with horizontal bedding in the host kame are coarser textured. One that underlies the cast contains 55 percent coarse and 41 percent medium sand which is yellowish red to reddish brown (5YR–5/8 to 4/4). The sand in the gravel is still coarser and darker (5YR–4/8 to 3/4). Clay skins are abundant.

At the extreme south end of the pit, 100–300 m from the casts, fine sand is bedded parallel to the slope of 5–15 degrees. It is 0.5–1.2 m thick and suggests a climbing dune from the south. Unfortunately the area is much disturbed through dumping of trash, and the field relations are not clear. In the area of the casts 0.5–2.0 m of loess and colluvium cover the truncated casts.

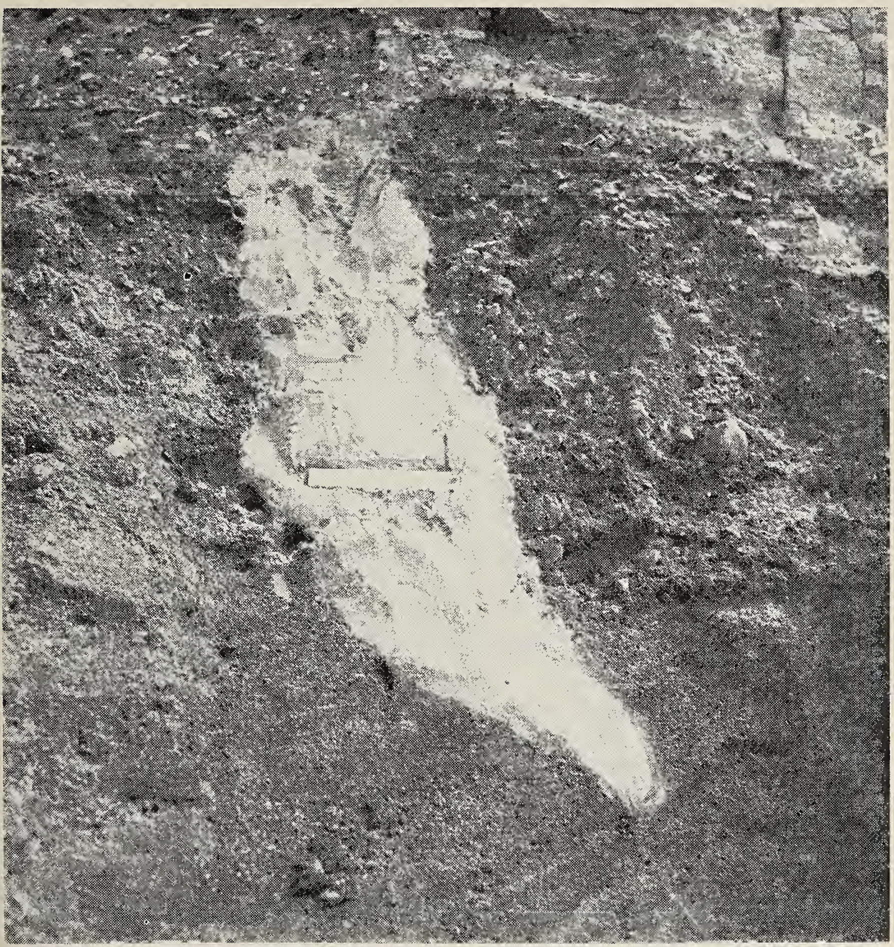

FIGURE 17. Ice-wedge cast, Locality 21, Green County. Six-inch scale.

A worker who was involved with the opening and working of the original pit stated that the wedges of sand were much larger and more common along the axis of the ridge of kames.

Locality 22, Green County

On June 5, 1961, the writer saw a wedge-shaped filling in a road cut at the junction of County N and C, 3 miles west of Monticello. Basal variegated shale and sandstone beds of the St. Peter formation of Ordovician age are contorted along a northeasterly axis which is cut obliquely by a wedge-shaped filling that is 55 cm wide and 80 cm high. The filling of poorly-sorted reddish brown (5YR–5/3 to 4/4) colluvium or till contains some clay, abundant silt and sand up to coarse size, and granule size fragments of shale and dolomite. It is very hard and compact when dry. The horizontal axis of the wedge is oblique to slope and structure and is difficult to explain. Upturning of the St. Peter bedding planes along the wedge demonstrate pressure effects, but proof that this feature was an ice wedge is not available.

Mode of Formation

If it is conceded that large till or drift patches that cross much if not all the width of many casts and that horizontal or diagonal bedding and flow structures are proof of filling of voids essentially the size of the wedges, then most casts were true ice wedges initially rather than sand wedges. At least the development of seasonal frost wedges and solution phenomena seem not to be applicable, and no alternative origin comes to mind. Rarely, as at localities 14 and 16 particularly, the lowermost tip of some casts indicate possible sand wedge growth initially. At least vertically oriented cracks up to a few millimeters in width are filled with sand and cut the host as in active sand wedges in Antarctica. Yet those same wedges have typical large inclusions and slump structures in the middle and upper parts and must be considered true ice-wedge casts or at least composites with more ice than sand.

If we accept the ice-wedge origin initially, then we must account for the remarkable similarity of the sand filling the casts in 20 of the 22 localities (filling at localities 19 and 22 are loess and colluvium or till). Such similarity suggests uniform conditions throughout the state during the replacement of the ice by the sand and also a single or common mode of emplacement. Although a lake can be demonstrated to have inundated locality 2, lakes with such uniform bottom sands cannot be demonstrated for the other localities which commonly are on the highest land in the area. The textural analyses, rounding, frosting, and mineral distribution point toward wind as the agent of transportation that brought the sand to the casts. However, the situation is still somewhat perplexing because sand identical to that in any one cast is not now found on or anywhere in the vicinity of any cast (at locality 16 the sand is somewhat different and at locality 21 sand 100–300 m away has not been studied.) Stone lines show marked truncation of all casts, except possibly some of those at locality 16, but such sand is not found in the colluvium or soils nearby. Where has it gone? Or was it ever widespread? We don't really know.

Composition of the sand suggests multiple sources, particularly the local drift surface and the Cambrian–Ordovician sandstones. The amount of contribution from each source is not known but seems to differ somewhat depending on the locality. We seem to have no problem getting the sand in the first place, but concentrating it in the casts without building up deposits nearby is difficult and not explained. In order for such large fillings with so little contamination to form, one would expect to see dunes over the casts as at locality 16. Migrating dunes would permit textural and mineralogical variations at any one cross section such as seem to have taken place there. If such dunes were more commonplace on and near the other localities, the writer would feel better about the situation.

In addition the uniformity of filling in the casts from top to bottom indicate that surface conditions did not change appreciably during the emplacement. Fillings worked downward and laterally with remarkably little contamination from the walls of many inclined casts or those whose lower apices were almost horizontal as in figure 7. Flow structures of till and other patches of unconsolidated material or stratification indicated water was present. The details of the filling mechanism are obviously open to various interpretations.

From these few observations and conclusions it is readily apparent that details of the origin of the casts, require many more observations before any definitive answers are likely to be forthcoming.

Time of Formation

We do not know either the time when the original ice wedges were formed nor when they were destroyed and replaced with sand. No definitive criteria even suggesting their time of formation have been found. At the present time we can do no more than suggest a time by analogy—that is by parallelism of events or changes of climate. This procedure is fraught with difficulties and leaves much to be desired.

The climatic changes of the late Pleistocene in Wisconsin are not known in detail, but the broad pattern is recognized (Frye, Willman, and Black, 1965; Black, Hole, Maher, and Freeman, 1965). We know that permafrost does not exist anywhere in the state today and that filling of the casts ceased long enough ago for all to develop weak-moderate stains of iron oxide and clay skins at former groundwater levels or levels of wetting and drying. These require presumably only a few centuries or millenia, but do not exclude a time encompassing many millenia. The presence of fresh easily weathered rocks and minerals, including glauconite, olivine, pyroxene, amphibole, and calcic plagioclase, suggest a relatively short but vague time since replacement. Truncation by colluviation and mass movements is extensive and universal; such processes are going on today at least locally, but most casts are protected by a cover of loess. Hence, truncation of the casts largely ceased prior to the deposition of the bulk of the loess over them. Unfortunately loess deposition seems to have been continuous in many places beginning about 29,000 years ago up to the present day, and cannot be used as a time indicator. Thus, we have no good clue when replacement ceased, although it seems to have been some thousands of years ago.

At the opposite extreme the age of the material in which casts are found defines the maximum limit for a wedge. Most casts are in Paleozoic strata or drift of Rockian age—29,000 to 32,000 years ago—but casts in two localities (16 and 17) are in till considered Cary in age, about 12,500 to 16,000 years ago. (The Valders ice advance of about 11,000 to 9,500 years ago either went over or around locality 16, but the till in which the casts are found seems typical of the Cary rather than the Valders. The Cary ice closed around but apparently not over the hill at locality 1.) Those casts in Cambro–Ordovician bedrock without drift cover of Rockian age have loess filling that is less than the maximum age found in the state (29,000 years old; Hogan and Beatty, 1963) based on the degree of weathering. Consequently, no wedge formation is considered as old as the Rockian advance, with the possible exception of the buried and truncated wedges (?) at locality 15. It seems clear that the Rockian ice advanced over a spruce forest, but no trace has been found that trees grow again in the state until Two Creeks time, about 11,000 to 12,500 years ago. The interval from 12,500 to about 29,000 years ago seems then to be the logical time for growth of the original ice wedges. However, the wedges need no more than a few thousand years at most and more likely only 1,000–3,000 in which to grow to their present size when compared with growth rates of ice wedges measured in Alaska and Antarctica (Black, 1952a and 1963; Black and Berg, 1963 and 1964). It seems reasonable then to assume that most wedges grew at about the same time during a particularly cold period that logically would be related to a glacial advance.

In Illinois the Farmdalian Substage of deglaciation spans much of the early part and the Woodfordian Substage of multiple ice advance and retreat the latter part of the time from 29,000 to 12,500 years ago (Frye and Willman, 1960; Frye, Willman, and Black, 1965). The peak or maximum extent southward of ice in the middle United States during that interval seems to have been about 20,000 years ago (Flint, 1963). It is not axiomatic that permafrost conditions in Wisconsin were most severe at precisely that same time, but they can be presumed to be because of the southward shift in storm tracks that should have accompanied the southward flow of ice. Such a southward shift would be brought about by the ice in the Des Moines lobe west of Wisconsin and the Lake Michigan lobe east of Wisconsin. Those lobes left central and southwest Wisconsin free of ice where the Rockian drift had been 10,000 years before. Almost continuous cold high pressure air would have existed over the area of the ice sheet, leaving the relatively small reentrant in Wisconsin largely outside the zone of influence of the moist air from the Gulf of Mexico, which supplied the bulk of precipitation to the state. Hence, it is expected that winters would be very cold and with relatively little snow; summers would be cloudy from overrunning Gulf air but still cold. Permafrost conditions would be optimal. They would last at their peak only a few thousand years.

In theory this might explain the origin and time of formation of the ice wedges in the Rockian drift, but not those of the two localities in the Cary drift. No evidence that they are in older drift overrun by the Cary ice has been found. Whether permafrost was able to develop locally in connection with the Valders glaciation is not known, but climatic changes during that time seem not to have been so severe (West, 1961). Both locations are high, wind swept, and near former lakes associated with the Valders retreat; sporatic permafrost seems possible and a ready supply of sand was available. Not all other localities were, however, and no case can be made to have all wedges produced so late in the Wisconsinan Stage. At least two times then—20,000 and about 10,000 years ago—seem most likely for permafrost and ice wedge formation, but presumably other climates were such as to have permitted sporadic permafrost to develop.

Destruction of the ice wedges and replacement with sand is even more difficult to place into proper time sequence. Glaciation and cold climates are in general a smaller part of the interval from 29,000 years ago to the present than are warmer climates without permafrost conditions. Although buried glacial ice from the Rockian glaciation seems to have survived in southern Wisconsin until Two Creeks time, as in the buried bedrock valley now containing Lake Geneva, and in northern Wisconsin until after the Valders glaciation, such deeply buried ice masses melt out very slowly. They would have no affect on the formation of ice wedges nor on their destruction. Only climatic conditions would have been important. A ready supply of sand, wind, and rapid thaw of the ice wedges are required. Abundant vegetation, particularly forests, would not favor the sand fills, but prairie conditions could. Hot dry summers seem to be called for to promote melting and evaporation. We cannot pinpoint one or more such periods with much assurance, and the arguments are very tenuous (West, 1961). At our present state of knowledge we can do no more than suggest that destruction of those wedges that might have been produced 20,000 years ago could easily have accompanied the climatic changes of the late Woodfordian (Frye and Willman, 1960) or following the Tazewell–Cary substages; those possibly produced during the Valders must have accompanied the destruction of that ice for no indicators suggest any permafrost existed in the state after that ice disappeared. Such unsatisfactory chronology does not tell us whether wedges were produced at different times in the area of the Rockian drift or were destroyed during more than one period.

Paleoclimatologic Significance

As ice wedges grow only in permafrost and permafrost forms only where the mean annual air temperature is close to or below 0°C, a marked change in the climate of Wisconsin must have taken place for mean annual air temperature today is about 5–7°C. An analogy with ice wedges growing today in polar regions, where their growth rates can be compared with their physical environment, is interesting (Black, 1954 and 1963; Black and Berg, 1963 and 1964; Lachenbruch, 1962). Without going into the many details or exceptions it can be said that primary and secondary networks of ice-wedge polygons are generally found only in continuous permafrost where mean annual air temperatures are generally colder than –5°C. Ice wedges are growing more readily in fine-grained materials with high moisture contents and are less common and poorer developed in the sandier and more permeable materials which characterize the hosts in Wisconsin. Lack of casts in frost-susceptible materials can be contributed not to the absence of wedges, nor to the climate, but perhaps to concurrent flow and collapse of the host material during melting of the ice which prevented formation of wedge-shaped voids that could collect sand. Consequently we can conclude that the well-developed networks of primary and secondary polygons in western Wisconsin represent continuous permafrost with annual ground and air temperatures at least as cold as –5°C; the less well developed nets of primary polygons and isolated wedges in southern Wisconsin call for discontinuous to sporadic permafrost with ground and air temperatures slightly warmer than –5°C. Humidity was higher than that which characterizes much of Antarctica where so many sand wedges are growing actively. No quantitative values can be given at this time because they are not known well enough for existing wedges.

The shape of the wedges can at times or certain places be related to rapidity of seasonal temperature charges in the ground and consequently to climatic conditions. Short wedges that have not been truncated indicate only a shallow penetration of the seasonal temperature cycle whereas deep ones prove that large temperature changes carried to those depths. It seems necessary to have a rapid seasonal change in ground temperature of at least 4°C to initiate contraction cracks and changes of at least 2°C to propagate them to depth where the ground has more ice than pore space—that is where mineral matter is a suspension in ice. As thermal coefficients of rock are only about one-fifth that of ice, correspondingly greater temperature differences are needed to affect cracking in under-saturated sediment or rock. Rapidity of temperature change is perhaps equally important as total change in initiating cracking. At least relatively long cold periods of many days are required to permit loss of heat in the ground to extend to depths of 2 to 4 m. Rapidly alternating warm and cold periods of a few days each produce only short wedges. The former seems more characteristic of western Wisconsin and the latter of southern Wisconsin during the time of growth of the ice wedges.

Destruction of the ice wedges calls for rapid thawing and emplacement of the sand to avoid more contamination than is present. Abrupt climatic change seems needed. Furthermore, wind action to move the sand to the casts implies paucity of forests and relatively dry periods during each year. Lack of evidence of surface runoff following the troughs of the ice wedges or of vegetation in the casts suggest relatively low total precipitation. Replacement of the ice with sand hardly could have taken more than some decades in order to avoid more modification of the wedges and casts than is seen. Moreover, truncation of the sand casts by colluviation and mass movements indicates a change of climate to more moist conditions prior to deposition of the loess.

The whole story seems so complicated and the facts so few that much more field evidence is needed to constrain our musings. At least it is clear that our climate has changed abruptly and over a wide range of conditions during the time from perhaps 20,000 to 10,000 years ago.

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SOME MINERALOGIC CHARACTERISTICS OF SANDY SOILS IN WISCONSIN

*Frederick W. Madison and Gerhard B. Lee**

Sandy soils occupy about 7300 square miles, or 13.8 percent, of the total land area in Wisconsin (Whitson, 1926). Some of these soils are farmed, others are used for forestry, wildlife, recreation, or other purposes. While considerable effort has been devoted to the study of sandy soils, particularly in regard to their use and management for agronomic or silvicultural purposes, relatively little is known about some of their basic characteristics. This is reflected in their present classification which groups them into a few, broadly defined soil series. While it has been observed that differences exist among the soils that comprise these series, the magnitude of this variation and its relative importance is not well known. Conversely, several series of sandy soils include very similar soil individuals. Both problems result in part from the historical practice of using geographic and physiographic factors as criteria for grouping. Present-day efforts in classification, however, are aimed at ordering soils according to their morphology and other genetic characteristics. In many cases we lack the knowledge necessary to do this well.

The purpose of the present study has been (1) to establish some basic mineralogical characteristics of sandy soils in Wisconsin and of the sediments from which they formed and (2) to delineate general geographic areas in which sandy soils are apt to be mineralogically similar.

Location of Samples

Soils used were selected in order to obtain samples representative of the principal soil series in major sandy soil regions of the state (Fig. 1)[1]. In some cases it was possible to include two or

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[1]Among the samples used were several collected during an earlier study of Plainfield and associated soils (Soil Survey Staff, 1957) and several collected for subsoil fertility studies (Corey & Beatty, 1961).

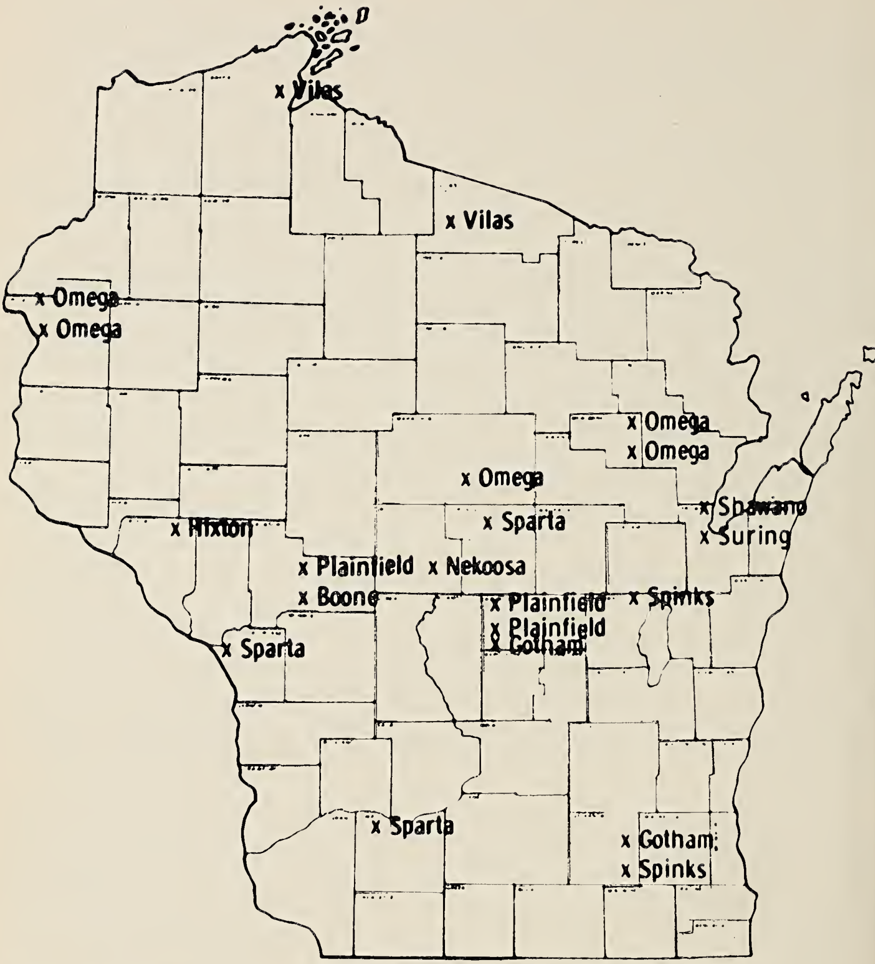

FIGURE 1. Map of Wisconsin Showing Location of Sample Sites.

more widely separated profiles of the same kind of soil. This made it possible to compare the mineralogical composition of soil individuals classified in the same series which may have been formed in sediments from different source areas or which may have been subjected to different degrees of reworking or weathering. Conclusions regarding the mineralogic character of these soils and their parent sediments are based on lithological studies of the gravels (particles greater than 2 mm. in diameter), grain-size analysis and mineralogical studies of the light and heavy minerals, heavy minerals being those minerals with specific gravities greater than 2.95.

Methods of Analysis

Air-dried samples were passed through a 2 mm square mesh screen. The gravel fraction was treated with 6N HCl to remove iron oxide coatings after which individual pebbles were identified and counted.

Particle-size distribution of the less than 2 mm fraction was determined by the hydrometer method of Day (1956), except in the case of the six profiles collected for a study of Plainfield and related sandy soils (1957) whose particle-size distribution had previously been determined by the pipette method (Kilmer and Alexander, 1949).

Volume measurements of heavy minerals were made as described by Madison and Lee[2] using pear-shaped centrifuge tubes having a calibrated neck in which the heavy minerals settled and where their volume could be easily determined to the nearest hundredth of a milliliter. Weight percentages of heavy minerals was also determined.

Very fine sand-sized heavy minerals were mounted on glass slides with Lakeside #70 cement. Light mineral grains were impregnated with a 3:1 mixture of Castoglas and Styrene, mounted on glass slides and thin-sectioned (Madison, 1963)[3]. Slides were etched with hydroflouric acid and the potassium feldspars stained with sodium cobaltinitrite as described by Baily and Stephens (1960). Percentages of the various minerals present were determined by point counting with a standard petrographic microscope.

Results and Discussion

Lithology of Gravel Fraction

Lithological studies of gravel fractions were made to determine if any particular rock type was dominant in the suite, this dominance serving in turn as a basis for interpretation of source area. A further purpose was to determine the presence of lithological discontinuities which would imply a change in source area. The gravel fraction in soil profiles from the central sand area reflected the influence of the Pre-cambrian rock complex in the Wausau area. Amounts of coarse materials decrease rapidly southward down the Wisconsin River Valley. This is attributed to two factors: namely, increased distance from source area and dilution of the sediment by the addition of quartzose materials from the Paleozoic sandstones. A great variety of rock types and general lack of con-

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[2]Madison, F. W. and G. B. Lee, 1965. A simple method for determining the heavy mineral content of sands and its application to soil genesis research. In manuscript.

[3]Madison, F. W., Mineralogical studies of some sandy soils in Wisconsin. M. S. Thesis, University of Wisconsin, 1963.

sistent patterns are the dominant characteristics of the gravel fractions of the sandy sediments of northern Wisconsin. This is a reflection of the complexity and diversity of rock types found in the Pre-cambrian shield. A lack of coarse clastic material can be attributed to (1) reworking of sediments, (2) fine and medium grained source rocks, (3) moderate competency of the transporting medium, or (4) extensive transport of sediments prior to deposition. Results of the present study suggest that the first two of these processes have been primarily responsible for the textural characteristics of the sands of the "Driftless Area", whereas all of the first three processes have been operative in producing the textural characteristics of the sands of northeastern Wisconsin.

Mineralogical Composition of Soil Parent Materials

Results of mineralogical studies of C horizons are summarized in Table 1. In this table, soils are grouped according to geographical location.

Vilas soils are representative of podzolized sandy soils of northern Wisconsin. The wide ranges shown for all constituents reflect the mineralogic complexity of the Pre-cambrian shield area. Generally high feldspar percentages as well as high volume percentages of heavy minerals suggest that source rocks are primarily igneous and/or metamorphic and that these sediments are in their first cycle of erosion. The latter suggestion is further supported by the occurence of large percentages of augite and hornblende in the heavy mineral fraction, as well as lesser percentages of andalusite, sillimanite, hypersthene and diopside, all of which are relatively unstable in the zone of weathering.

Omega soils often occur in complex association with Vilas soils. They are also associated with other podzolic soils in northern Wisconsin in a zone extending from Polk and Burnett counties in the west through Marathon county to Shawano and Menominee counties in the east. Geologically this region coincides roughly with the contact between the Pre-cambrian shield rocks and the Cambrian sandstones which overlap them. The data (Table 1.), particularly values for quartz and feldspar, show a mineralogic similarity of parent materials over a wide geographic range. Two samples from Polk county showed the influence of the Pre-cambrian Iron Formation in that their volume percentages of heavy minerals ranged from 3.08 to 4.24 and that their heavy mineral suites were dominated by iron oxide minerals. The mineralogy of these sediments also implies geologically young materials which are probably in their first cycle of erosion.

Shawano and Suring soils are formed primarily from glacio-lacustrine sands in the Valders drift region of northeastern Wis-

Soil Series	Location in Wisconsin	Number of Samples	Range in Percent Frequency of Light Minerals (by Count)[1]				Volume Percent of Heavy Minerals[1]		Dominant Heavy Mineral Species[2]
			Quartz	Feldspars					
				Orthoclase	Plagioclase	Total	Range	Average	
Vilas	N	2	60–80	11–17	2–12	12–29	1.12–4.00	2.35	Opaques[3] Augite Hornblende
Omega	N	5	62–68	16–19	5–9	24–27	1.24–4.24	2.54	Opaques Augite Hornblende Garnet
Shawano Suring Spinks	NE	3	75–77	13–15	5–8	18–20	0.80–1.80	1.71	Opaques Zircon Hornblende
Plainfield Nekoosa Gotham	C	4	76–83	5–10	2–4	8–12	0.44–1.12	0.90	Opaques Hornblende Garnet
Plainfield Boone Hixton	WC	3	85–96	1– 8	2–3	2–12	0.01	0.01	Zircon Tourmaline Garnet
Gotham Spinks	SE	2	60–80	6–16	6–7	12–23	1.20–1.96	1.48	Opaques Hornblende Garnet
Sparta	C SW	3	70–83	6–13	5–8	10–20	0.88–1.48	1.06	Opaques Hornblende Garnet

[1]Total sand (2.0–0.05 mm) fraction.
[2]Very fine sand (0.10–0.05 mm) fraction.
[3]Mainly magnetite, hematite, ilmenite, and leucoxcene.

consin. Spinks (and Leeman) soils in this area are developed in eolian deposits associated with these glacio-lacustrine basins. Parent materials of these soils appear to be very uniform both in particle-size distribution and mineralogical composition of major constituents. Data from mechanical analyses of these samples showed more than 80 percent fine and medium sand; that is, material ranging from 0.5 to 0.1 mm in diameter. The general uniformity of these materials is believed due to extensive reworking in glacio-lacustrine environments associated with the Valders glaciation. Paleozoic sandstones of the area have also contributed to this uniformity because of their own textural and compositional maturity.

Plainfield, Nekoosa, and Gotham soils, with associated Morocco and Kellner soils, occur over extensive areas in the central sand plain of Wisconsin. Mineralogically these materials showed higher quartz contents and lower contents of feldspars and heavy minerals as compared to sands in the northern part of the state. This appears to be due to the addition of quartzose materials from local Paleozoic sandstones which have, in effect, diluted the sediments derived from Pre-cambrian rocks in the Wausau area. Heavy mineral suites of these sands were found to contain monazite, a cerium phosphate mineral, in equal or greater amounts than apatite, suggesting that the former mineral may be, in some instances, an important source of the nutrient element phosphorus.

Boone and Hixton are residual soils formed from sandstone and are found primarily in the "Driftless" area of west central Wisconsin. Many valleys in this area are filled with fluvial sands and soils formed in these sediments have been classified as Plainfield. The Paleozoic sandstones of Wisconsin have been through several erosional cycles and, hence, are both texturally and compositionally very mature. From the data (Table 1) it is apparent that residual soils from these rocks, as well as related soils formed in transported sediments, reflect this maturity. Authigenic feldspars, which are potassium feldspars formed during the lithification of the sandstones, were the most variable constituent of these sediments. Heavy mineral contents of these materials were found to be extremely low; heavy mineral suites were made up of only the most resistant minerals.

The remaining groups represent two mineralogically anomalous situations. One of these groups included samples of Gotham and Spinks soils obtained from the interlobate moraine in southeastern Jefferson county. This area is underlain by Ordovician limestones. The ablation of glaciers, however, has concentrated large numbers of igneous and metamorphic erratics in this area which is believed to account for the mineralogic complexity and variability of these sediments.

The other group includes samples from Sparta soils. Two of these were obtained from terraces along the Wisconsin River in Iowa and Portage counties while the third came from a terrace along the Mississippi River in La Crosse county. These sands, because of their association with major drainageways, are made up of materials derived from a variety of sources and, as such, are mineralogically anomalous in the areas where they occur.

Weathering of Sandy Soils

Weathering studies were made in an attempt to determine if differential weathering has occurred within a sequence of sandy soils in which varying degrees of podzolization can be recognized morphologically. To assess the intensity of weathering, the ratio of zircon plus tourmaline to hornblende was calculated for the A, B, and C horizons of four soils; namely, Vilas—a Spodosol, Omega—a podzolized Entisol, and Shawano and Plainfield—two less podzolized Entisols.

Figure 2 shows the results of this study. Based on the formulae of Frye et al (1960), calculations were made which showed a 55 percent depletion of hernblende in the A2 and 15 percent in the Bhir of the Vilas. Weathering in the Omega appears to have been less intense with only a 22 percent depletion of hornblend in the A1 and 12 percent in the Bhir. The two less podzolized soils showed little, if any, effects of weathering. It is recognized that hornblende is not the most sensitive indicator of weathering; however, it does appear that this mineral can be used as a qualitative means for estimating weathering intensity.

Conclusions

Results of this study suggest that it is possible to delineate general areas of sandy soil in Wisconsin that are mineralogically similar. On the basis of results obtained, the following conclusions appear to be warranted: sandy soils derived from local Cambrian or Ordivician sandstones in west-central Wisconsin are characterized by their quartzose nature, by the presence of authigenic feldspars, and by heavy mineral contents of less than .01 percent by volume. Sandy soils of the northern third of the state are less quartzose, contain 15 to 25 percent feldspar, have volume percentages of heavy minerals suggesting that these sediments are in their first cycle of erosion. Sandy soils of central Wisconsin have less than 15 percent feldspar and have volume percentages of heavy minerals ranging from .44 to 1.12 percent. In the area south of Wausau, monazite, a cerium phosphate, is a constituent of sand de-

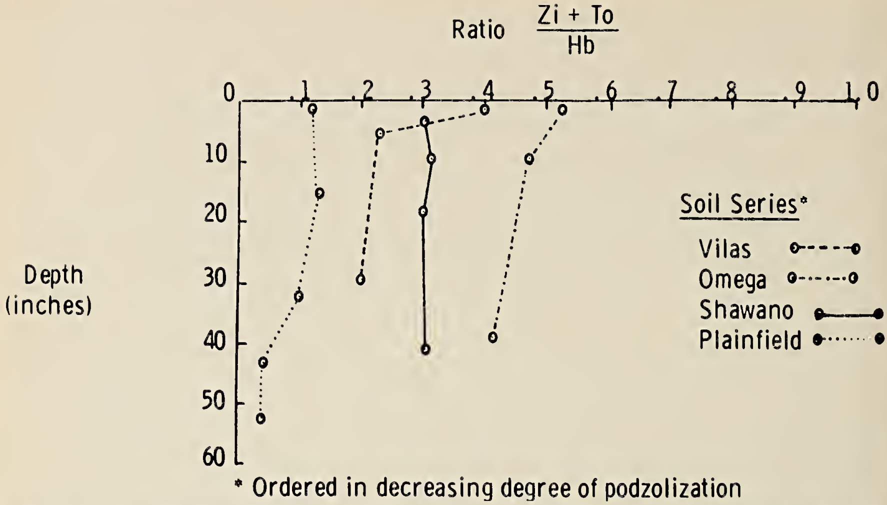

FIGURE 2. Weathering Ratios as a Function of Depth in Sandy Soils Showing Varying Degrees of Podzolization.

posits. In northeastern Wisconsin sands are distinguished by their fine grain size, their quartzose nature, and volume percentages of heavy minerals ranging from .80 to 1.80%. Within any of these general areas, local variations are apt to occur; these may be related to differences in source area or to mode of transport and deposition.

Studies of four profiles using depletion of hornblende as an index of weathering indicate increased weathering related to podzolization in sandy soils. Observed differences in weathering are believed to be primarily a function of the climatic and vegetative factors of soil formation.

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ART AS SETTING IN *THE MARBLE FAUN*

*Gene A. Barnett**

One hundred years after its publication, Hawthorne's *The Marble Faun* is at last being approached on its own terms as regards the much criticized Italian setting. Major critics from James to Matthiessen have made substantially the same complaint—that setting gets altogether too much attention in the novel. Even after second thoughts and a revised edition of his excellent work on Hawthorne, H. H. Waggoner still objects that there is "too *much* of Rome, and too much about art."[1] In my 1961 dissertation, I undertook a defense of the Italian setting, including the art,[2] and the same year Edward Wagenknecht noted the extent of Hawthorne's use of art as setting in his study of the romancer: "Every stage in its [*The Marble Faun's*] development, every important idea expressed in it, is suggested by or symbolized by or embodied in a work of art, and the reactions and relationships of the characters to various works of art became a very important element in characterization."[3] More recently, Gary J. Scrimgeour briefly advanced a similar argument concerning works of art in his very fine article on the general importance of Italy as a setting for the novel,[4] but in disagreement with him, I submit that critical analysis of such material, far from being "wordy and impertinent," can be quite worthwhile.

A close examination of the uses of art in *The Marble Faun* reveals that art works are employed consistently and much more organically and functionally throughout the novel than any other aspect of setting, even the historical ruins of the Roman landscape. Furthermore, a variety of uses may be noted. Most obvious, of course, is the use of such works simply to make the scene interesting, to capture the atmosphere of Rome and Italy as an age-old center for the development of the arts. Hawthorne's American readers, delighting in romances set in somewhat exotic foreign countries, would naturally expect to encounter at least a few of the world-famous statues and pictures, and the romancer would not

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*The author is a member of the Department of English, Wayne State University.

[1] *Hawthorne: A Critical Study*, rev. ed. (Cambridge, Mass., 1963), p. 223.

[2] *Hawthorne's Use of Setting in His Major Novels*, University of Wisconsin, Department of English.

[3] *Nathaniel Hawthorne: Man and Writer* (New York, 1961), p. 43.

[4] "*The Marble Faun:* Hawthorne's Faery Land," *American Literature*, XXXVI (November, 1964), 271–287.

disappoint them. A second reason for bringing such objects into the scene is that they afford the author an opportunity to make his own comments on certain works, or more broadly, on the two principal media: painting and sculpture. And this he does, albeit not always to the delight and edification of the modern reader. In general, however, Hawthorne's remarks on art command a certain amount of respect, occasionally for their validity, but more often for their honesty. As Norman Holmes Pearson notes, he frequently came close to absurdity in his praise of the work of his countrymen who were painters, but his remarks on the work of American sculptors evoke "only admiration for the perspicuity which kept him aware of their inadequacy."[5]

There are more meaningful employments for art, however. One of these is that art objects are made to become highly functional in a scene. For example, the statue of Pope Julius seems to bestow the blessing of heaven on the reunion of Donatello and Miriam. It is a reminder that their sin as well as their love has brought them together, and that heaven will exact expiation for the one by forbidding them the joys of the other. Another important—perhaps the most important—use of art is as a symbol for or comment on character. There are few instances in the novel in which art figures which fail to fill out in some way the personality and character of one of the chief players. The "Faun" of Praxiteles would certainly be foremost in this category. Finally, works of art offer thematic connotations. The busts which Kenyon makes of Donatello are excellent illustrations of this, for they successively mirror in stone and plaster the moral growth of the young Italian as sin seems to elevate and deepen his character through remorse over his murder of the monk. These devices just mentioned suggest the several possibilities which Hawthorne has explored in his attempt to make art functional in his novel, and it remains now to consider specific variations or instances as they relate to the four principals, beginning, appropriately enough, with Donatello, the "Marble Faun" come to life. Since he and Kenyon are most frequently associated with sculpture rather than painting, the two male characters will be considered before going on to Hilda and Miriam who work in the (for Hawthorne) more feminine medium of paint.

The opening paragraph of the novel serves several purposes. The four principal characters are introduced, though not by name; the setting is pinpointed—"one of the saloons of the sculpture gallery in the Capitol at Rome"; the theme is implied in the age-old choice of good or evil symbolized in the statue of a child "clasping a dove to her bosom, but assaulted by a snake"; and the major

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[5]*The French and Italian Notebooks,* I (unpublished Ph.D. dissertation, Department of English, Yale University, 1941), lxvii.

role of art within the setting is indicated. By mentioning the names of several famous statues—the "Dying Gladiator," the "Lycian Apollo," "Antinous" and others—Hawthorne immediately attempts to capitalize on his famous setting to lend a glamorous reality and authenticity to it. The "Faun" of Praxiteles is not introduced until the third page when attention is immediately called to it by Donatello's resemblance to it. Miriam declares that the " 'portraiture is perfect in character, sentiment, and feature,' "[6] and these first two chapters are given over to, among other things, developing this parallel. A paragraph on the character of the "Marble Faun" is worth quoting for what it tells of Donatello's character, and for what it implies about the story to be told and the theme to be unravelled:

> Perhaps it is the very lack of moral severity, of any high and heroic ingredient in the character of the Faun, that makes it so delightful an object to the human eye and to the frailty of the human heart. The being here represented is endowed with no principle of virtue, and would be incapable of comprehending such; but he would be true and honest by dint of his simplicity. We should expect from him no sacrifice or effort for an abstract cause; there is not an atom of martyr's stuff in all that softened marble; but he has a capacity for strong and warm attachment, and might act devotedly through its impulse, and even die for it at need. It is possible, too, that the Faun might be educated through the medium of his emotions, so that the coarser animal portion of his nature might eventually be thrown into the background, though never utterly expelled. (24).

A great part of the story of the novel is to be seen here in the description of the character of the stone figure. Donatello's love for Miriam is implied, along with the sacrifice of his innocence for her—the "death" of the old Donatello—and his moral growth through expiation. Significantly, it is Miriam who comments further on the nature of the "Faun" (27–28), incidentally implying a contrast between its carefree nature and a shadow on her own heart. Hawthorne then illustrates what she has seen in the stone figure by describing the utter amorality of the flesh-and-blood counterpart, Donatello, in his childlike admiration of her. Finally, the romancer provides a lengthy literal description of the "Faun," though it is interesting to note that he has not described it accurately, a fact easily noticed by comparing his account with any photograph of the statue. Julian Hawthorne calls attention to it in *Hawthorne and His Circle,* noting that his father "could not have visited it often; for both in his notes and in his romance he makes the same mistake as to the pose."[7]

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[6]*Works.* VI (Boston and New York, 1891), p. 21. Further references to this volume will be indicated by page number placed in parentheses in the text.

[7](New York, 1903), p. 325. Contrary to Hawthorne's description, the "Faun" has nothing in his right hand and his left arm is akimbo.

Certainly one may assume that most of the description of the "Faun" is meant to apply to Donatello also. " 'If there is any difference between the two faces,' " remarks Hilda, " 'the reason may be, I suppose, that the Faun dwelt in woods and fields, and consorted with his like; whereas, Donatello has known cities a little, and such people as ourselves. But the resemblance is very close, and very strange.' " (21–22) Mariam adds to this by disagreeing. " 'Not so strange, . . . for no Faun in Arcadia was ever a greater simpleton than Donatello. He has hardly a man's share of wit, small as that may be.' " (22) Later they both agree that Donatello's gamboling play is " 'the very step of the Dancing Faun.' " (29) The two are alike even in age, though so many years separate them, for Donatello, like his stone counterpart, " 'has a look of eternal youth in his face.' " The statue, morally as well as physically, represents the Donatello who exists at this point in the novel. The living faun's transformation will be viewed in terms of his departure from this stone norm, and the humanizing process will also be depicted at certain stages in other statuary shaped by Kenyon who, as spectator, is best able to view the change objectively.

While Praxiteles' "Faun" depicts and characterizes the young Count as he is at the beginning of the story, the two busts Kenyon makes of him portray him at other points in his moral development. The first of these is executed at Monte Beni. Since this is not long after the murder, Donatello's features mirror the emotional shock and the death of his innocence. This is difficult for the sculptor to capture, and indeed he gives up, but by "some accidental handling of the clay, entirely independent of his own will," Kenyon gives the countenance "a distorted and violent look, combining animal fierceness with intelligent hatred." (314) Hawthorne adds that, had Miriam and Hilda seen this bust, they would have recognized the face of the boy-faun as he was when in the act of murder. Donatello insisted that the bust not be changed so that he would have before him a reminder of his crime, but Kenyon would not agree.

Later in the novel, Kenyon executes another bust of his friend. Through Hilda's response to it, the reader becomes aware that this work has symbolic significance and, further, that it makes Kenyon's first attempt more significant too. " 'It gives the impression of a growing intellectual power and moral sense,' " Hilda says. " 'Donatello's face used to evince little more than a genial, pleasurable sort of vivacity, and capability of enjoyment. But, here, a soul is being breathed into him; it is the Faun, but advancing towards a state of higher development.' " (433) Kenyon is surprised at this, but Hilda advances the parallel a bit further. " 'Is it not, perhaps, the chance result of the bust being just so far shaped out, in the marble, as the process of moral growth had advanced in the original?' " It is indeed, but not by chance on the romancer's part, for previous to this discussion, he had mentioned in an aside that his reader was probably acquainted with Thorwaldsen's "three-fold analogy": "the clay model, the Life; the plaster cast, the Death; and the sculptured marble, the Resurrection." Donatello himself is the clay model, the living image of Praxiteles' "Faun" which captures the essence of the spirit of life. Kenyon's plaster cast was never put in a more permanent form and existed only for a few moments, but this was long enough for it to become symbolic of the instant death of Donatello's innocence and his immediate awareness of sin. The second bust, which Kenyon was executing in marble, captured the resurrection of a human being who had tasted sin and had developed morally through contact with it. In these three pieces of statuary there is a working out of the *felix culpa* theme which, because of Hawthorne's reticence to allow his characters to fully accept it, must finally be discounted. However, it does remain the theme of the novel, though phrased as a question rather than a statement.

Functioning in a more complex manner is the statue of Pope Julius. Here story, theme, and setting are all united as three of the four major characters come together at noon under the upraised hand of the venerable Pope, a reunion which signifies by Donatello's acceptance of Miriam that he has begun to develop, to realize that he must live in the world with his sin and share it with his fellow sinner. Here a familiar Hawthornian theme is being touched on: sin as a force which isolates man from his fellows and so damns him. But to a degree, this has been averted, for a divine approval seems to be given to Donatello's strange alliance with Miriam, for the "majestic figure" seems to bless them and approve "the pledge of a deep union that had passed under his auspices." (371) Donatello's attitude toward the stone pope also suggests a new reliance on God for mercy and forgiveness, for he compares it to the brazen serpent which Moses raised up in the wilderness for the healing of the Israelites when they were plagued by snakes. (361)

Two other examples of the use of sculpture may be mentioned briefly. One involves an analogy Hawthorne draws between the sylvan dance in the Borghese park and a bas-relief on an antique vase or the front of a sculptured sarcophagus. (110) Such ornamentation would depict a dance of satyrs, nymphs and other ancient poetic creatures; these are the stone counterparts of Donatello, Miriam, and their dancing comrades. But always in the art image, "some tragic event is shadowed forth or thrust sidelong into the spectacle," Hawthorne adds, and at this point, the spectre-model-monk enters the dance and the whole atmosphere of the scene changes, suggesting the evil influence he will presently have on Donatello and Miriam. Finally, there is the broken "Venus" which was found covered with earth in the excavations on the campagna. At first it seems it is Kenyon who discovered her, but this would be less appropriate, and the original find is attributed to Donatello. The "Venus" here is undoubtedly meant to symbolize the shattered ruin of the Faun's early pagan-like attraction to Miriam. Now, out of the ruins of their lives, suggested by the physical ruins in the area of the excavations, a mature, Christian-oriented relationship could develop, thanks to the humanizing experience Donatello has undergone.

Only in two or three instances are paintings or portraits important in connection with Donatello. In Miriam's studio he is startled by a picture of "a woman with long dark hair, who threw up her arms with a wild gesture of tragic despair, and appeared to beckon him into the darkness along with her. . . . 'When my eyes first fell upon her, I thought her arms moved, as if beckoning me to help her in some direful peril,' " he admits, foreshadowing the beseeching glance by which Miriam would cause him to murder the monk. (58) At this point, the innocent nature of the boy only occasionally recognizes the deeper, spiritual struggle Miriam (the woman in the portrait, of course) is having with her past which has come to light and life in the shape of the spectre-model.

At another point, the frescos in a saloon at Monte Beni are a comment on the frame of mind of the owner of the castle. Though they are faded and appear to be "like the ghosts of dead and buried joys," Donatello recalls that " 'when I brought my own cheerfulness into the saloon, these frescos looked cheerful too.' " (262) Now that the observer has changed, the faded paintings reflect the loss of *joie de vivre* of the Monte Beni descendant. Similarly, after his great sin Donatello comments on Fra Angelico's pictures to Kenyon, who is trying to pursuade him to look at some of them. " '. . . His angels look as if they had never taken a flight out of heaven; and his saints seem to have been born saints, and always to have lived so. Young maidens, and all innocent persons, I doubt not, may find great delight and profit in looking at such holy pictures. But they are not for me.' " (356) The beginnings of a conscience are evinced in this rejoinder, marking in yet another way the evolutionary process through which Donatello will completely lose his natural innocence.

Kenyon is the "man of marble," and he is consistently and naturally associated only with statuary throughout the novel. His work as an artist is to attempt to capture the idealized essence of a subject, and as Darrel Abel suggests, he himself represents something of an ideal in his role as a self-contained, fully developed artist—a standard, as it were, by which the other two artists may be measured.[8] It is inherent in the general role of the ideal artist to be detached somewhat from life about him; thus he is capable of looking more objectively at his surroundings. Kenyon is such a figure. He moves easily and unobtrusively through the narrative, for he is in accord with the other three major characters, yet somehow aloof from their susceptabilities. He is more stable intellectually and more fully developed aesthetically than the others, and this is why he can be a close friend and confidant to all three, different as they are. He is created in the mould of other Hawthornian characters such as Holgrave and Coverdale in that he is more often the spectator than the active participant in the action of the novel. Finally, he is able to see his art in relation to time. What is good is timeless and will endure; what is not is, like the portrait busts of contemporaries, simply "concretions and petrifactions of a vain self-estimate." (144)

Aside from the busts of Donatello already discussed, the "Cleopatra" is probably the most notable example of Kenyon's art. After a lengthy description of the statue which was really the work of William Wetmore Story, an intimate friend of the Hawthornes, the romancer comments on the "repose" of the work: "The spectator felt that Cleopatra had sunk down out of the fever and turmoil of her life, and for one instant . . . had relinquished all activity, and was resting throughout every vein and muscle." (152) Then, following a succinct comment on the features of the figure ("The face was a miraculous success"), there is a summing up of the spirit of the statue: "fierce, voluptuous, passionate, tender, wicked, terrible, and full of poisonous and rapturous enchantment. . . ." (153) This is Kenyon's work of art, and a strange one it is for the "man of marble" to have created. It may be that Hawthorne's enthusiasm for his friend Story's work carried him too far here, or it may be as Rudolph von Abele has suggested, that the "Cleopatra" represents a duality in the sculptor's attitude, for while he was fashioning her, "full of 'hot life,' fresh from the 'fire' of his imagination," he was also in love with the "spotless virgin" Hilda.[9] But as Kenyon shows his masterpiece to Miriam for the first time, she immediately recognizes a kindred being in her friend's creation, for she too is a strong, passionate woman. On the supposition that Kenyon has the insight into such a nature to be able to create a work like the "Cleopatra," Miriam appeals

[8]Darrel Abel, "A Masque of Love and Death," *University of Toronto Quarterly*, XXIII (October, 1953), 18.

[9]*The Death of the Artist* (The Hague, 1955), p. 90.

to him for sympathy and is about to take him into her confidence.[10] Just in time she senses his reluctance to share her secrets—perhaps a sensible Victorian attitude on his part, but also a reluctance peculiar to the artist who must look at the world with detachment, without becoming too involved in it. The "Cleopatra" characterizes him in his role as the artist who must have the insight to create an art product with life, yet with ideality; a timeless work, yet a work of individuality and particularity for his time and place. This statue also is a comment on Miriam, for she has in common with the Queen of the Nile her rich passionate nature. Her character is made more vivid and alive by her recognition of the kindred vitality in Kenyon's work of art.

Somewhat later in the novel, Hilda also sees the "Cleopatra," and though she sincerely admires it, it does not have the appeal for her that it has for Miriam. Her own nature and character are not reflected in it, and neither her aesthetic sense nor her womanly passion can give her an insight to equal that which her good friend experienced.

The small sculptured hand modeled on Hilda's is another interesting example of Kenyon's art. Illustrated here, of course, is not only his love for Hilda and his determination to possess her hand in marriage, but also his way of viewing every aspect of life about him in terms of his art. He also models "a beautiful little statue of maidenhood gathering a snow-drop." (427) Such a fragile, airy creation was never put into marble, but it suggests the "delicate character" the sculptor assumed while being "unconsciously wrought upon" by Hilda's influence.

Two other examples of Kenyon's art must be mentioned. One is a statue of a youthful pearl-fisher "who had got entangled in the weeds at the bottom of the sea, and lay dead among the pearl-oysters, the rich shells, and the sea-weeds, all of like value to him now." (142–143) This symbolizes the search and the sacrifice of the artist for the ideal in his art. Miriam, however, sees only a moral in it: " '. . . what a strange efficacy there is in death. If we cannot all win pearls, it causes an empty shell to satisfy us just as well.' " Perhaps this suggests her contentment with something less than the ideal in her own art. Finally, there is a bust of Milton which Kenyon has executed. It has been suggested that this piece of work is simply a tribute on Hawthorne's part to "one who had preceded him in probing deep into man's universal nature."[11]

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[10]This incident recalls a moment during the "moonlight ramble" when Miriam looks at the bronze equestrian statute of Marcus Aurelius on the Capitoline Hill and longs for someone such as the fatherly-looking old ruler to go to with her griefs and problems. Both statues, though the "Cleopatra" indirectly, draw from her an appeal for comfort and consolation.

[11]Roy R. Male, *Hawthorne's Tragic Vision* (Austin, Texas, 1956), p. 162.

The bust is then a reminder that Milton had considered in *Paradise Lost* the same theme of the fall of man which occupies Hawthorne in this novel.

Any work of art which relates to Miriam, whether she is the artist or whether she simply comments on it, is invariably highly significant. Since she, like Kenyon, is an artist with an artist's sensitivity, Hawthorne takes care that this aspect of the character-setting relationship is worked out very carefully. The first reference to Miriam's work serves to underline her predicament in the novel by characterizing her relationship with the spectre. After she meets him in the catacombs, he follows her about and serves as model for some of her work. Since he is evil, his influence immediately becomes apparent, for art is ideally a clear, pure medium of expression which would not fail to be changed by a negative element. The "shadow or reminiscence" of the features of the monk lingers in Miriam's drawings, and the "moral atmosphere of these productions was thereby so influenced, that rival painters pronounced it a case of hopeless mannerism, which would destroy all Miriam's prospects of true excellence in art." (47)

The chapter on Miriam's studio is especially interesting for its use of art. Through the device of having her show Donatello some examples of her work, the reader is introduced to a series of functional and symbolic pictures and drawings from which he may deduce Miriam's psychological attitude. (60–61) Each one of this stack of "pen-and-ink sketches and pencil-drawings" deserves some comment. In the first, Jael is depicted driving a tentnail through the temple of Sisera. (Judges, Ch. 4) In its initial conception, Jael had been pictured as "perfect womanhood," but by a "wayward quirk of her pencil," Miriam made her into a "vulgar murderess." The second sketch is of Judith after she had decapitated Holofernes. A third represents Salome receiving John's head on a charger. Hawthorne apparently got the idea for this sketch from Luini's picture in the Uffizzi Gallery, but he has Miriam imparting to the Roman daughter a sense of remorse and love which others have not so generously granted her. "Over and over again," Hawthorne writes, "there was the idea of woman acting the part of a revengeful mischief towards man," and the "moral" was always that "woman must strike through her own heart to reach a human life, whatever were the motive that impelled her." (61) One writer suggests that by "drawing sketches of violence, she tries to purge herself of the model's presence, but . . . fails by recognizing that the violence she imagines would be even more wicked if practiced than anything the model himself has done."[12] Hawthorne, however,

[12] Merle E. Brown, "The Structure of *The Marble Faun*," *American Literature*, XXVIII (November, 1956), 304.

seems to be implying here that Miriam has committed some deed for which she cannot be altogether condemned, but still a deed which may be held over her by someone who knows of her guilt or shares it with her. As a heroine she may have a mysterious background which must remain fascinatingly vague, but she must also be acceptably innocent to the other characters and the reader until her involvement in the crime of murder which motivates the novel. These sketches do not please Donatello, and even their creator admits that they are " 'ugly phantoms that stole out of my mind; not things that I created, but things that haunt me.' " (62)

Miriam has drawings of a different kind, however, things created in "a happier mood of mind, and one, it is to be hoped, more truly characteristic of the artist." (62) The subjects here are scenes of everyday life, and once again one may note Hawthorne's emphasis on the semi-Platonic ideal which shines through a work of art, for he writes that they were "so finely and subtilely idealized that they seemed such as we may see at any moment, and everywhere; while still there was the indefinable something added, or taken away, which makes all the difference between sordid life and an earthly paradise." The significant aspect of this group of sketches is that in almost every one "a figure was portrayed apart" which looked in as a spectator on the homey scenes of day-to-day life, a figure of which "the face and form had the traits of Miriam's own." (63–64) Again Hawthorne's theme of sin as an isolating force is touched on, though the exact sin which figures in Miriam's past is never made clear. Plainly she feels some guilt or responsibility and recognizes, in her own view at least, that this sets her apart morally from society about her.

One other picture in Miriam's collection must be mentioned. This is a self-portrait, a picture of a woman so beautiful "that she seemed to get into your consciousness and memory, and could never afterwards be shut out, but haunted your dreams, for pleasure or for pain. . . ." (65) She is one "Jewish aspect," and Donatello had no trouble at all in recognizing the subject. But what would a more refined observer have seen? Hawthorne suggests that the artist "had doubtless conveyed some of the intimate results of her heart-knowledge into her own portrait, and perhaps wished to try whether they would be perceptible to so simple and natural an observer as Donatello." (66–67) In yet another way, then, the author implies that Miriam has some secret to hide, but that it would take a kindred eye to detect it.

In another chapter, there is a third set of sketches. When the "aesthetic company" gathers in the apartment of one of its members, a discussion comes up over a group of faded and yellowed drawings. Hilda affirms that one of these had been executed by

Guido, a favorite of hers, and that the sketch was a rough draft for a painting that hung in the Church of the Cappuccini. This painting in turn had served as the model for a mosaic in a shrine in St. Peter's, the shrine at which Hilda was later to kneel in prayer. The sketch shows the Archangel Michael in the act of subduing a demon, and Hilda recalls that the artist had found it necessary to state publicly that no resemblance was intended between the demon of the painting and a certain Cardinal Pamfili. But the features of the devil seem somehow familiar to Hilda and Kenyon; Donatello immediately identifies them as those of Miriam's model. Hawthorne, as he often does, suggests by a series of questions all the possibilities for such a resemblence. It seems likely that a family relationship might be intended between the old Cardinal of Guido's time and Brother Antonio, Miriam's tormentor.

A visit to the Church of the Cappuccini for the purpose of reexamining the painting is proposed for the following day, and it is at this point that the painting begins to be revealing in connection with Miriam, for later on that very same evening of the discussion of the drawing, he and Donatello become guilty of murder. The next day at the church, Miriam, being the more articulate of the two, expresses a much stronger feeling about the painting when she views it and questions whether it is a valid representation of the struggle between good and evil. For her auditors she pictures the scene as it should be painted. The struggle would be grim and fierce; the Archangel would be wounded and the devil would writhe under his foot, still contesting the victory. But with all " 'this fierceness, this grimness, this unutterable horror, there should still be something high, tender, and holy in Michael's eyes, and around his mouth.' " (217)

Kenyon is impressed with her approach to the subject and suggests that she paint such a picture. Miriam replies that she is " 'sadly afraid the victory would fall on the wrong side.' " In her response to the picture, she is relating her own struggle with evil; victory in such a battle is not easy, as it would seem to be for Hilda, but involves a desperate struggle, one which Miriam herself has, in fact, just lost, for her final pronouncement is made as she recollects the murder on the preceding evening.

Hilda's admiration of Guido's dainty Archangel who, with unruffled wings and unhacked sword, has defeated the demon is indicative of the ease of her victory in her own struggles with evil, and recalls that she herself has throughout the novel been associated with the Virgin of her aloof shrine. In this instance she is characterized as the New England Puritan who really is pure in heart and whose Calvinism is sufficient unto any day. Her perception of evil is no greater than her perception of the depths of human character, for Hilda is a copyist, one who copies or imitates repeatedly the famous works of the European museums. She is so morally pure and aesthetically sympathetic that it is easy for her to enter into the intent of the artist and so achieve a better copy, a copy which captures the spirit of the work more satisfactorily than the work of her rivals. The old masters, Miriam tells Kenyon, are his " 'only rivals' " for Hilda's hand. She does not wish to be a creative artist, and her aloof nature limits her to dealing only with such works as are wholly moral, as for example Guido's "Archangel Michael." Even his "Beatrice," she insists at first, is sinless, though later she agrees that the luckless heroine deserved her fate. Still, the moral note is inherent in either attitude. A work with no obvious moral intention she would not have attempted to copy, and it was not her practice anyway to reproduce the whole painting, but to choose "some high, noble, and delicate portion of it, in which the spirit and essence of the picture culminated. . . ." (76) By subordinating her own talents, which were not inconsiderable, to those of the masters, she chose "the better and loftier and more unselfish part, laying her individual hopes, her fame, her prospects of enduring remembrance, at the feet of those great ones, who she so loved and venerated. . . ." (78) Such an attitude is obviously functional, underscoring dramatically the fact that Hilda is a conformist and an imitator, as contrasted with being a creative individualist.

After the tour of Miriam's studio, it is only to be expected that Hilda's studio will also be introduced into the story, but Hilda has only one painting that is significant, and it is more important for what it says about Miriam than about its creator. It is easy for Hawthorne to describe Hilda's work, for it is a copy of a famous painting by Guido, a portrait of Beatrice Cenci. The original was supposedly in the Barberini Palace and its owner would not let anyone copy it, though it was otherwise open for inspection. Like other artists, Hilda has studied the picture and carried it away in her heart bit by bit. According to Miriam, hers is the best copy yet made. The portrait of "a very youthful, girlish, perfectly beautiful face, enveloped in white drapery" is dominated by a note of sadness, and the eyes seem to make "a strange, ineffectual effort to escape." (82) The final effect is to make the viewer "shiver as at a spectre."

Hawthorne uses the portrait of Beatrice—and the connotations it must of necessity have—as a principal device in characterizing Miriam as tragically isolated from "the sphere of humanity." He never makes a definite connection between the two which would suggest that Miriam was directly modeled on Beatrice, nor does it seem likely that he meant it to be so. He simply uses the beauty of the subject and the aura of sin which the Cenci name evokes to suggest a similar vague background of sin for the beautiful Jewess who both condemns and understands the act imputed to Beatrice. The reader is undoubtedly meant to get the impression that she has been in a similar situation herself. She is not even certain herself of the extent of her own guilt and resents any reflection on her innocence. While looking at Kenyon's "Cleopatra," she surprises him with the statement that her conscience is " 'still as white as Hilda's' " and then adds, " 'Do you question it?' " Kenyon, of course, immediately replies in the negative. But as Miriam looks at her friend's copy of the "Beatrice," she is forced to disagree with Hilda's statement that the legendary beauty was a " 'fallen angel,—fallen, and yet sinless.' " " 'If I can pretend to see at all into that dim region, whence she gazes so strangely and sadly at us, Beatrice's own conscience does not acquit her of something evil, and never to be forgiven,' " Miriam says. Then she inquires of Hilda, " '. . . do you think that there was no sin in the deed for which she suffered?' " Hilda is forced to agree that Beatrice's was a " 'terrible guilt, an inexpiable crime' " and that " 'her doom is just.' " At this, Miriam becomes once more almost defensive: " 'Your judgements are often terribly severe,' " she replies to Hilda, " 'though you seem all made up of gentleness and mercy. Beatrice's sin may not have been so great: perhaps it was no sin at all, but the best virtue possible in the circumstances.' " The importance to Miriam of the degree of Beatrice's sin may be seen in her remark which sums up for her the whole conversation: " 'I would give my life to know whether she thought herself innocent, or the one great criminal since time began.' " (84–5)

At this point, the scene becomes most meaningful with the following development:

> As Miriam gave utterance to these words, Hilda looked from the picture into her face, and was startled to observe that her friend's expression had become almost exactly that of the portrait; as if her passionate wish and struggle to penetrate poor Beatrice's mystery had been successful. (85)

Here, in an attempt to fathom the secret of the picture, Miriam seems to give away some part of her own secret by unknowingly allowing Hilda to glimpse a sisterhood between her and the subject of the painting. Hawthorne's use of art in this case is highly functional, based on parallelism, for this is the first incident in a chain which leads Hilda to conclude the general nature of Miriam's guilt. In preparation for a later summary of the situation, it might be said at this point that if X equals the revealing expression on Beatrice's face, then Miriam's expression equals X, because in this scene they momentarily have this aspect in common.

The next step is an illustration of the innocence of Hilda which emphasizes her strange capacity to allow the mood of another artist to enter into her own so that she can duplicate the sprit of another's painting. Hawthorne comes to this in a scene just preceding that of Hilda's rejection of Miriam on the day after the murder. The picture of Beatrice is again the frame of reference, and this time a "peculiarity" of the portrait is mentioned which will be most important.

> It is a peculiarity of this picture, that its profoundest expression eludes a straightforward glance, and can only be caught by side glimpses, or when the eye falls casually upon it; even as if the painted face had a life and consciousness of its own, and, resolving not to betray its secret of grief or guilt, permitted the true tokens to come forth only when it imagined itself unseen. No other such magical effect has ever been wrought by pencil. (238–9)

Opposite the easel on which this picture rests is a mirror which reflects the faces of both the artist and the subject on the canvas. In "one unpremediated glance," Hilda experiences a moment of truth through her ability to enter into the mind of a subject. (239) "She fancied—nor was it without horror—that Beatrice's expression, seen aside and vanishing in a moment, had been depicted in her own face likewise, and flitted from it as timorously." She immediately feels guilt transferred to her own soul; yet she knows she is innocent of any sinful act. However, it was "the knowledge of Miriam's guilt that lent the same expression to Hilda's face," so she feels guilt simply by knowledge or "association," though she is, of course, innocent. Still, since her face mirrors Beatrice's expression for a moment, Hilda also assumes the quality associated with the expression X.

At this point, Hawthorne seems to step in in his own person to declare that Beatrice is indeed innocent. "Who . . . can look at that mouth . . . and not pronounce Beatrice sinless? It was the intimate consciousness of her father's sin that threw its shadow over her, and frightened her into a remote and inaccessible region, where no sympathy could come." (239) The lady's guilt, then, Hawthorne seems to be saying, is not really actual guilt at all, but a reflection of the guilt of her father—guilt by knowledge or "association." And X, the expression on the face of the picture, is now directly associated with Beatrice the subject whose innocence (for the purpose of the romance) Hawthorne has established.

Now, since Miriam's expression equals X, Hilda's equals X, and finally Beatrice's also equals X, presumably Miriam, Hilda and Beatrice should all be innocent, or if guilty in any degree, only so by "association," i.e., knowledge or acquaintance. Yet, of the three, presumably only Miriam may actually be considered guilty

—and this only since the night of the moonlight ramble—because she acquiesced in the murder of the monk. Before that time, it might be assumed that she, like Hilda and Beatrice, merely reflected the guilt of someone about her, possibly Brother Antonio—again guilt by "association." It is extremely subtle of Hawthorne to allow Hilda first to recognize Beatrice's innocence (which the romancer ascribes to her only later), and then, on Miriam's urging, to agree that Beatrice was guilty, though as Hawthorne suggests, only in her knowledge of a crime. This is the type of guilt Hilda recognizes in herself as she glimpses her image in the mirror; this is the type she knows Miriam harbors, for she has seen her give silent consent to the murder. In her shocked state of innocence, Hilda can show her friend no mercy. Hawthorne seems to suggest that true innocence is complete unawareness and ignorance of evil. At least, this seems to be so for such characters as Hilda and Donatello, who are never the same after their contact with sin. For both, however, such a contact led to a higher level of moral consciousness which recognizes sin in the world as an undeniable part of human existence. The portrait of Beatrice Cenci has functioned to demonstrate this, and to indicate subtly the type and degree of guilt of two major characters.

It only remains to note that the matter just discussed represents the principal instance in *The Marble Faun* of Hawthorne's use of the mirror motif. Here, the mirror, as always, symbolizes the truth of the imagination which finally is a more enduring and eternal truth than that reported through the medium of the physical world. Hawthorne is careful to use the right verb—"fancied"—when he has Hilda recognize in a moment the nature of Beatrice's guilt, for "fancy" here suggests the imagination, though Hawthorne did make some distinctions between them.

The portrait of Beatrice figures in the story once more, though somewhat incidentally. A young Italian artist notices Hilda standing before a portrait entitled "Joanna of Aragon" and captures on his canvas her expression at that moment. Hilda is attracted to the picture because she thinks she detects a slight resemblance to Miriam, but the young artist draws her gazing "with sad and earnest horror" at a spot of blood on her white robe. Hawthorne adds that the picture of Hilda attracted considerable attention and was thought to have been suggested by a copy of Guido's "Beatrice." The young artist called the picture "Innocence, dying of a bloodstain," and was laughed at for his trouble, for a viewer was all too apt to assume that the subject of the painting had perpetrated some dark deed to cause her to have that sad expression. But the young artist was insistent. " 'Can you look at the innocent anguish in her face, and ask that question?' " he demands. " 'No; but, as I read the mystery, a man has been slain in her presence, and the blood, spurting accidentally on her white robe, has made a stain which eats into her life.' " (378) The artist painted more wisely than he knew, of course, for the parallel of his interpretation with what actually happened is figuratively quite correct.

Two other chapters remain to be considered. Hilda is the only major character in these, for her friends have departed from Rome and she is left to herself with her knowledge of the crime of Miriam and Donatello. At such a time and in such a mood of despondency as is upon her, it is only natural that she turn to the great interest of her life—art—for solace. In Chapter XXXVII, "The Emptiness of Picture Galleries," Hawthorne does three things. First, there is a casual tour of the work of several famous painters that must have delighted readers who were familiar with Rome's art treasures. He also steps aside to make a few comments of his own which are relevant to Hilda and her immediate situation. For examples, he discusses Sodoma's fresco at Siena of Christ bound to a pillar. In her desolation, Hilda wishes to see this picture again, and the implication is that the artist captured emotions (e.g., "a sense of loneliness") which Hilda is experiencing at this time. Finally, and probably most important, Hawthorne illustrates in these two chapters (XXXVII–XXXVIII) the inefficacy of art as a consoling force for sorrowing mankind. He does this by causing Hilda, who is alone in the city to turn to art for comfort in her anxiety. But she has lost her sympathetic insight into the old masters, and with it the ability which had made her the best copyist in Rome. Why and how such a loss? Hawthorne seems to imply that her knowledge of the murder has brought about this "transformation," for he notes that "her capacity of emotion was choked up with a horrible experience," and "it inevitably followed that she should seek in vain, among those friends so venerated and beloved, for the marvels which they had heretofore shown her." (383) However, the fault is not all Hilda's. In writing of certain "Italian masters," Hawthorne puts a portion of the blame on the artists and their approach to their art. They were "not human," he says, "nor addressed their work to human sympathies, but to a false intellectual taste, which they themselves were the first to create. . . . they substituted art instead of nature."

Though Hawthorne does not directly say so, one wonders too if Hilda is not suffering because she has cut herself off from Miriam, her true friend. If this idea is acceptable, it would be another variation on the usual handling of the theme of the fall of man, for it would have Hilda sinning and suffering by deliberately isolating herself from another who needed her help and sympathy.[13]

Hilda, then, can no longer console herself with art. In Chapter XXXVIII, "Altars and Incense," she is to be found making a series of pilgrimages to the churches of Rome. Since art provides no consolation, she has begun to turn to God. Hawthorne toyed with the idea of the Virgin Mary as a mother-image for his character, but suggests his own rejection of Catholicism when he concludes that Hilda "never found just the virgin mother whom she needed." (396) Always there is a human element in the picture or statue which keeps the girl from kneeling to her. Only once does she go this far—at the shrine in St. Peter's which was decorated by the mosaic of Guido's "Archangel Michael and the Demon"—and then she quickly retracts her tribute.

The shrine adjacent to that decorated by the Guido mosaic is adorned with a painting by Guercino. It represents "a maiden's body in the jaws of the sepulchre, and her lover weeping over it; while her beatified spirit looks down upon the scene, in the society of the Saviour and a throng of saints." (401) Hilda comes to wonder whether she may not rise above her despondency and look at her situation as objectively "as Petronilla in the picture looked at her own corpse." This hope born in her foreshadows the scene in the confessional in the next chapter when Hilda does indeed get some relief from her anguish by telling a priest what she has witnessed.

The art in the setting of *The Marble Faun,* so well integrated with plot, theme and characterization, is the most colorful and interesting aspect of this romance. Without it, the book could hardly exist, for it provides an "objective correlative" around which the theme of "transformation"—the spiritual rise through a moral fall —is worked out. Art is used as a device for characterizing the several aspects of all four principal characters. It contributes to thematic development, and such works as the "Faun" and the "Beatrice" are unifying devices for the novel and important to its structure. But even were it not for these matters, the intrinsic value of art as a setting justifies Hawthorne's attempt to capture this aspect of the Roman scene of the 1850's. Surely it is not exaggerating to say that the American romancer was something of a pioneer in developing to such a great extent the role of art in a romantic fictional setting.

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[13]Arlin Turner, *Nathaniel Hawthorne, An Introduction and Interpretation* (New York, 1961), p. 64.

PREDATION BY INTRODUCED MUSKELLUNGE ON PERCH AND BASS, I: YEARS 1–5

*James R. Gammon and Arthur D. Hasler**

Introduction

This report summarizes the results of experiments in which young muskellunge were stocked in two small, bog lakes containing small numbers of normally-growing bass and large populations of stunted perch. Johnson (1954) initiated the study. He described the unbalanced perch and bass populations, found that many young bass were eaten by perch and postulated that a reduction in density of the perch would increase bass survival and eventually lead to a better balance between the populations. Similar conditions were found in nearby Corrine Lake and it was included in the study.

From 1953 to 1955, various methods, including the stocking of largemouth bass and walleye pike, netting and local application of rotenone, failed to reduce the numbers of perch. In May, 1956, 400 yearling muskellunge obtained from the Wisconsin Department of Conservation, Woodruff, Wisconsin, were stocked in George Lake. 395 large, young-of-the-year muskellunge were introduced into Corrine Lake in October, 1956.

The objectives of the study were to determine (1) the efficiency of the muskellunge as a predator (2) the growth rates of perch and bass and (3) the mortality rate of stocked muskellunge.

The Experimental Lakes

About 5% of the shoreline of George Lake (17.3 ha) and 80% of that of Corrine Lake (14.6 ha) consist of bog. In George Lake, the littoral area is mostly sand and rubble, while in Corrine Lake it is mostly muck. Aquatic vegetation is sparse in both lakes. There is a mid-summer absence of oxygen below three meters in Corrine Lake and below five and a half meters in George Lake. Morphometric characteristics are described by Gammon (1961).

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Methods

Fish were captured by a combination of fyke nets, electrofishing and angling. The initial annual estimate was the Schnabel type if less than 25% of the estimated population was marked or a Schumacher–Eschmeyer type if more than 25% were marked. This was followed by a Petersen estimate based on recapture data collected immediately after the initial estimate or during the following year. The majority of sample sizes were higher than those recommended by Robson and Regier (1964) for management studies. The independent estimates for most years were averaged since there was little reason to select one over another. The 1957 Corrine Lake estimates were generally poor because the fyke nets used were left stationary during a study of bass homing (Parker and Hasler, 1959) and the estimate based on 1958 data was regarded as the best. The marks and tags used on George Lake muskellunge permitted the useful calculation of 1956 and 1957 virtual populations, discussed by Parker (1958).

Scales were collected in 1958, 1959 and 1960 from members of all species of fish except muskellunge. These were removed from the right side near the tip of the pectoral fin, mounted dry and projected at 50 diameters magnification by means of a bioscope. Several scales from each fish were examined. Linear relationships between total lengths and anterior scale radii were determined for each population, but an acceptable regression was obtained only for the smallmouth bass, the only population in which good representation of all age groups was attained ($Y = 38.01 + 1.290\ X$, where Y = total length in mm and X = anterior scale radius in mm $\times$ 50). Accurate estimates of this relationship for the other populations were not possible because of the scarcity of largemouth bass younger than age 6 and perch older than age 2. Therefore, the X-intercept (22.8 mm) derived by Parker (1958) for largemouth bass in nearby Flora Lake was used for this species, while an X-intercept of 25 mm was used for perch. These latter correction factors, used in conjunction with a nomograph (Carlander and Smith, 1944; Hile, 1950), led to back-calculated growth rates at ages 1 and 2 which closely corresponded to those obtained by length frequency determinations.

The back-calculated lengths were used to determine the average rates of growth before and after the introduction of the muskelunge and the mean lengths at each age were then compared statistically by means of the "t" test.

The lengths and weights of all largemouth and smallmouth bass captured from 1955 through 1960 were transformed into common logarithms which were then used to calculate a regression of log weight on log length for each year of the study. An analysis of covariance was used to compare the adjusted mean weight found in 1955 with that of each subsequent year. The comparison for perch in George Lake was between a random sample selected from the 1955 catch and the combined catch of 1958, 1959 and 1960. The vast majority of these comparisons showed no statistical differences and it was concluded that the length-weight relationships of all species were unaltered after the introduction of muskellunge.

The food habits of bass and muskellunge were investigated by means of a stomach-flushing apparatus similar to that described by Seaburg (1957). This method has some disadvantages over the traditional procedure, but these were outweighed by the advantage of being able to return the fish to water unharmed, after flushing out the stomach. The stomach contents were examined, identified and enumerated as to frequency of occurrence.

Results

Largemouth Bass

There was little annual variation in the number of largemouth bass two years old and older before the introduction of muskellunge into George Lake (Table 1 and Figure 1). The relatively low estimate of 1952 does not include age II bass. Enough young bass entered the population annually to balance the losses during this period. The population doubled in size in 1957, apparently because of an unusually successful hatch in 1954, also recorded in nearby Flora Lake by Parker (1956), then decreased to its former level. With the exception of 1958, young largemouth bass were notably absent following the introduction of muskellunge. This was not the result of poor hatching conditions, because good numbers of fry were observed in 1957 and 1959 and excellent hatches occurred in 1958. This latter year class was only moderately abundant by 1959 and almost absent by 1960. With little recruitment, the population steadily declined following the introduction of muskellunge.

The changes in the largemouth bass population of Corrine Lake were generally similar, but more extreme (Table 2). Beginning in 1954 at a fairly high level, the population level dropped steadily until 1960. Few young bass entered the population following the introduction of muskellunge (Figure 2). An excellent hatch of young was observed in 1957, but few were found the next year. Reproductive success was poor thereafter until 1960 when fair numbers were again observed.

The mean length, its variance and 95% confidence interval at each age before and after the introduction of the muskellunge and the statistical comparison of each pair of means at each age are summarized in Tables 3 and 4. The only statistically significant

TABLE 1. SUMMARY OF POPULATION ESTIMATES OF LARGEMOUTH BASS OF AGE GROUP II AND OLDER IN GEORGE LAKE

Date	Sample Size	No. Recaps.	Estimated Population	95% Confidence Interval	Type of Estimate	Average of Estimates
1951[1]	55	25	93		S	
1951[1]	46	25	101	79–140	P (1952 data)	97
1952[1]	54	19	75[2]		S	
1952[1]	51	35	78[2]	66–101	P (1953 data)	77
1953[1]		45	27[3]		S	
1954	34	7	115		S	115
1955	145	321	147	122–166	SE	147
1956	66	24	132	98–198	SE	
1956	24	14	102	75–160	P (1957 data)	115
1957	69	16	200	149–302	SE	
1957	52	16	240	163–400	P (1958 data)	220
1958	53	26	88	63–146	SE	
1958	47	25	100	78–138	P (1959 data)	94
1959	35	13	112	53–∞	SE	
1959	26	10	91	57–182	P (1960 data)	101
1960	22	4	76	37–∞	SE	76

[1]Johnson, W. E. (1954).
[2]Excluding age group II.
[3]Age group II only.
S—Schnabel estimate.
P—Petersen estimate.
SE—Schumacher–Eschmeyer estimate.

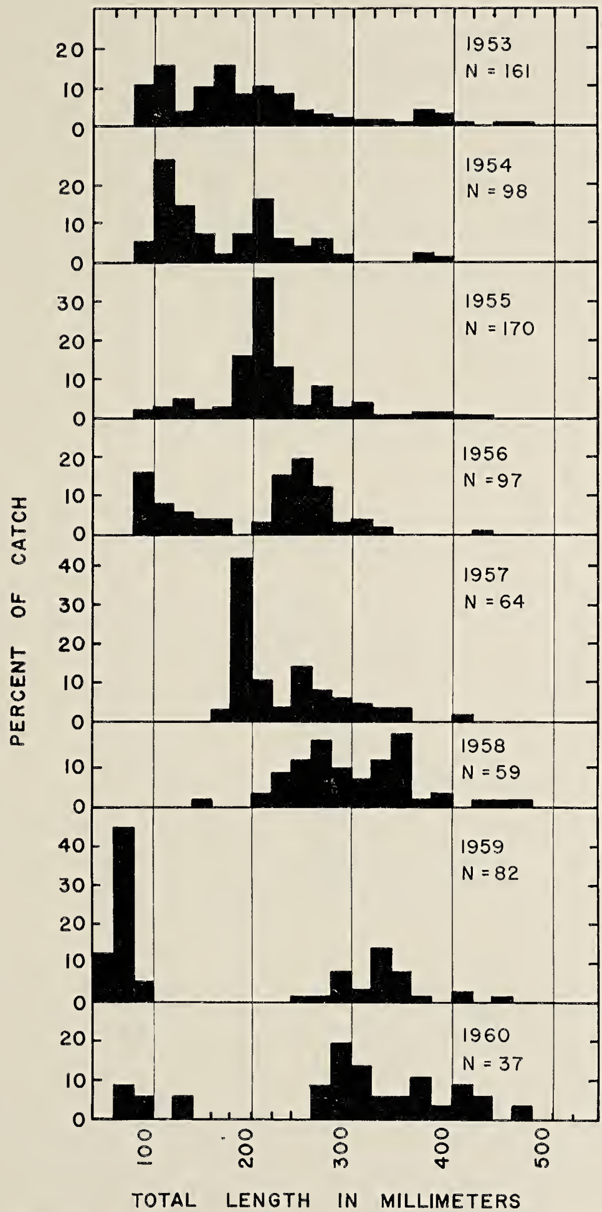

FIGURE 1. Annual catch of largemouth bass in George Lake from 1953 through 1960.

TABLE 2. SUMMARY OF POPULATION ESTIMATES OF NATIVE LARGEMOUTH BASS, AGE GROUP II AND OLDER, IN CORRINE LAKE

Date	Sample Size	No. Recaps.	Estimated Population	95% Confidence Interval	Type of Estimate	Average of Estimates
1954.........	128	26	207	156–308	SE	
1954.........	188	54	445	349–587	P (1954 data)	326
1956.........	279	108	231	192–290	SE	
1956.........	54	45	228	200–270	P (1957 data)	230
1957.........	88	36	58	30–100	SE	
1957.........	58	23	136	98–209	P (1958 data)	136
1958.........	110	44	77	62–101	SE	
1958.........	41	23	103	82–132	P (1959 data)	90
1959.........	58	13	94	66–156	SE	94
1960.........	8	0				40?

S—Schnabel estimate.
P—Petersen estimate.
SE—Schumacher–Eschmeyer estimate.

change in the growth of largemouth bass in George Lake was a reduced rate of growth in young-of-the-year. In Corrine Lake a statistically significant decrease occurred at age five.

Smallmouth Bass

The changes in the numbers of smallmouth bass, of George Lake, are quite different from those of the largemouth bass (Table 5). An initial increase in numbers occurred in 1956 owing to a large 1954 year class. Unlike the largemouth bass, however, the numbers did not return immediately to the original level but remained fairly level at more than twice the former abundance. This high level was maintained by a small, but steady production of young bass during the years following 1956 (Fig. 3), although a decline was measured in 1960.

A statistically significant increase in rate of growth was demonstrated only at age three (Table 6).

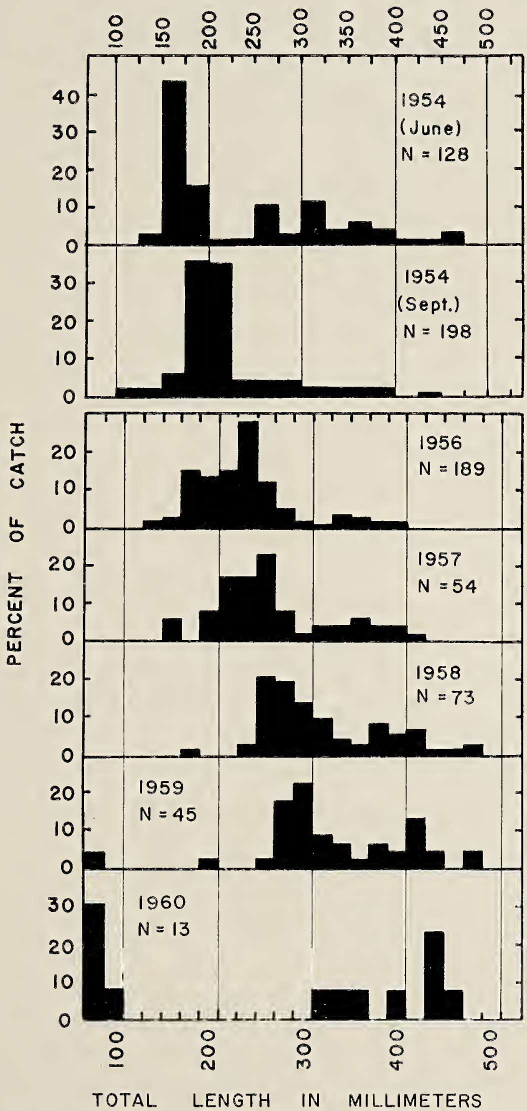

FIGURE 2. Annual catch of largemouth bass in Corrine Lake from 1954 through 1960.

TABLE 3. SUMMARY OF STATISTICS FOR COMPARISON OF THE GROWTH OF LARGEMOUTH BASS IN GEORGE LAKE BEFORE AND AFTER THE INTRODUCTION OF MUSKELLUNGE

AGE	PERIOD OF OBSERVATION								t
	Pre-treatment				Post-treatment				
	No.	s^2	mean length (mm)	$t_{.05}s_{\bar{x}}$	No.	s^2	mean length (mm)	$t_{.05}s_{\bar{x}}$	
1.........	42	284.3	82.8	5.25	8	35.4	70.8	4.98	3.616**
2.........	36	1115.6	159.6	11.32	9	1058.9	181.9	25.01	—1.695
3.........	31	1452.3	212.5	13.97	13	2033.7	231.5	27.25	—1.429
4.........	23	1581.9	246.4	17.20	20	1498.2	266.6	18.14	—1.682
5.........	17	1793.7	269.1	21.78	21	1246.5	293.2	16.07	—1.914
6.........	11	1378.9	295.6	24.94	24	1432.7	311.5	15.99	—1.160
7.........	7	1317.3	332.4	33.57	20	1443.3	331.0	17.78	0.091
8.........	5	1477.7	348.2	47.72	14	1650.6	342.5	23.46	0.273
9.........	3	2863.0	378	132.93	11	1024.7	345.6	21.50	1.363
10.........					8	1866.0	351.6	36.12	

**Acceptance probability 0.01.

TABLE 4. SUMMARY OF STATISTICS FOR COMPARISON OF THE GROWTH OF UNTAGGED LARGEMOUTH BASS IN CORRINE LAKE BEFORE AND AFTER THE INTRODUCTION OF MUSKELLUNGE

AGE	PERIOD OF OBSERVATION								t
	Pre-treatment				Post-treatment				
	No.	s^2	mean length (mm)	$t_{.05}s_{\bar{x}}$	No.	s^2	length (mm)	mean $t_{.05}s_{\bar{x}}$	
1.........	27	127.7	79.5	4.47					
2.........	27	586.5	151.8	9.58					
3.........	27	859.6	194.5	11.60					
4.........	19	1033.8	239.3	15.50	7	446.3	222.4	19.54	1.283
5.........	9	1132.6	297.1	25.87	10	615.6	266.7	17.75	2.257*
6.........	7	1363.5	336.9	34.15	10	1261.1	309.0	25.40	1.569
7.........	5	1163.7	361.8	42.35	4	2035.7	343.5	71.79	0.695
8.........	2	98.0	354.0	88.94	4	988.3	379.5	50.02	—1.064
9.........					3	276.5	412	41.31	
10.........					2	761.0	424	247.86	

*Acceptance probability <0.05.

TABLE 5. SUMMARY OF POPULATION ESTIMATES OF SMALLMOUTH BASS AGE GROUP II AND OLDER IN GEORGE LAKE

Date	Sample Size	No. Recaps.	Estimated Population	95% Confidence Interval	Type of Estimate	Average of Estimates
1951[1]	52	21	87		S	
1951[1]	55	33	87	70–115	P (1952 data)	87
1952[1]	68	29	81		S	
1952[1]	37	21	119	90–160	P (1952 data)	97
1952[1]	54	41	90	80–115	P (1953 data)	
1953[1]	?	34	60[2]		S	60
1954	25	2	97		S	97
1955	87	137	94	93– 95	SE	94
1956	138	82	203	176–239	SE	
1956	68	50	188	164–228	P (1957 data)	195
1957	101	63	147	116–202	SE	
1957	96	27	360	262–510	P (1958 data)	250
1958	109	40	238	192–313	SE	
1958	84	40	229	170–305	P (1959 data)	233
1959	84	26	249	199–333	SE	
1959	66	32	173	135–241	P (1960 data)	211
1960	56	21	132	104–179	SE	132

[1]Johnson, W. E. (1954).
[2]Age group III and older.
S—Schnabel estimate.
P—Petersen estimate.
SE—Schumacher–Eschmeyer estimate.

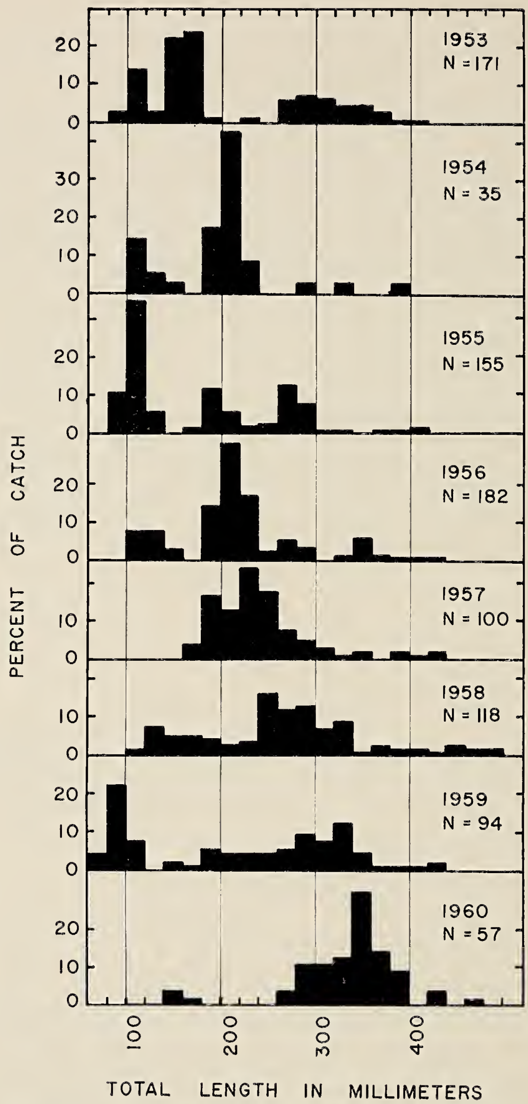

FIGURE 3. Annual catch of smallmouth bass in George Lake from 1953 through 1960.

Perch

The numbers of George Lake perch were decreasing before the muskellunge introduction (Table 7). By 1957 the numbers were so low that no population estimates could be obtained. In 1957 an effort of 104 fyke-net-days yielded only 21 perch. Ten days of fyke

TABLE 6. SUMMARY OF STATISTICS FOR COMPARISON OF THE GROWTH OF UNTAGGED SMALLMOUTH BASS IN GEORGE LAKE BEFORE AND AFTER THE INTRODUCTION OF MUSKELLUNGE

Age	Period of Observation								t
	Pre-treatment				Post-treatment				
	No.	s^2	mean length (mm)	$t_{05}s_{\bar{x}}$	No.	s^2	mean length (mm)	$t_{05}s_{\bar{x}}$	
1.........	81	59.0	89.6	1.70	40	153.2	93.2	3.96	—1.621
2.........	69	361.2	154.0	4.58	46	344.4	155.8	5.53	—0.508
3.........	53	544.1	202.0	6.43	38	479.6	218.6	7.19	—3.433**
4.........	25	722.2	254.0	11.09	35	777.4	265.5	7.22	—1.591
5.........	15	1122.4	295.5	18.56	19	725.7	304.8	12.99	—0.895
6.........	11	1020.1	345.1	21.46	10	1121.9	332.2	23.96	0.903
7.........	7	1655.2	378.0	37.63	7	845.3	348.6	26.89	1.556
8.........	3	250.5	414	39.32	6	1493.4	384.0	40.56	1.271
9.........	3	90.5	430	23.64	2	1478.0	429	345.40	0.062
10.........	3	212.5	443	36.21					

**Acceptance probability <0.01.

TABLE 7. SUMMARY OF POPULATION ESTIMATES OF AGE GROUP II AND OLDER PERCH IN GEORGE LAKE

Date	Sample Size	No. Recaps.	Estimated Population (thousands)	95% Confidence Interval (thousands)	Type of Estimate	Average of Estimates
1953[1]........	2880	30	157.9		S	
1953[1]........	2299	48	137.9	96–221	P (1953 data)	147,000
1954.........			107.7		P	107,700
1955.........	6654	299	61.3		S	
1955.........	3124	173	120.2	88–149	P (1955 data)	90,720
1956.........	1748	102	22.1		S	
1956.........	1290	56	40.3	30– 55	P (1956 data)	31,200
1957 to 1960..	NO ESTIMATE POSSIBLE					

[1]Johnson, W. E. (1954).
S—Schnabel estimate.
P—Petersen estimate.
SE—Schumacher–Eschmeyer estimate.

netting and electrofishing in May, 1958, produced only 18 small adult perch. The 19,600 perch removed by netting in 1953 and 1954 may have contributed to the early decline. The age structure can be seen in Fig. 4. Despite the extreme paucity of mature perch, excellent annual hatches of young were noted through 1960.

The moderately dense perch population of Corrine Lake increased slightly prior to the muskellunge introduction, stabilized at about 10,000 individuals thereafter, and then declined pre-

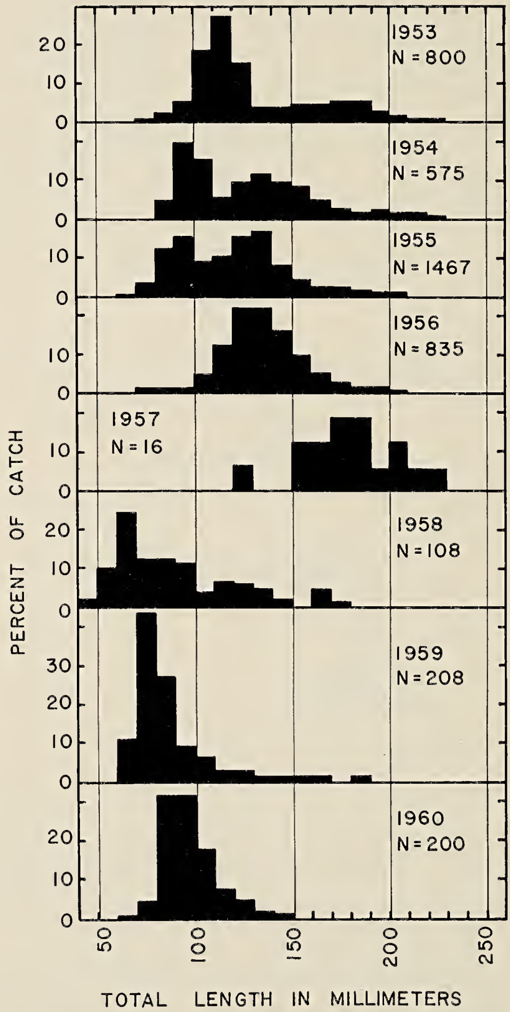

FIGURE 4. Annual catch of perch in George Lake from 1953 through 1960.

cipitously in 1959 (Table 8). In 1960 the age structure was similar to the George Lake population (Fig. 5).

An increase in the growth of the perch during the first two years of life occurred after the predators were introduced into George Lake (Table 9), but there was no increase in the growth of older fish. In Corrine Lake the average growth rate remained about the same (Table 10). The perch in both lakes grew at about the same rate as those in Weber and Silver Lakes (Schneberger, 1935) and Flora Lake (Parker, 1958). The growth rate of George Lake perch was also about the same as that found earlier by Johnson (1954).

Muskellunge

A high mortality seems to have taken place in George Lake muskellunge (Table II). Possibly as many as 25% perished during

TABLE 8. SUMMARY OF POPULATION ESTIMATES OF PERCH, AGE GROUP II AND OLDER, IN CORRINE LAKE FROM 1954 THROUGH 1960

Date	Sample Size	No. Recaps.	Estimated Population (thousands)	95% Confidence Interval (thousands)	Type of Estimate	Average of Estimates
1954.........	469	9	8.7		S	7,630
1954.........	527	35	6.5	4.8–9.5	P (1954 data)	
1956.........	511	27	10.3		S	
1956.........	1959	102	9.8	7.5–12.9	P (1956 data)	10,030
1957.........	414	85	1.2	1.0– 1.6	SE	
1957.........	459	87	2.2	1.9– 2.6	P (1957 data)	11,200
1957.........	1016	37	11.2	8.3–15.6	P (1958 data)	
1958.........	1016	56	7.0		S	
1958.........	283	24	12.0	8.5–18.0	P (1958 data)	9,480
1959.........	294	27	1.9		S	1,900
1960.........	NO ESTIMATE POSSIBLE					

S—Schnabel estimate.
P—Petersen estimate.
SE—Schumacher-Eschmeyer estimate.

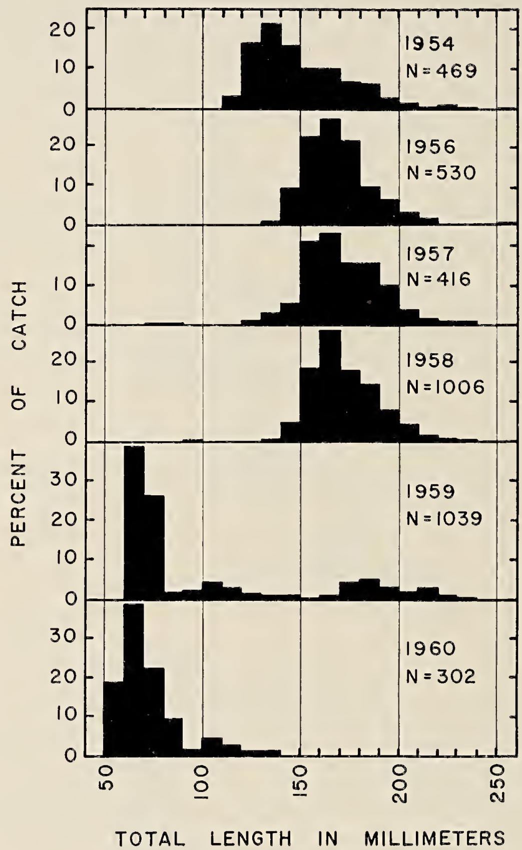

FIGURE 5. Annual catch of perch in Corrine Lake from 1954 through 1960.

TABLE 9. SUMMARY OF STATISTICS FOR COMPARISON OF THE GROWTH OF YELLOW PERCH IN GEORGE LAKE BEFORE AND AFTER THE INTRODUCTION OF MUSKELLUNGE

Age	Period of Observation								t
	Pre-treatment				Post-treatment				
	No.	s^2	mean length (mm)	$t_{05}s_{\bar{x}}$	No.	s^2	mean length (mm)	$t_{05}s_{\bar{x}}$	
1..........	31	33.1	55.4	2.11	43	127.0	62.0	3.47	—3.327**
2..........	17	148.9	81.9	6.28	47	129.2	93.1	3.35	—3.412**
3..........	6	115.8	114.8	11.30	14	189.8	112.8	7.95	0.323
4..........	4	220.7	149.0	23.64	8	368.3	139.5	15.65	0.861
5..........					5	75.8	161.2	10.81	

**Acceptance probability <0.01.

TABLE 10. SUMMARY OF STATISTICS FOR COMPARISON OF THE GROWTH OF YELLOW PERCH IN CORRINE LAKE BEFORE AND AFTER THE INTRODUCTION OF MUSKELLUNGE

Age	Period of Observation								t
	Pre-treatment				Post-treatment				
	No.	s^2	mean length (mm)	$t_{05}s_{\bar{x}}$	No.	s^2	mean length (mm)	$t_{05}s_{\bar{x}}$	
1..........	50	46.8	67.6	1.95	31	60.8	65.7	2.86	1.188
2..........	41	130.2	103.6	3.60	39	72.5	93.0	2.76	4.739**
3..........	34	132.9	129.7	4.04	15	285.4	124.2	9.39	1.145
4..........	30	194.3	145.8	5.21	9	569.2	154.8	18.34	—0.958
5..........	20	197.4	163.4	6.58	11	288.7	160.4	11.41	0.519
6..........	11	271.0	172.8	11.06	15	132.7	174.4	6.38	—0.288

**Acceptance probability <0.01.

TABLE 11. SUMMARY OF THE ESTIMATES OF THE MUSKELLUNGE POPULATION IN GEORGE LAKE FROM 1956 THROUGH 1960

Date	Sample Size	No. Recaps.	Estimated Population	95% Confidence Interval	Type of Estimate	Average of Estimates
May 1956....			400			400
June 1956....	104	27	226	163–369	SE	
			274		V	300
	59	15	378	346–400	P (1957 data)	
June 1957....	58	8	210	150–350	SE	
			178		V	
	45	8	290	217–400	P (1957 data)	250
	72	15	261	181–400	P (1958 data)	
May 1958....	72	14	213	171–281	SE	
	44	23	137	108–189	P (1959 data)	175[1]
May 1959....	39	11	113	73–400	SE	130
June 1960....	15	3	67	22–400	SE	67

P—Petersen estimate.
SE—Schumacher–Eschmeyer estimate.
V—Virtual population.
[1]45 muskellunge removed in August 1957.

the 49 day period following their introduction. A weighted estimate of the subsequent survival rate (0.76) was calculated as follows:

$$s = \frac{N_2 + N_3 + \ldots. + N_n}{N_1 + N_2 + \ldots. + N_{n-1}}$$

where s = annual survival rate
N_1 = estimated population size in 1956
N_2, N_3, etc. = estimated population size in later years

In Corrine Lake, where a similar mortality did not occur (Table 12), the estimated annual survival rate, excluding the 1960 estimate, was 0.87. These survival rates are higher than that reported by Crossman (1956), but are similar to the estimates of 0.78 and 0.71 derived from the catch data of Schloemer (1936) and Helm (1960).

TABLE 12. SUMMARY OF THE POPULATION ESTIMATES OF THE MUSKELLUNGE IN CORRINE LAKE FROM 1956 THROUGH 1960

DATE	SAMPLE SIZE	NO. RECAPS.	ESTIMATED POPULATION	95% CONFIDENCE INTERVAL	TYPE OF ESTIMATE	AVERAGE OF ESTIMATES
Oct. 1956.....			395			395
June 1957....	30	4	116		S	
	79	13	182	113–339	P (1957 data)	325
	141	13	325	201–604	P (1958 data)	
May 1958....	133	48	277	212–393	SE	
	81	33	346	272–497	P (1959 data)	310
May 1959....	79	15	263	154–984	SE	
	79	15	227		S	245
1960....	30	0				150?

S—Schnabel estimate.
P—Petersen estimate.
SE—Schumacher–Eschmeyer estimate.

During 1958 and 1959 the stomach contents of 220 muskellunge were examined (Table 13). About one-third of these contained food, all of which was fish except for two gyrinid beetles. Other studies have shown the muskellunge to be almost exclusively piscivorous, (Hourston, 1952; Parsons, 1958; Anderson, 1948). The bulk of the diet consisted of perch, the ratio of smaller to larger perch eaten corresponded closely to their actual ratio in the lakes.

The initial population estimates were made by fin-clipping. Beginning in 1958 all muskellunge captured were tagged with numbered plastic tags attached to stainless steel wire which was sewed around the preopercular bone. In 1959 it was found that the wire tended to move posteriorly through the preopercular bone leaving a distinguishable track. Annual tag losses were approximately 20%, a higher loss than that found by Crossman (1956).

Muir (1960) has shown this tag to be deleterious to the growth of muskellunge. There was no adverse effect on the growth of muskellunge in George Lake, but there was in Corrine Lake. An analysis of covariance indicated no difference in the length-weight relationship (see Gammon 1961).

TABLE 13. FREQUENCY OF OCCURRENCE OF FOOD ITEMS IN THE STOMACHS OF MUSKELLUNGE IN GEORGE AND CORRINE LAKES

	George Lake				Corrine Lake			
	1958		1959		1958		1959	
Number empty	27		13		75		31	
Number containing food	18		6		38		12	
Food Items	f	%	f	%	f	%	f	%
Perch								
yearlings and smaller	6	33.3	4	66.7	10	26.3	6	50.0
larger	2	11.1			13	34.2	4	33.3
Largemouth Bass								
yearlings and smaller	7	38.9			2	5.3		
larger								
Smallmouth Bass								
yearlings and smaller								
larger			1	14.3				
Unidentified fish	3	16.7	1	14.3	12	31.6	5	41.7
Coleoptera								
adult	1	5.6						
immature					1	2.6		

The growth rate of muskellunge (Figures 6 and 7) in George Lake decreased considerably from 1959 through 1960. A lack of appropriate food was probably responsible for this, since perch of all sizes were abundant only during the first year following the introduction of muskellunge. Many small perch were available after 1957, but few were larger than four inches, and the muskellunge probably could not capture enough of these to allow for normal growth. It is likely that the depression in growth rate would have occurred earlier except for the production of the extremely large 1958 year-class of largemouth bass. That year the muskellunge grew faster than they did either the previous or the succeeding year. The analysis of stomach contents shows that bass fry and fingerlings were prominent in the diet (Table 13). Growth of muskellunge in Corrine Lake was slow during the first summer, gradually increasing with each year. In the fourth year of life, fish from both populations were of the same length. The growth rate of both populations was below that of the average for muskellunge in Wisconsin (Schloemer, 1936) (Figure 8).

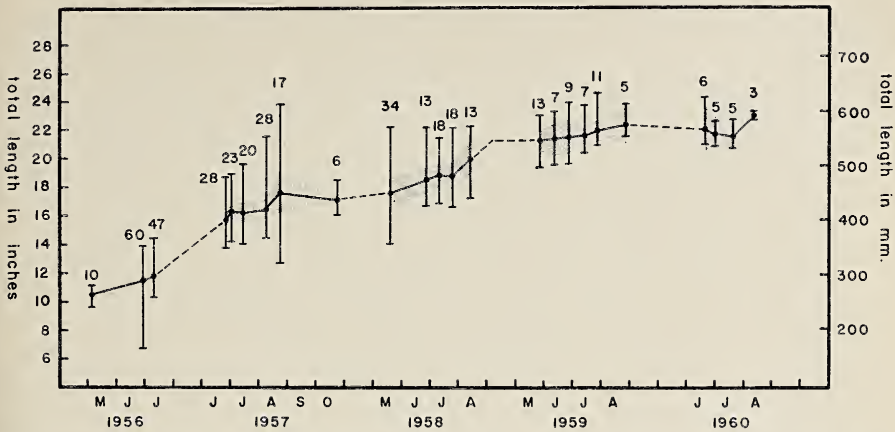

FIGURE 6. Growth of muskellunge in George Lake including the sample size, the range in length, and the mean length and its 95% confidence interval.

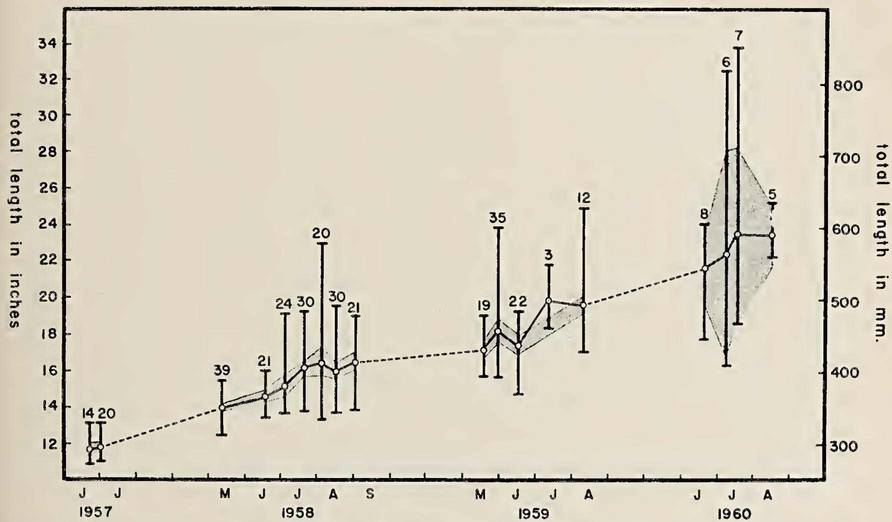

FIGURE 7. Growth of muskellunge in Corrine Lake including the sample size, the range in length, and the mean length and its 95% confidence interval.

DISCUSSION

The investigations of Alm (1946) have shown that cycles of population abundance occur regularly in bog lakes of Sweden which contain European perch, *Perca fluviatilis,* and few other fish. This cycle began with the production of a new, strong year class which proceeded to dominate the population for a number of years by preying heavily on their own young and preventing significant re-

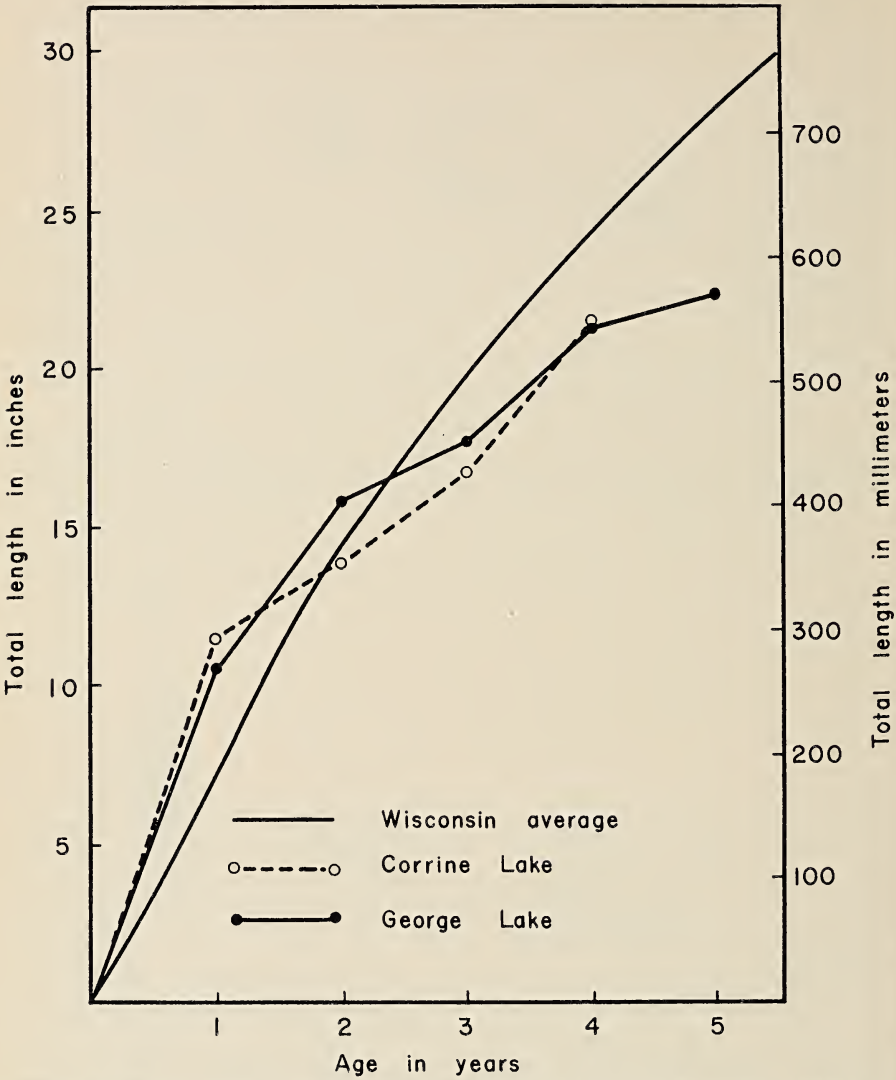

FIGURE 8. The growth rates of muskellunge in George and Corrine Lakes as compared to the average for muskellunge in Wisconsin.

cruitment. Only after this strong year class became greatly diminished in numbers toward the end of their life span was a new, strong year class produced. Although no similar research has been conducted in North America, it seems possible that abundance cycles might also be generated by *Perca flavescens* populations in lakes containing few other species. The two species are similar in many respects, including food habits, and differ primarily in life span. Shorter cycles would be expected in *P. flavescens* populations because of the shorter life span of this species.

The postulation of such a cycle of abundance is helpful in interpreting the events which followed the introduction of muskellunge into George and Corrine Lakes. The course of events following the introduction seem to have depended upon the timing of the introduction in relation to the abundance cycle of the perch.

In George Lake the total number of perch was being reduced by netting between 1953 and 1956. Yearling perch were very abundant in 1955, perhaps beginning a new cycle of abundance, and were probably the main source of food for the small muskellunge in 1956. The muskellunge grew rapidly and by the end of the first summer averaged more than 15 inches in length, long enough to eat any but the largest perch. The combination of predation on the strong 1954 year class and natural mortality of older perch could have led to a collapse of the population. The age distribution of perch changed greatly in 1958, two years after the introduction of muskellunge (Figure 4). The subsequent annual growth of the muskellunge depended greatly upon the success of the annual hatch of perch and bass which was inadequate to allow for normal growth even in the best years. All evidence available supports the view that the perch density remained low between 1957 and 1960 because of predation by muskellunge and bass. Few small perch were present when the muskellunge were introduced, and most of the population consisted of individuals too large to be eaten. Actually, these large perch were probably competing with the muskellunge for the same food items during the first year. The muskellunge grew slowly at first, but had grown sufficiently large by 1958 to prey upon some of the older perch. The number of small perch increased only when the number of old perch decreased (Figure 5). The age distribution of this population, as was the case with the George Lake fish, changed about two years after the introduction of the predator. Moreover, it has been demonstrated by Gammon (1961) and by laboratory studies (Gammon, 1963) that, in this study the prey consumed bears a theoretically feasible relation to the calculated production of predator flesh.

Another aspect of this study that bears discussion is the differential change in the large and smallmouth bass populations following the muskellunge introduction. The largemouth bass populations of both lakes declined steadily in spite of strong year classes produced in 1957 and 1958. The population of adult smallmouth bass actually increased during the same period, although no exceptional year classes were produced in any year. Indeed, consistently fewer young smallmouth bass were observed annually than young largemouth bass.

The difference in the relative abilities of these two species to survive the extensive predatory activity of muskellunge appears to be explainable from different early behavior and habitat preference. Young largemouth bass formed and maintained dense schools from hatching, well into the second summer. Moreover, these schools, as determined by netting and underwater observation, were closely associated with cover of some kind, usually beds of vegetation and brush piles. Smallmouth bass were also found in schools shortly after hatching, but these became more and more diffuse and by mid- or late July disappeared. After this time the individuals were found scattered singly or in small groups in the shallow water near shore, often in rocky or sandy areas. These behavioral patterns have also been noticed by Rodeheffer (1939, 1944), Bennett and Childers (1957) and Ridenhour (1958).

In George and Corrine Lakes the largemouth bass congregate in the very same scattered areas that are preferred by the muskellunge. If the density of muskellunge had been lower or if a greater number of individuals of other species had been available, much better survival of the young largemouth bass might have been expected.

Smallmouth bass, on the other hand, increased in numbers even though no exceptionally large year classes were produced. It seems likely that here, too, the reduction in perch density aided the survival of fry and that the different habits of the smallmouth bass acted in such a manner as to reduce contact between themselves and the muskellunge.

Summary

Two small northern Wisconsin lakes containing perch and bass were stocked with young muskellunge and the changes in population density, growth rate and length-weight relationship were measured. Within a year, perch in one lake decreased from 31,000 individuals to a density which was too low to estimate. Three years lapsed before a comparable reduction occurred in the other lake. Population levels of largemouth bass decreased because of the virtual absence of small bass surviving to the third summer of life, although several strong year classes were produced. Population levels of smallmouth bass increased significantly because of a net increase in recruitment, although no strong year classes were observed. The different responses of these two species appear to be related to differences in the schooling tendencies and habitat preferences of the young. The growth rate of one- and two-year-old perch increased after the reduction in the number of perch. The length-weight relationship of all species remained unchanged. About 25% of the muskellunge stocked in the spring was unaccounted for after

one and a half months, but there was no evidence of a similar high mortality of those stocked in the fall. After the initial loss, a relatively constant annual mortality rate of 20% to 25% was observed in both populations.

Abstract

Two small northern Wisconsin lakes containing perch and bass were stocked with young muskellunge and the changes in population density, growth rate and length-weight relationship were measured. Within a year, perch in one lake decreased from 31,000 individuals to a density which was too low to estimate. Three years lapsed before a comparable reduction occurred in the other lake. Population levels of largemouth bass decreased because of the virtual absence of small bass surviving to the third summer of life, although several strong year classes were produced. Population levels of smallmouth bass increased significantly because of a net increase in recruitment, although no strong year classes were observed. The different responses of these two species appear to be related to differences in the schooling tendencies and habitat preferences of the young. The growth rate of one- and two-year old perch increased after the reduction in the number of perch. The length-weight relationship of all species remained unchanged. About 25% of the muskellunge stocked in the spring was unaccounted for after one and a half months, but there was no evidence of a similar high mortality of those stocked in the fall. After the initial loss, a relatively constant annual mortality rate of 20% to 25% was observed in both populations. The course of events which followed the introduction of the predator is discussed in relation to a postulated cycle of perch abundance.

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PREDATION BY INTRODUCED MUSKELLUNGE ON PERCH AND BASS, II: YEARS 8–9

*William R. Schmitz and Roland E. Hetfeld**

Introduction

The changes in the population density, growth rate, and length-weight relationships of the resident fish populations following the introduction of muskellunge into two Wisconsin bog lakes have been described by Gammon and Hasler (1965). During the five years following the introduction: the perch virtually disappeared; the largemouth bass decreased in number; the smallmouth bass, in the lake containing this species, increased in number; increases in the rate of growth of the perch accompanied the reduction of the adult perch population; little change in the rate of growth of the basses occurred, and no changes in the length-weight relationship of any resident species occurred; the annual rate of mortality of the muskellunge was 20–25%, and the growth of this species was exceptionally slow.

This paper describes the results of continued observations on the same lakes during the eighth and ninth years after the introduction of young-of-the-year muskellunge. The objectives of this study are to determine the effect of the decreased stock of muskellunge on the resident fish; to determine changes in the rate of growth of the resident fish; and finally to verify the annual rate of mortality of the predator.

Methods

The lakes employed in this study are George Lake (17.3 ha) and Corrine Lake (14.6 ha), both in Vilas County. They are described briefly by Gammon and Hasler (1965) and in detail by Gammon (1961).

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*Contribution from the Laboratory of Limnology, Department of Zoology, University of Wisconsin–Madison. We are indebted to Mr. Guido Rahr, Rainbo Lodge, the Notre Dame University, and the Wisconsin Conservation Department for the use of their facilities and lands in this work. The financial support of Rainbo Lodge and the National Science Foundation Research Participation Program are gratefully acknowledged. Dr. Schmitz is Assistant Professor of Zoology and Botany at the University of Wisconsin, Marathon County Center, and Mr. Hetfeld is instructor in biology at Merrill High School, Merrill, Wisconsin.

Except for measurements of the survival of the predator which was estimated in both lakes, most observations were confined to Corrine Lake.

Fish were captured by means of fyke nets. There were two distinct periods of netting in each of two years. Muskellunge were netted in May. In 1963, muskellunge captured were measured, weighed and removed from the lake. In 1964 they were measured, weighed and marked by means of fin clipping and returned to the lake. Population estimates were of the Petersen type (Bailey modification) based on subsequent recaptures later in May and in June. The perch was the only species caught during this May period. The catch of perch during May of 1963 contained disproportionately high numbers of small males and fishing for this species was thereafter relegated to the second netting period in June and early July.

During the June–July period of netting, all species were captured by means of small-mesh fyke nets (approximately 10 mm bar mesh). All perch age II and older were measured, fin clipped and returned to the lake. A Schnabel estimate was made of the perch during this period in each of the two years. It is assumed that marked fish and unmarked fish were equally vulnerable to natural mortality and subsequent fishing by the nets. No adjustment was considered necessary for recruitment into the fishable population because of the brief duration of netting i.e. 21 days in 1963 and 16 days in 1964. Muskellunge captured were removed from the lake. Largemouth bass were measured, weighed and returned. Insufficient numbers of this latter species were caught for purposes of estimating the population. Scale samples were taken from perch. Scales were collected and processed, in the standard manner. The back-calculated lengths obtained for the perch were used to determine the average rates of growth for statistical comparison with the pre-treatment control i.e. the period prior to the introduction of the muskellunge in 1956.

No estimates of the size of the populations of largemouth bass were made. The adult part of the bass population remained so low in Corrine Lake that an estimate of its size was impossible. Seven adults were captured in 1963 and eight in 1964. In 1963, in addition to the seven adults, 80 bass of age I were captured. None of these fish exceeded 140 mm in total length (range = 83 to 132 mm, $\bar{x} = 106.6$ mm, $s_{\bar{x}} = 1.18$, $n = 80$).

The percent catch of the various size classes of the 1963 catch is presented in Fig. 1 and the significance of the distribution is discussed below.

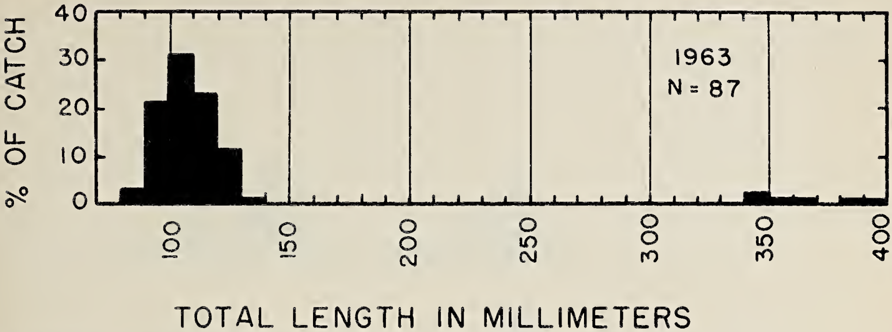

FIGURE 1. Catch of largemouth bass in Corrine Lake in 1963.

Perch

Gammon and Hasler (1965) reported that the part of the perch population age II and older in Corrine Lake was too small to census by 1960. The population estimates of 1963 and 1964 (Table 1), show a recovery in numbers. However, the size-distribution of the 1963–64 fish was not unlike that of 1960 in that few fish exceeded 150 mm in length. By contrast, the population of 1959 included individuals to 240 mm in total length (Figure 2).

The mean size of the individual perch captured in 1964 was greater than that of those captured in 1963 (see Table 2).

Scale samples from the four year classes represented in the perch catches of 1963 and 1964 were used to back calculate the length of these fish during the years since 1959. That these fish grew at a significantly greater rate as compared with the pre-

TABLE 1. POPULATION ESTIMATES OF PERCH IN CORRINE LAKE IN 1963 AND 1964

Date	Age Group	Sample Size	No. Recaps.	Estimated Population (thousands)	95% Confidence Interval (thousands)	Type of Estimate
1963	I	12				none possible
1963	II and older	940	38	12.1	8.8–19.1	Schnabel
1964	I					*
1964	II and older	752	158	2.2	1.9– 2.5	Schnabel

*No estimate was made, however exceedingly high catches e.g. as many as 2500 per single net, were counted.

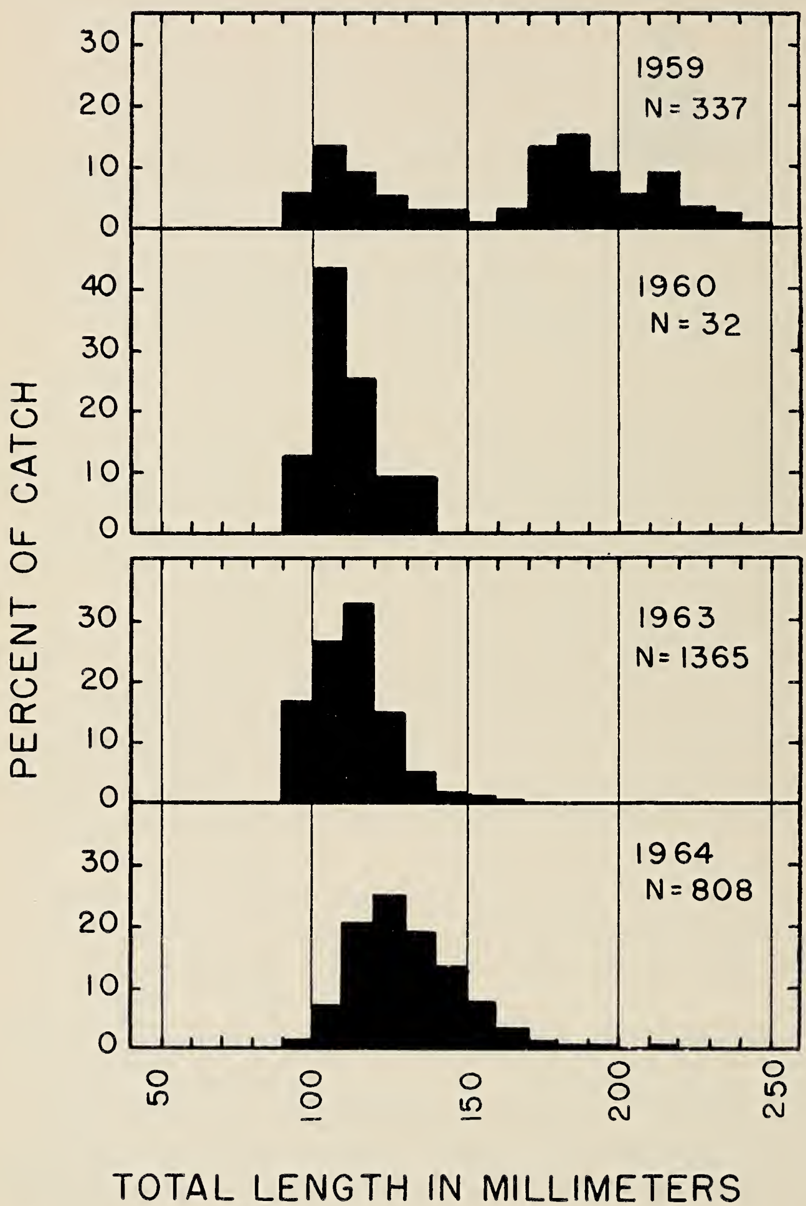

FIGURE 2. Annual catch of perch 90 mm and larger in Corrine Lake 1959–1964.

TABLE 2. MEAN SIZE OF PERCH AGE II AND OLDER IN CORRINE LAKE

Year	Total Length				Weight			
	No.	range (mm)	mean (mm)	$s_{\bar{x}}$	No.	range (gm)	mean (gm)	$s_{\bar{x}}$
1963	874	77–168	112.0	0.382	268	3–36	12.1	0.959
1964	342	76–198	128.3	0.948	415	3–80	19.1	0.142

treatment rate of growth is shown in Table 3. Gammon and Hasler found significant increases in the growth of perch in George Lake, only after the decline of the perch population (1965). Likewise, no significant increases in rate of growth were detected in Corrine until after the reduction of the perch that occurred during 1959 and 1960.

Although the analysis is not shown here, still greater increases can be demonstrated by comparison of the rate of growth of only those year classes living after the near demise of the perch in 1960 i.e. the 1960, 1961 and 1962 year classes, with the pretreatment rate of growth.

The 38 muskellunge trapped in Corrine Lake during 1963 were removed from the lake. Petersen (Bailey modification) estimates of the muskellunge populations were made only during 1964. In

TABLE 3. SUMMARY OF STATISTICS FOR THE COMPARISON OF THE GROWTH OF THE PRETREATMENT[1] AND THE 1959–62 YEAR CLASSES[2] OF PERCH IN CORRINE LAKE

Age	Period of Observation								t
	Pretreatment				1959–62 year classes				
	No	s^2	mean length (mm)	$t_{.05}s_{\bar{x}}$	No.	s^2	mean length (mm)	$t_{.05}s_{\bar{x}}$	
1	50	46.8	67.6	1.95	117	121.7	82.6	2.02	5.88**
2	41	130.2	103.6	3.60	117	224.2	113.7	2.73	2.46*
3	34	132.9	129.7	4.04	51	563.8	130.6	6.66	0.136
4	30	194.3	145.8	5.21	20	172.8	149.0	6.15	0.310
5	20	197.4	163.4	6.58	3	240.5	184	38.5	0.763

*Acceptance probability <0.05.
**Acceptance probability <0.01.
[1]From the data of Gammon and Hasler (1965).
[2]From the 1963–64 collections of this study.

George Lake the best estimate (16 May) was 23 individuals (95% confidence interval = 19–58). The best estimate for Corrine Lake (15 May) was 35 individuals (95% confidence interval = 24–133).

An annual survival rate of 0.76, applied to the last population estimate made by Gammon and Hasler (1965) for this species, in both George and Corrine Lakes, yields approximately the populations estimated for May of 1964, provided the removals are taken into consideration.

The size of the muskellunge is shown in Table 4. Gammon and Hasler (1965) found a marked decrease in the rate of growth of this species only in George Lake (see Fig. 3). The curve of the mean weights indicates that the change in rate must have occurred during 1960 and that this lower rate persisted in the absence of sufficient numbers of forage fish.

TABLE 4. MEAN SIZE OF MUSKELLUNGE IN CORRINE AND GEORGE LAKES

Date	Total Length				Weight			
	No.	range (mm)	mean (mm)	$s_{\bar{x}}$	No.	range (gm)	mean (gm)	$s_{\bar{x}}$
Corrine Lake								
7 June 63	38	510–727	621	6.3	38	737–2098	1316	38.5
5 June 64	23	505–930	660	15.5	23	652–5330	1586	183
George Lake								
7 May 63	14	595–685	636	7.2	6	879–1474	1124	80.4
1 June 64	3	640–744	708	34	2	1474–2183	1828	

DISCUSSION

Cycles of abundance such as those described by Alm (1946), or synchronous variation in strength of year-class observed by LeCren (1955) would complicate the interpretation of the results of any introduction of predator species. However, certain observations made during these eighth and ninth years and in the earlier years as well, can be related directly to the action of the introduced predator, i.e. the continued elimination of nearly all perch and largemouth bass in excess of 150 mm in length (Figs. 1 and 2). That these missing size-classes are not merely the result of reduced reproductive success, is attested to by the failure of strong year classes to enter the larger size classes e.g. 1957, 1958 and 1959 year classes of bass and the 1960 year class of perch (Gammon and Hasler 1965).

The elimination of the larger resident fish and the continued reproductive success of the perch and bass during 1963 and 1964

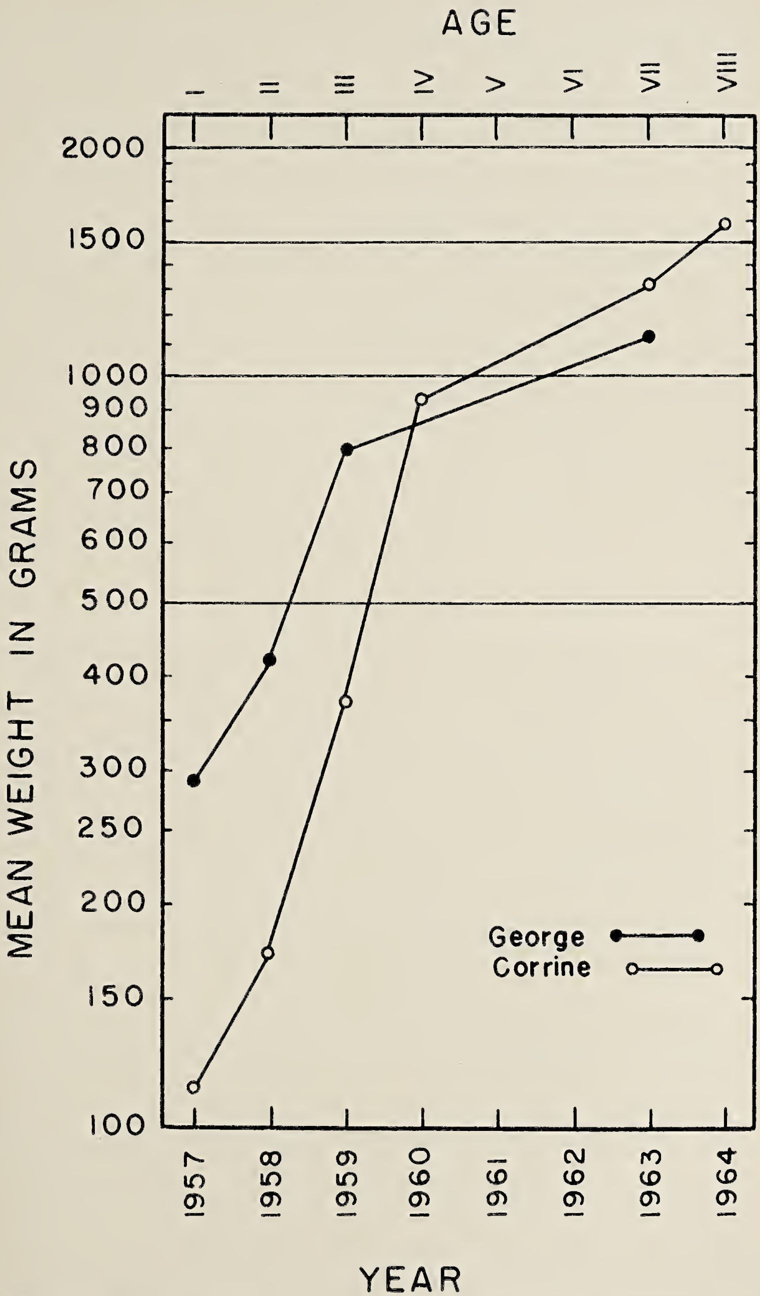

FIGURE 3. The growth in weight of muskellunge in George and Corrine Lakes, ages I through VIII.

suggest that Ricker's (1952) type C predator-prey relationship prevails, where predators take all of the individuals of a prey species that are present, in excess of a certain minimum number. The minimum, in this case, dictated by both minimum size and probably "safe" density of numbers of prey. As the number of predators decrease, the type B predation can be anticipated, where "Predators at any given abundance take a fixed fraction of prey species present, as though there were captures at random encounters" (Ricker 1952). Under these conditions it would further be expected that some survival of prey to the older year classes would prevail. In Corrine Lake, between the years 1959 and 1964, the predators were reduced from 245 individuals having an aggregate weight of 90 kg, to 23 individuals having an aggregate weight of 36 kg. During the same period the catches of perch indicate a trend toward an increased size-range (Fig. 2) and a corresponding increase in mean length and weight (Table 2).

Other events recorded during the eighth and ninth years are manifestations of intraspecific competition. Significant increases in the rate of growth of age I and age II perch were demonstrated for fish living during and after the reduction in the adult population that occurred in 1959–60 (Table 3). No corresponding increase was demonstrated for any age classes of perch during the years of muskellunge activity prior to the decline of prey. Nor would such an increase be expected, since, as Gammon and Hasler (1965) point out, little change occurred in the adult population during the first five years in Corrine Lake. Further, changes in growth rate due to changes in population density would not be expected among age 0 perch because of their food habits eg. they are primarily plankton feeders (Pycha and Smith 1955). It is generally observed that effects of mortality are less likely to be manifested in increased rate of growth in fish stocks that depend upon abundant food sources such as plankton.

Many studies, such as those cited by Larkin (1956), demonstrate the changes of food habits with age in fish. For the pikes, the observations of Frost (1954), Hourston (1952), Ivanova (1959) and others, show that prey-size corresponds with the size of the predator. Examples of the failure of the predator to secure prey of appropriate size resulting in marked reductions in growth of young pike are depicted by Karsinkin (1939), and of older muskellunge by Muir (1960). The effects of competition among the predators in this study is best illustrated by the growth curve for muskellunge in the two lakes (Fig. 3). The abrupt change in rate of growth in Corrine Lake is concomitant with the virtual disappearance of the age II and older perch. The corresponding change in George Lake is described by Hasler and Gammon (1965). Similar changes in the third and fourth summers of growth are reported by Muir (1960) for the Nogies Creek muskellunge and attributed to the lack of large forage species. The muskellunge in Corrine and George Lakes are growing at a rate comparable to the slowest group reported by Muir (1960) and less than the slowest reported by Schloemer (1936) for Wisconsin.

Summary

Measurements of population changes were made eight and nine years after the introduction of muskellunge into lakes containing perch and bass. There was a recovery in numbers of age II perch and older. However, little recruitment into size-classes of either prey fish over 150 mm in total length occurred. The growth rate of age I and II perch was significantly greater after the severe reduction of perch that occurred in 1960. The annual survival rate for the predator in two lakes was 0.8. Marked decreases in the growth rate of the muskellunge bore a temporal relation to the reduction in numbers of the prey species.

Abstract

Measurements of population changes were made eight and nine years after the introduction of age 0 muskellunge into lakes containing perch and bass. There was a recovery in numbers of age II perch and older. However little recruitment into size-classes of either prey fish over 150 mm in total length occurred. The growth rate of age I and II perch was significantly greater after the severe reduction of perch that occurred in the fifth year. The annual survival rate for the predator in two lakes was 0.8. Marked decreases in the growth rate of the muskellunge bore a temporal relation to the reduction in numbers of the prey species. The type of predation and intraspecific competition manifested are discussed.

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HYBRIDIZATION IN *GENTIANA (GENTIANACEAE)*: A RESUME OF J. T. CURTIS' STUDIES[1]

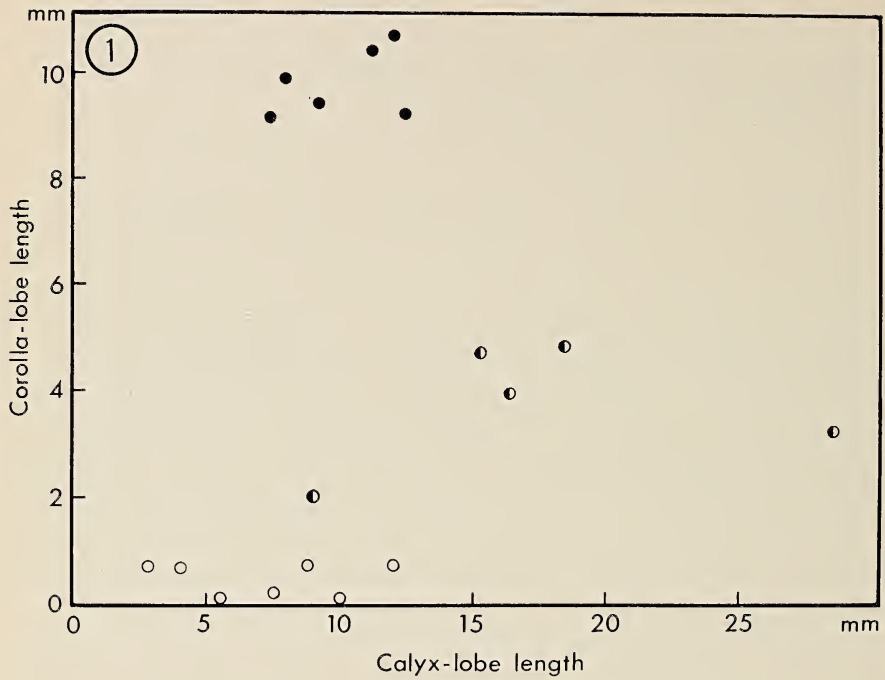
James S. Pringle
Royal Botanical Gardens, Hamilton, Ontario

The perennial gentians (*Gentiana* L. sensu stricto) were of especial interest to Dr. J. T. Curtis, late professor of botany at the University of Wisconsin. During his lifetime he made many crosses involving various species in this genus, as well as studies of natural hybridization. Although Dr. Curtis did not live to see his studies reach the degree of completion he considered desirable before publication, his meticulously recorded data and carefully preserved specimens appear to be of great potential value to future students of this group. Despite the recent publication of several papers on the taxonomy of *Gentiana,* many questions pertaining to phylogeny within this large genus remain unanswered. Dr. Curtis's records of hybridization, involving both North American and Eurasian species, may provide valuable clues when employed in conjunction with data from additional studies. Illustrations of his specimens should be useful in the interpretation of problematic natural populations. In addition, his data could be useful to plant breeders, as gentians are among the favorites of connoisseurs of hardy perennials.

I am very grateful to Mrs. Curtis for permission to borrow Dr. Curtis's records and specimens, which eventually will be deposited in the University of Wisconsin Herbarium, and to prepare this compilation. In addition, voucher specimens for some of the hybrid swarms are deposited in the University of Wisconsin Herbarium in Madison. I should also like to acknowledge the excellent photographs of the specimens by Mr. Max A. Gratzl of the University of Wisconsin. All photographs are of Dr. Curtis's specimens, and all graphs have been adapted from his graphs.

Three species of *Gentiana* are frequent in southern Wisconsin. All apparently are involved in natural hybridization (see Pringle, 1964). Figure 1 shows certain measurements from a natural hybrid swarm north of Swan Lake, in Columbia County, Wisconsin, on

[1]Contribution no. 4 from the Royal Botanical Gardens, Hamilton, Canada.


1
mm
10
8
6
4
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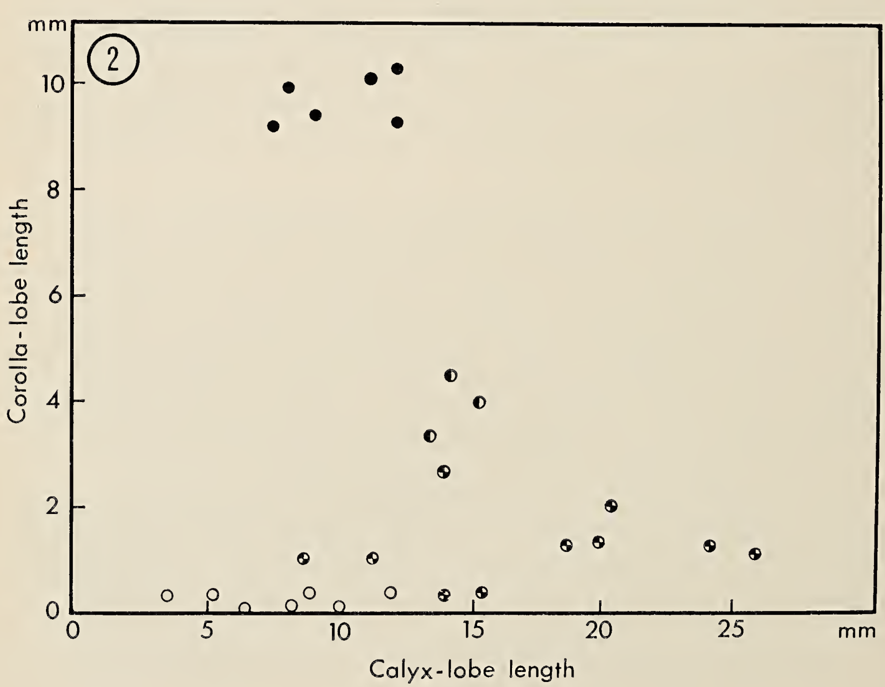
Corolla-lobe length
0
5
10
15
20
25
mm
Calyx-lobe length


2
mm
10
8
6
4
2
0
Corolla-lobe length
0
5
10
15
20
25
mm
Calyx-lobe length

the edge of a sedge meadow and adjoining the local country club, which appeared to involve only two of these species, namely *G. andrewsii* Griseb. and *G. puberula* Michx. Specimens from this population have been shown in a previous publication (Pringle, 1964). In Figure 1, plants from this population are contrasted with plants from several pure populations of *G. andrewsii* var. *andrewsii* (the native variety in Wisconsin) and *G. puberula.* To be compared with this representation of a natural hybrid swarm is Figure 2, which shows measurements of two generations of progeny from an experimental cross involving the same species. Figure 3 shows additional measurements from F_1 and F_2 generations from a simi-

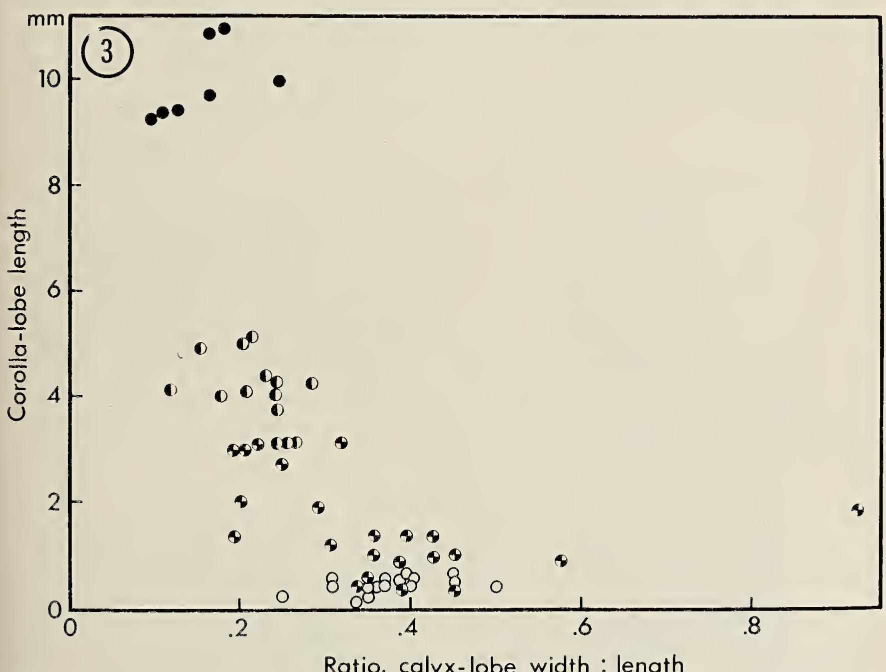
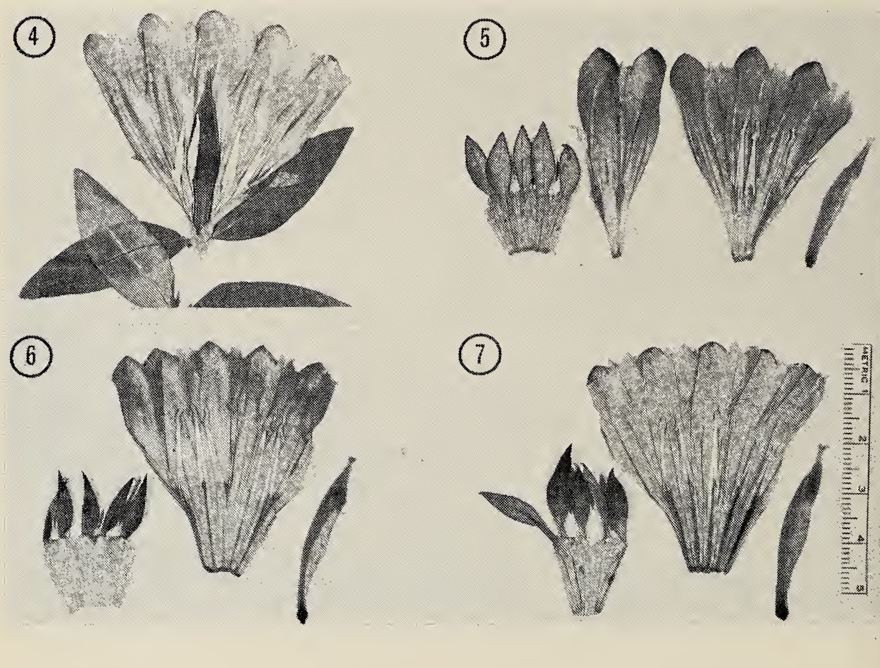


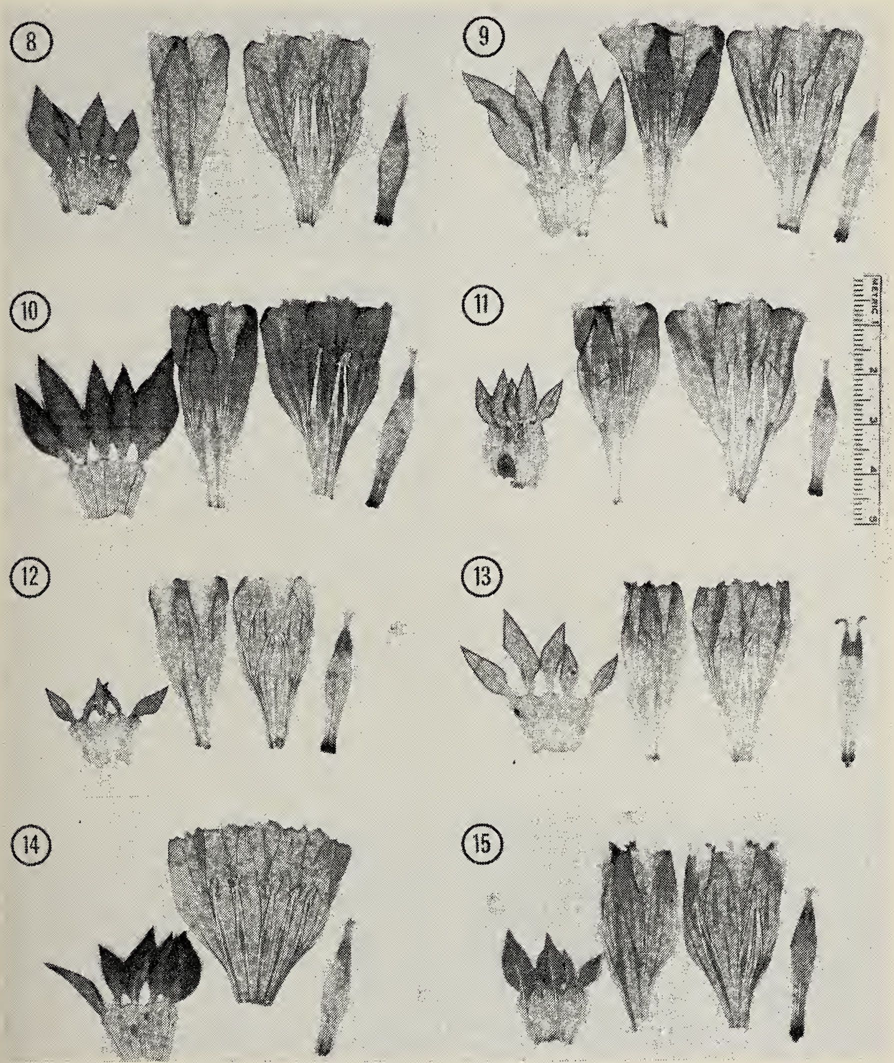
FIGURE 3. Additional measurements from F_1 and F_2 generations from an experimental cross of *G. andrewsii* X *G. puberula,* compared with the parental species. Symbols as in Figure 2.

FIGURES 1 AND 2. *Gentiana puberula* (black dots), *G. andrewsii* (open circles), and their hybrids. Figure 1. A natural hybrid swarm at Swan Lake, Wisconsin (halved circles), compared with pure populations of the parental species. Figure 2. F_1 (halved circles) and F_2 (quartered circles) from an experimental cross compared with populations of the parent species.

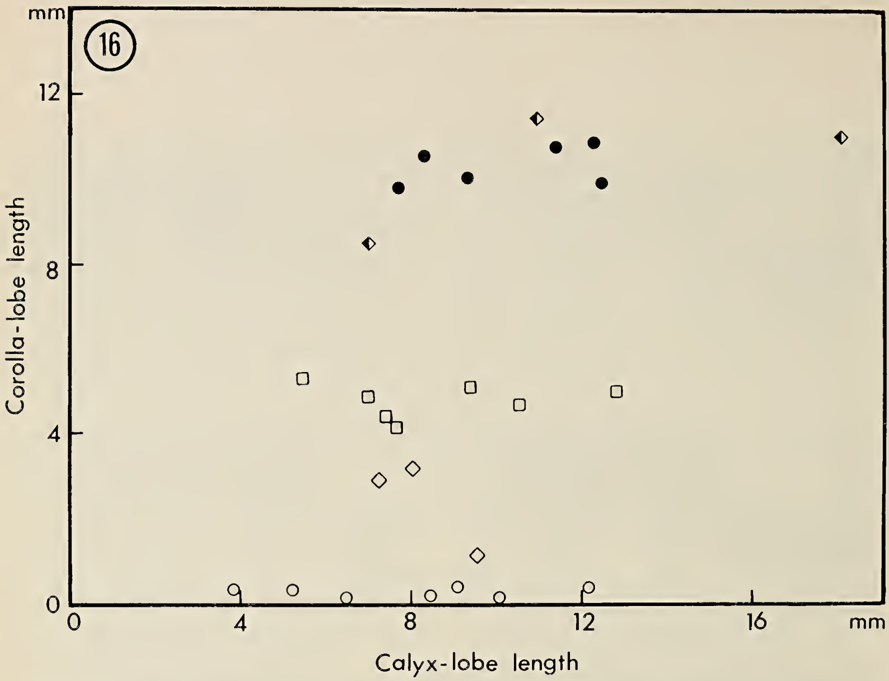
lar cross. Specimens from the F_1 and F_2 generations are shown in Figures 4 to 15. The corolla lobes of the F_2 plants varied widely in size. The corolla shown in Figure 15 is essentially indistinguishable from those of typical *G. andrewsii* in this respect. The hybrid plants tended to have larger calyx lobes than plants of either of the parental species. In the traits measured, the entire F_2 generation was more like the "control" population of *G. andrewsii* than like that of *G. puberula*. The natural hybrid population also appears to have retained a greater similarity in these characteristics to *G. andrewsii.*

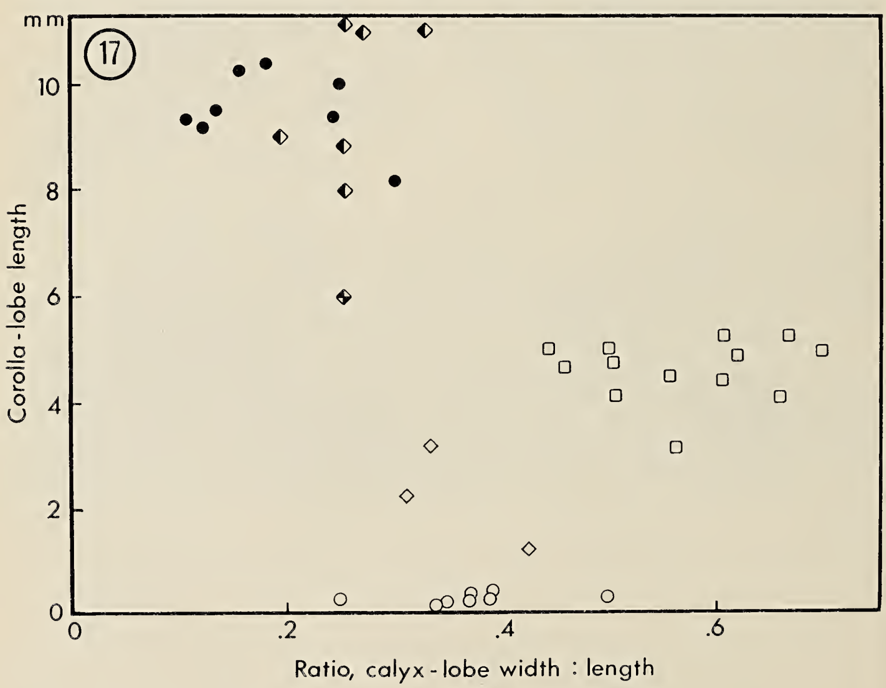
Figures 16 and 17 represent graphically the results obtained by crossing both of the species mentioned above (*G. andrewsii* and *G. puberula*) with *G. alba* Muhl. (*G. flavida* Gray). No specimens of these experimental plants were encountered. However, Figures 18 to 27 are of Dr. Curtis's specimens presumed to be derived from the natural crossing of *G. puberula* with *G. alba,* although *G.*





FIGURES 4–15. Corollas, calyces, and pistils of hybrids produced by crossing *G. andrewsii* X *G. puberula*, X 4/7. Figure 4. F_1. Figures 5–15. F_2.


16
mm
12
8
4
0
Corolla-lobe length
0
4
8
12
16
mm
Calyx-lobe length


17
mm
10
8
6
4
2
0
Corolla-lobe length
0
.2
.4
.6
Ratio, calyx-lobe width : length

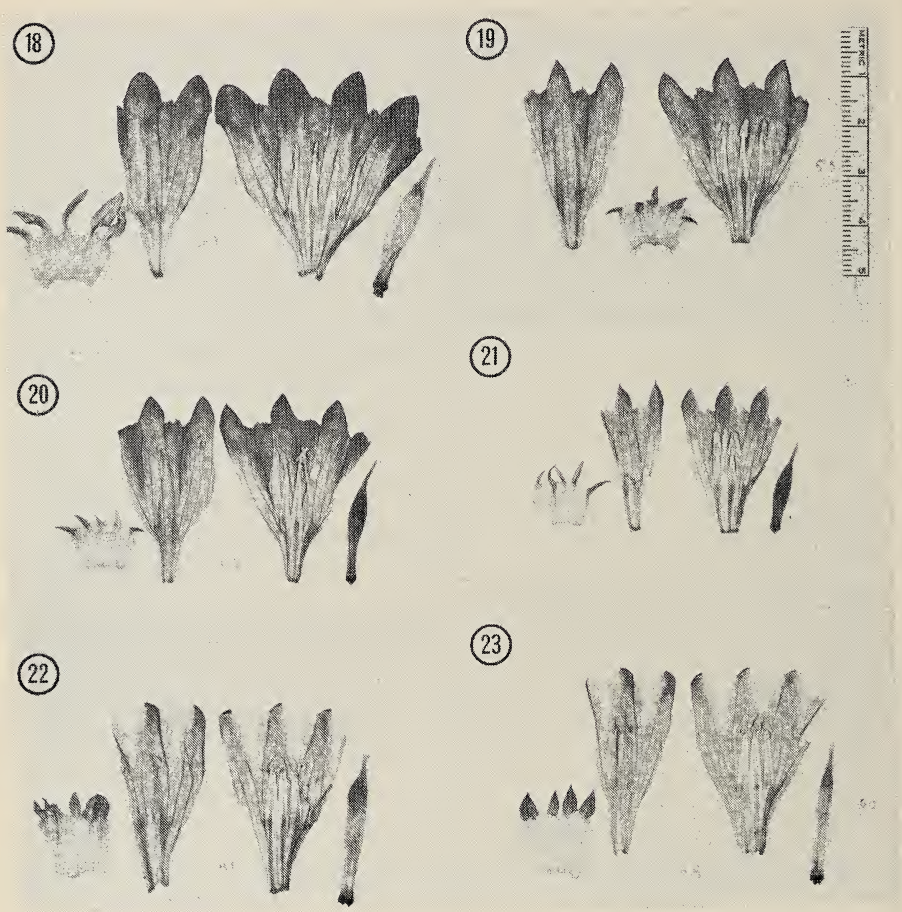
andrewsii may also have been involved to some extent. These specimens were collected in another area also near Swan Lake. Calyx lobes ranged from ovate, as in *G. alba,* to linear, as in *G. puberula* and from strongly keeled, as in *G. alba,* to keelless, as in *G. puberula.* The influence of *G. alba* is manifested in these specimens by low, obliquely triangular free portions of the corolla appendages. (In *G. andrewsii, G. puberula,* and hybrids of these two species these structures are more nearly symmetrical, and bifid.) The color remains well preserved in many of the corollas. In addition, Dr. Curtis recorded the colors of some. The corollas shown in Figures 18–20 were deep blue; in Figure 21, reddish purple; in Figures 22 and 23, white, suffused with light blue on the upper parts of the petals (excluding appendages) ; in Figure 24, pink; in Figures 25 and 26, white, suffused with pink on the petals; in Figure 27, whitish, as in *G. alba.* The flowers also varied in the degree of closure of their corollas and fusion of their anthers.

In certain areas near Swan Lake, all three of these species grew in close proximity to each other and evidently hybridized. In Figure 28, measurements obtained by Dr. Curtis from this series of apparent polhybrid swarms are contrasted with comparable measurements from plants of each of the three species from pure populations elsewhere in Wisconsin.

Dr. Curtis's breeding experiments involved many additional species, including some in three of the sections into which the genus was divided by Kusnezow (1895). Species native to Wisconsin were obtained locally from the wild. *Gentiana clausa* was obtained from New Hampshire. The other species were raised from seed purchased from Rex D. Pearce, Moorestown, New Jersey. He kept detailed records on the set of seed and its subsequent germination. Table 1 indicates which crosses were attempted and which resulted in the production of germinable seed. In this table, the nomenclature of the Wisconsin species and their hybrids has been brought into conformity with Mason and Iltis (1965) and Pringle (1964).[2] Other names are retained as they appeared in Dr. Curtis's records. The hybrids *G.* X *billingtonii (G. andrewsii* X *G. puberula)* and *G.* X *curtisii (G. puberula* X *G. alba)* had previously been synthesized by Dr. Curtis. Two of the successful crosses

[2]Since it has been recently shown (Pringle 1966) the *G. puberula* type (in P) is a plant of an eastern species, the Prairie Gentian has been renamed *G. puberulenta* Pringle.

FIGURES 16 AND 17. Crosses involving *G. alba. G. alba,* squares; *G. andrewsii,* open circles; F_1 hybrids, *G. alba* X *G. andrewsii,* open diamonds; *G. puberula,* black dots; F_1 hybrids, *G. alba* X *G. puberula,* halved diamonds; F_2 hybrids, quartered diamonds.


18
19
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21
22
23

were intersectional. In addition, some of those within section Pneumonanthae, such as those involving *G. lagodechiana,* were between species of conspicuously different morphology. Unfortunately, little information is available on the appearance of the hybrids derived from exotic species. According to Mrs. Curtis, many seedlings died in an exceptionally adverse winter. However, the F_1 progeny from the crosses *G. clausa* X *G. septemfida, G. alba* X *G. clausa,* and *G. alba* X *G. andrewsii* are described as having open corollas.

FIGURES 18–27. Corollas, calyces, and pistils from plants in a hybrid swarm at Swan Lake involving *G. alba* and *G. puberula,* X 4/7.

TABLE 1. RESULTS OF DR. CURTIS'S EXPERIMENTAL CROSSES

GENTIANA PISTILLATE PARENT	STAMINATE PARENT																	
	dahurica	*purdomi*	*farreri*	*sino-ornata*	*alba*	*andrewsii*	*asclepiadea*	X *billingtonii*	*clausa*	X *curtisii*	*lagodechiana*	*parryi*	*puberula*	*rubricaulis*	*scabra*	*septemfida*	*setigera*	(X *billingtonii*) X *andrewsii*
Sect. Aptera																		
dahurica Fisch.																		
purdomi Marquand	—	*														+		
Sect. Frigida																		
farreri I. B. Balf.																		
'*Macauleyi*' (*farreri* X *sino-ornata*)													—					
sino-ornata I. B. Balf.										—			—					
Sect. Pneumonanthae																		
alba Muhl.				*		*		*	*	*	*		*		*	+		
andrewsii Griseb.					*	*		*					*					
asclepiadea L.					*					*			*					
X *billingtonii* Farw.						+	*	*		*			*		*			
clausa Raf.					+				*							+		
X *curtisii* Pringle							*			*	*							
freyniana Bornm. ex Freyn												—						
lagodechiana (Kusn.) Grossheim ex Moellers					*		—			*	*				*			
parryi Gray																	*	
puberula Michx.					*	*	*	*		*	*		*		*	—		
rubricaulis Schwein.					*									*				
scabra Bunge															*			*
septemfida Pall.			—		*				*	*		—			—	*	—	
setigera Gray																		
(X *billingtonii*) X *andrewsii*																		*

* cross successful, seedlings numerous; +, cross successful but fewer than 10 seeds produced or fewer than 10% of seeds germinated; — cross attempted but unsuccessful.

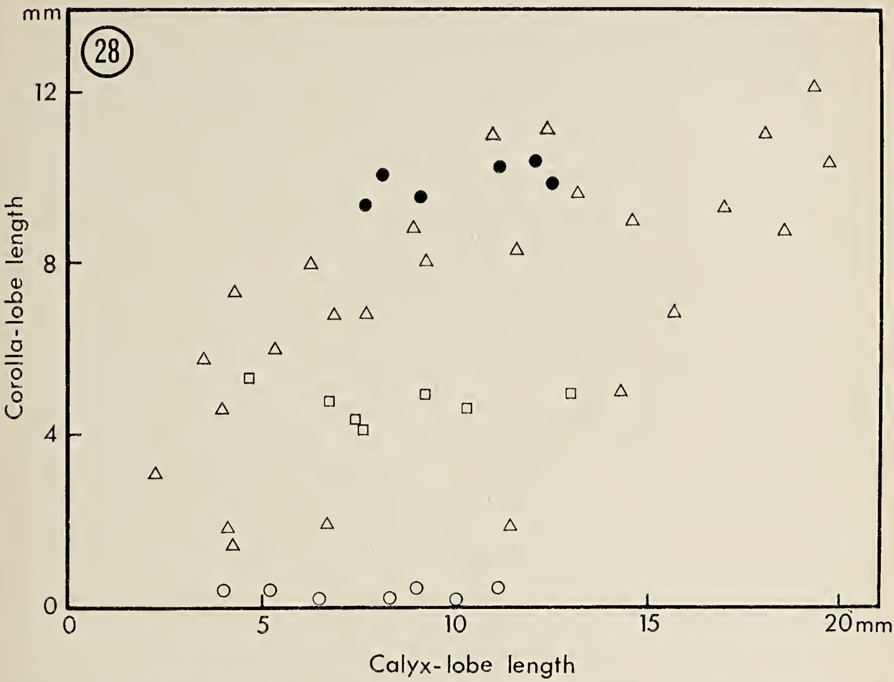

FIGURE 28. Plants from a hybrid swarm at Swan Lake (triangles) involving *G. puberula*, *G. andrewsii*, and *G. alba*, compared with plants of the parental species from pure populations (symbols as in Figures 16 and 17).

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———. 1966. *Gentiana puberulenta* sp. nov., a known but unnamed species of the North American prairies. Rhodora 68. (in press).

PRELIMINARY REPORTS ON THE FLORA OF WISCONSIN NO. 53. *GENTIANACEAE AND MENYANTHACEAE*— GENTIAN AND BUCKBEAN FAMILIES

Charles T. Mason Jr.[1]
Herbarium, University of Arizona, Tucson
and
Hugh H. Iltis[2]
Herbarium, University of Wisconsin, Madison

There are few flowers that have inspired nature lovers as much as the gentians. For the gardener, the large flowers, often of an unsurpassedly intense and brilliant blue, are among the most beautiful to grace a rock garden, while the species are among the "fussiest" ever to tax horticultural ingenuity (Wilkie 1950, Berry 1951). For the professional botanist, gentians are rewarding in different ways, and as a group have great promise in the solution of many an evolutionary puzzle. With highly specific ecological requirements (and consequent ecological, geographic, and often seasonal isolation); with intricate, as yet poorly understood, adaptations to insect pollination (such as glands, spurs, nectaries, in addition to various flower colors and shapes); with often minute seeds ideally suited to long-range dispersal (which can be related to geographic disjunctions and migrations of such groups as *Gentianopsis* or *Halenia*); with chromosomal homogeneity and nearly complete interfertility within some genera (e.g. *Gentiana*), and, in contrast, with sharp differences in chromosome number between genera;—with all this intrinsic biological appeal, as well as their beauty, it is not surprising that gentians are beloved by botanists wherever they occur. Let the joy that layman and biologist alike receive from these flowers be to them an admonition—(what with many of our Wisconsin species faced with extinction)—an admonition to exercise fully their social responsibilities: for without both self-restraint in picking and (more importantly) the preservation of samples of the diverse natural plant communities in which gentians live, these brilliant flowers will never gladden the eyes of future generations.

The present study discusses primarily the taxonomy and geography of the Wisconsin *Gentianaceae* and *Menyanthaceae*, while

[1]University of Arizona, Agricultural Experiment Station, Department of Botany, Journal Article No. 839.

[2]Field work and preparation of manuscript supported in part by the Research Committee of the University of Wisconsin, on funds from the Wisconsin Alumni Research Foundation, the costs of illustrations in part by the Norman C. Fassett Memorial Fund.

other recent publications have dealt more specifically with hybridization in *Gentiana* (Mason 1959; Pringle 1964, 1965) and evolution and migrations of our species of *Gentianopsis* (Iltis 1965). Material from the following herbaria was intensively studied: University of Wisconsin–Madison (WIS), University of Wisconsin–Milwaukee (UWM), Milwaukee Public Museum (MIL), the private herbarium of Katherine Rill (RILL), Clintonville, Wis., and the University of Arizona (ARIZ). In addition a few indisputable records were taken from the studies of Hartley (1962) of the Driftless Area flora, of Gillett (1957) dealing with *Gentianella*, and from Pringle's as yet unpublished monograph of Eastern United States *Gentiana* subgenus *Pneumonanthae*. Each dot on the distribution map represents one or more collections from a particular location, each triangle a county record without specific location. Triangles in Illinois are based on Winterringer and Evers (1960) and Jones and Fuller (1955).

We wish to thank Dr. James Pringle, of the Royal Botanical Gardens, Hamilton, Ontario, for his elucidation of many critical aspects of the Genus *Gentiana* and for a careful reading of the manuscript; Drs. K. F. Parker and L. I. Nevling for checking the U.S. National Herbarium and the Gray Herbarium, respectively, for Wisconsin specimens of *Sabatia* and *Swertia;* Mrs. Katharine Snell, Miss Carol Mickelson and others from the Herbarium of the University of Wisconsin for help with manuscript and maps, and, finally, Mrs. Pat Mason for the meticulous habit drawings of the Wisconsin species.

KEY TO FAMILIES

1. Leaves simple, entire, opposite or subopposite, usually sessile; aestivation imbricate ------------------- *GENTIANACEAE.*
1. Leaves compound (trifoliolate), alternate, petioled; aestivation induplicate-valvate ------------------- *MENYANTHACEAE.*

GENTIANACEAE A. L. De Jussieu Gentain Family

[Gillett, J. M. 1963. *The Gentians of Canada, Alaska and Greenland.* Canada Dept. Agric. Publ. 1180. 1–19.]

Annual, biennial or perennial glabrous or minutely puberulous herbs (ours) to 1 m tall, with simple or branched stems. Leaves simple, opposite or subopposite, linear-lanceolate to ovate, or reduced to subulate scales, sessile, entire, exstipulate. Flowers regular, 4- or 5-merous. Corolla funnelform to campanulate. Stamens included, as many as the corolla lobes, inserted on the corolla tube. Pistil with 2 parietal placentae, 1-loculed, superior, the fruit a 2-valved, septicidal capsule. Seeds numerous, small to minute, variously shaped.

KEY TO GENERA

A. Leaves subulate scales 1–4 mm long; flowers minute, 2–5 mm long, 4-merous with free sepals and yellow-green corollas; stems usually unbranched; inconspicuous slender annuals .... 1. *BARTONIA*.

AA. Leaves linear-lanceolate to ovate; flowers 10–60 mm long, 4- or 5-merous, with sepal bases united into a tube, and often showy, variously colored corollas; stems simple or branched; annuals, biennials, or perennials.

B. Perennials with large, showy, 5-merous (or rarely abnormally 4-merous) sessile or subsessile flowers; corolla with conspicuous folded plaits between the lobes; seeds flattened and winged .... 2. *GENTIANA*.

BB. Annuals or biennials with 4- or 5-merous pedicellate flowers; corolla without conspicuous plaits between the lobes; seeds variously shaped, not winged.

C. Corolla funnelform or campanulate; anthers straight after anthesis; flowers 4- or 5-merous, variously colored, not pink.

D. Corolla 4- or 5-merous, not spurred, 15–60 mm long, blue, lilac or purple, rarely white.

E. Flowers 5-merous, blue, lilac or purple, 15–25 mm long, clustered in 3- to 10-flowered cymes on short bracteate pedicels, the apiculate lobes entire; calyx lobes with green margins; seeds round, smooth .... 3. *GENTIANELLA*.

EE. Flowers 4-merous, blue or purplish-blue, rarely white, 25–60 mm long, solitary on slender 1–20 cm long ebracteate pedicels, the round lobes fringed; calyx lobes with hyaline margins; seeds oblong-angular, covered with rounded to elongated inflated papillae; ...4. *GENTIANOPSIS*.

DD. Corolla 4-merous, 8–15 mm long, the 4 slender divergent basal spurs 3–5 mm long, greenish, greenish-purple or greenish-yellow .... 5. *HALENIA*.

CC. Corolla salverform with a slender tube; anthers spirally twisted after anthesis; flowers 5-merous, bright pink; rare adventive ca. 8–16 cm tall .... 6. *CENTAURIUM*.

1. BARTONIA Muhl. ex Willd. Bartonia

[Gillett, J.M. 1959. Revision of *Bartonia* and *Obolaria*. *Rhodora* 61:42–62.]

1. BARTONIA VIRGINICA (L.) B.S.P. Screwstem, Virginia Bartonia
Map 1; Fig. 1.

Slender erect unbranched (rarely branched above or at base)[3] annuals 5–28 cm tall, hemi-saprophytic with reduced roots, chlorophyll content (i.e. plants pale green or yellowish) and leaves, these opposite to sub-opposite subulate scales 1–4 mm long. Inflorescence cymose or reduced to 2 flowers at a node or plants one-flowered. Sepals 4, free, 2–3 mm long, linear-lanceolate. Corolla 3–5 mm long, deeply parted into 4 oblong apiculate lobes; petals yellow-green at anthesis, sometimes fading pink with age. Stamens 4, epipetalous, 2.5 mm long. Anthers 0.8 mm long, with an apical appendage. Pistil about 4 mm long. Seeds very numerous, nearly microscopic (like dust and ca. 0.1 mm $\times$ 0.15 mm) ellipsoidal, rusty brown. $2n = 52$ (Rork 1949).

An "Atlantic Coastal Plain" element (the 3 species of this Eastern N. American endemic genus centering on the Coastal Plain), in Wisconsin rare, mostly in the sandy, acid, often boggy former beds of glacial lakes (esp. Glacial Lake Wisconsin) in the Central Wisconsin Sand Plains, in moist or boggy sedge or sphagnum peat, moist sandy meadows, sandy acid sedge flats, less often on sandy lake shores, sphagnous White Pine–Red Maple woods, wet open sands with scattered Jack Pines, openings or thickets, often associated with other Coastal Plain elements, e.g. in wet black sandy muck of sedge-sphagnum meadow, 7 mi. S of City Point, Wood County, with *Drosera intermedia, Rhynchospora alba, Xyris torta* and sp., *Lycopodium inundatum, Viola lanceolata, Aronia melanocarpa, Muhlenbergia uniflora, Gerardia paupercula,* etc. (*Iltis & Koeppen 12277,* WIS). Flowering from mid-July to early September; fruiting as late as mid-October.

Bartonia is probably much more common than the scanty herbarium material would indicate, since because of its small size and inconspicuous flowers it is easily overlooked.

2. GENTIANA L. GENTIANS

[Mason, C. T. Jr. 1959. A hybrid among the perennial gentians. *Brittonia* 10:40–43; Pringle, J.S. 1966. Taxonomy of *Gentiana,* section *Pneumonanthae* in Eastern North America. (in MS.); See also Pringle, J.S. 1964, 1965a, 1965b, 1966a, 1966b.]

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[3]Saprophytism in *Bartonia* is cited by Gillett (1959) and earlier by Gilg (1895), who includes a short discussion of saprophytism in *Gentianaceae* emphasizing mycorrhizae and low amount of chlorophyll. Neither stresses the minute seeds, which, generally characteristic of saprophvtes, allows them to be both easily dispersed and washed deep into the soil. The subject is in need of study and verification. With exception of Steyermark's (1963) Flora of Missouri, apparently no flora or manual, including Gleason (1952) or Fernald (1950), mentions saprophytism in this or the related American genus *Obolaria.*

Slender to robust perennial herbs. Flowers large, blue, purple, yellowish or white, clustered at the stem apex or axillary in one or several of the upper nodes, sessile or subsessile, subtended by paired bracts. Calyx with 5 linear-lanceolate to ovate lobes, commonly with conspicuous intra-calycine membranes. Corolla 5-lobed, with 5 folded plaits *(plicae)* between the lobes, convolute in bud. Stamens 5, often with connate anthers. Pistil often stipitate. Seeds numerous, winged.

The large, world-wide genus *Gentiana*, variously divided into subgenera and sections but here considered in a restricted form, is represented in Wisconsin by four species and four interspecific hybrids. All belong to Sect. PNEUMONANTHAE Bunge, and, because of their beauty, should be given more consideration both as garden subjects, and as wild plants in need of protection.

KEY TO SPECIES[4]

A. Corolla lobes obsolete or reduced to small points; corolla plaits (plicae) several times longer than the corolla lobes; flowers blue, rarely white, remaining closed at anthesis -- 1. *G. andrewsii.*

AA. Corolla lobes prominent, equal to or several times as long as the plaits; flowers open at anthesis.

B. Corolla lobes erect; flowers white, yellow, or various shades of purple or blue; stems glabrous; leaves 1- to 5-veined.

C. Flowers yellowish or white, with greenish veins; calyx lobes ovate, keeled and divergent; leaves broadly lanceolate to ovate, 5-veined; prairies, mostly S. Wisconsin ------------------------------ 2. *G. alba (G. flavida).*

CC. Flowers blue to purple or grayish purple (rarely whitish or yellowish); calyx lobes lanceolate, ascending; leaves linear-lanceolate, 1- to 5-veined; mostly N. Wisconsin ------------------------ 3. *G. rubricaulis.*

BB. Corolla wide open (when in sun), the lobes spreading or reflexed; flowers a brilliant, deep blue; stems *minutely* puberulous all over; leaves linear-lanceolate, usually 1-veined; dry prairies, mostly S. Wisconsin -- 4. *G. puberula.*

1. GENTIANA ANDREWSII Griseb. Bottle Gentian Map 2; Fig. 2.

Stems 3–8(–10) dm tall, unbranched or rarely branched, glabrous. Leaves narrowly lanceolate to ovate-elliptic, *attenuate to base* and apex, 3- or 5-veined. Flowers ca. 3–15 in a tight, involu-

[4]Hybrids of species 1 x 2, 1 x 3, 1 x 4, and 2 x 4 are known and are discussed at the end of the genus (5a–d).

crated terminal cluster, and others often axillary in the 1–4 uppermost nodes. Calyx lobes lance-elliptic to lance-ovate, constricted at base, ciliolate, 5–15 mm long, erect to divergent. Buds rounded or subtruncate with vertical folds, to 30 mm long. Corolla 3–4.5 cm long, cylindric or barrel-shaped, *remaining closed at the anthesis, with laciniate plaits several times longer than the inconspicuous, highly reduced true corolla lobes, blue, becoming purple-tinged with age,* the apical fringe and inside folds often white, or flower wholly white (in f. ALBIFLORA Britton). Stamens united by their anthers. Mature capsule included or barely projecting from the marcescent corolla. $2n = 26$ (Rork 1949).

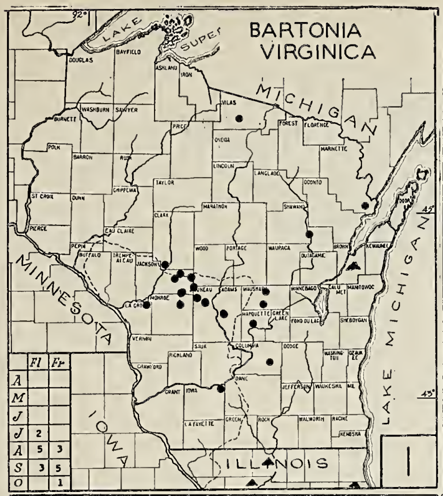
The most common Wisconsin gentian, in a variety of habitats, most often in low damp or wet soil of sedge meadows, prairies, streamsides, grassy lakeshores, swales, in the open or partial shade, sometimes in woods, roadsides and damp thickets. The white-flowered *G. andrewsii* f. *albiflora* is distinguished from the equally white *G. alba (G. flavida)* by the absence of corolla lobes and by closed flowers, occurs occasionally in northern Wisconsin, especially near St. Croix Falls (Polk Co.), and Bayfield County, where blue and white forms are reported as growing together. Flowering from (early) late August to mid-October, with a peak in the 2nd week of September, seasonally and/or ecologically isolated from the three other Wisconsin species, all of which may hybridize with it.

2. GENTIANA ALBA Muhl. White Prairie Gentian
Map 3; Fig. 4.

Gentiana flavida Gray (cf. Pringle 1964, 1965a).

Stems robust, 4–10 dm tall, glabrous. *Leaves lanceolate to ovate,* long-acuminate, *abruptly contracted to a clasping, subcordate base,* —fleshy, yellowish-green, 5-(7-)veined. Flowers 2–12 in a tight involucrated terminal cluster, or 1–3 occasionally axillary at the penultimate node, the large involucral bracts of the same size as cauline leaves. Calyx lobes broadly triangular-ovate, "with decurrent keels which causes them to spread horizontally" (Pringle 1965a), 3–10 mm long; tube ca. 1 cm long. Buds acute, contorted, the apex to 20 mm long. Corollas 3.6–4.5 cm long, *white or cream,* with a network of greenish veins, the lobes erect and not wide open when in flower, rounded to apiculate, about twice as long as the irregular-lobed to erose plaits. Anthers sometimes free (not connate). Capsules included or barely exserted from the persistent corolla.

In Wisconsin only within the region of limestones, on dry to moist, sometimes calcareous relic prairies along railroads or in old cemeteries, on calcareous morainal hills and roadsides, on the edges of dry oak woods or open wooded ridges or ravines, readily


BARTONIA VIRGINICA
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
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J 2
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S 3 5
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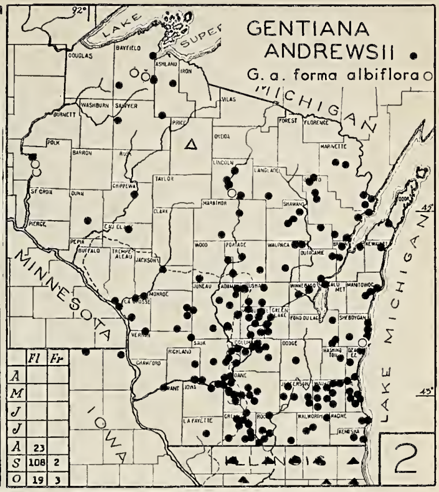
GENTIANA ANDREWSII
G. a. forma albiflora
MICHIGAN
MINNESOTA
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LAKE MICHIGAN
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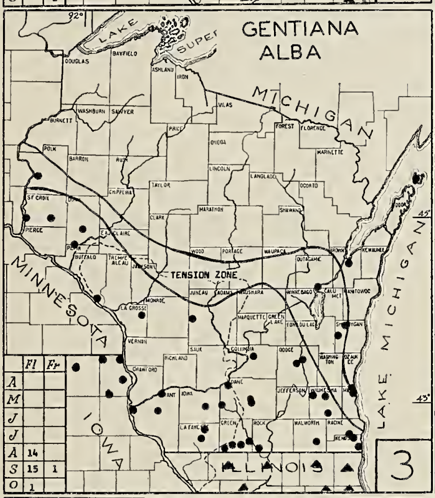
O 19 3
2


GENTIANA ALBA
MICHIGAN
TENSION ZONE
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IOWA
ILLINOIS
LAKE MICHIGAN
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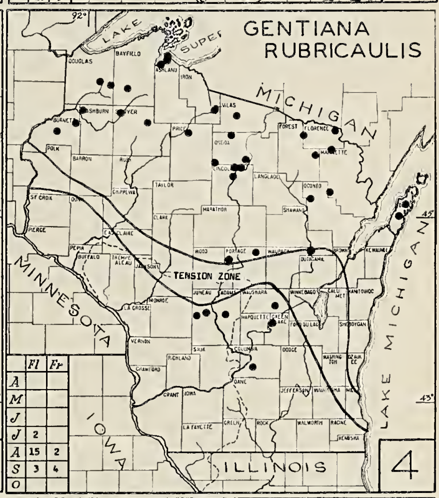
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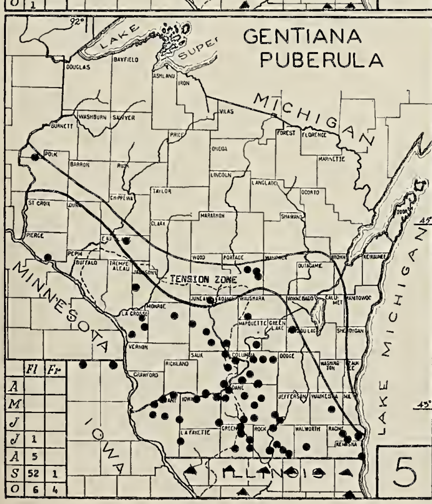
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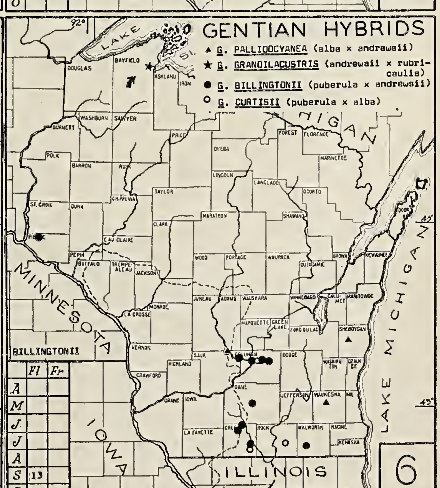
GENTIAN HYBRIDS
▲ G. PALLIDOCYANEA (alba × andrewsii)
★ G. GRANDILACUSTRIS (andrewsii × rubricaulis)
● G. BILLINGTONII (puberula × andrewsii)
○ G. CURTISII (puberula × alba)
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
BILLINGTONII
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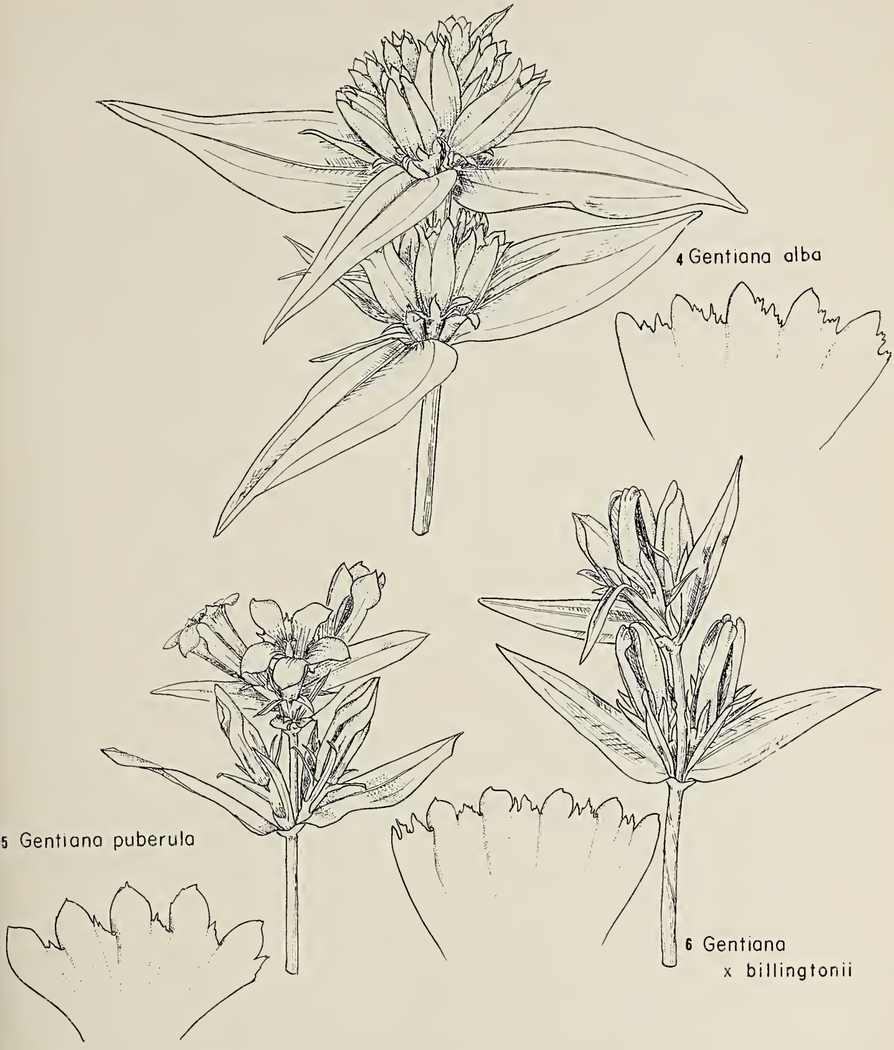
1 Bartonia virginica

2 Gentiana andrewsii

3 Gentiana rubricaulis

distinguished from the white *G. andrewsii* f. *albiflora* by larger corolla lobes and open flowers, and generally earlier flowering, i.e. from early August to late September, with a peak in the last week of August. Though three of our gentians occur mostly in prairies, *G. alba* in oak openings and mesic prairies, *G. puberula* in xeric or sand prairies, and *G. andrewsii* often in wet prairies, the latter two species seem to be isolated primarily seasonally from *G. alba*, which generally blooms 2 to 3 weeks earlier. According to Asa



Gray (1874:388) "[*G. alba* in the NE U.S.] begins to flower in July, far earlier than the next two" [species, i.e., *G. andrewsii* and *G. saponaria*].

Several collections of *G. alba* from areas where it grows together with *G. puberula,* and *G. andrewsii,* suggest hybridization. In his garden in Madison, J. T. Curtis crossed *G. alba* and *G. puberula,* producing an F_1 hybrid with characters approaching those of *G. andrewsii.* Field material from the moist prairie north of Swan Lake, Columbia County, is similar (Pringle 1964, 1965b).

3. GENTIANA RUBRICAULIS Schwein. Red-stemmed Gentian
Map 4; Fig. 3.

G. linearis var. *rubricaulis* (Schwein.) MacMillan.
G. linearis var. *latifolia* Gray of ed. 7, Gray's Manual.

Stems (2-)3–6(-8) dm tall, glabrous or minutely puberulous below each node, the upper internode frequently conspicuously elongated. Leaves long-acuminate, ± clasping or abruptly contracted at base, the *lower linear to linear-lanceolate,* the upper lance-ovate to ovate, 1-, 3-(or 5-)veined, frequently conduplicate in pressed specimens, the margins minutely puberulous. Flowers 1–6 in a tight terminal cluster *closely subtended by keeled, lanceolate to ovate-cordate outer bracts,* occasionally 1–3 flowers also at the penultimate node. Calyx tube 9–11 mm long, the lobes linear-lanceolate or elliptic, 3–16 mm long, ascending, separated by rectangular sinuses, the intra-calycine membrane conspicuous. Corolla 3–4 cm long, *blue, purple or grayish-lavender,* rarely white tinged with purple, or yellowish, cylindric with erect, broadly acute to obtuse or rounded lobes, the *irregular plaits* ⅓ *to* ½ *the length of the corolla lobes.* Anthers connate. Mature fruits long-stipitate (gynophore to 18 mm long!), sometimes greatly exceeding the persistent marcescent corolla.

Mostly in northern Wisconsin north of the "Tension Zone", in moist or wet areas as shores of lakes, swamps, moist woods, sedge meadows with *Carex, Solidago, Eupatorium, Pedicularis lanceolata,* etc., in open, acidic habitats, such as edges of bogs near roads, included by Curtis (1959) as a species characteristic of the Northern Sedge Meadows; in central Wisconsin rare, in moist prairie relics along railroad, (growing there with *G. andrewsii*), and in rather alkaline sedge meadows with *Solidago patula, S. gigantea, S. uliginosa* and *Aster junciformis (sub Iltis 15240,* near Rosholt, Portage Co.) Flowering from early August to early September, with a peak in the last week of August, apparently seasonally isolated from the later-blooming *G. andrewsii,* with which it may hybridize.

4. GENTIANA PUBERULA Michx.[5] Prairie Gentian, Downy Gentian
Map 5; Fig. 5.

Stems slender, (1–)2–5 dm tall, several to many from a deep root, with dense minute puberulous projections. *Leaves small,*

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[5]In his forthcoming monograph of *Gentiana* sect. Pneumonanthe in Eastern North America (Pringle 1966a) and another study (Pringle 1966b), Pringle shows that the type of *Gentiana puberula* Michx. in the Paris Herbarium is actually an eastern species different from the prairie species discussed here, and assigns to the latter the new name *G. puberulenta* Pringle.

mostly 2–5 cm long, 1 cm or less wide, linear-lanceolate, abruptly contracted at base, usually 1-, (rarely 3-) veined, the margins *minutely* puberulous. Flowers 1–5 in an open terminal cluster, or occasionally a few others axillary at the 1 or 2 (3) uppermost nodes, 5-merous (very rarely 4-merous, e.g. Kenosha Prairie, *D. Levin,* in Sept., 1964). Calyx tube 8–15 mm long; lobes linear to linear-lanceolate, 7–18 mm long and equalling the tube, with minutely puberulous margins. *Corollas 3.5–5 cm long, deep dark blue,* funnelform to campanulate, when in full sun *wide open with spreading to pronouncedly recurved lobes;* plaits variously lobed and cut, usually bifid ½ to ⅓ the length of the 10–15 mm long corolla lobes; anthers separate. Mature capsules often long-exserted beyond the persistent corolla (gynophore to 25 mm long), the winged seeds sometimes persisting into the following spring. $2n = 26$ (Rork 1949).

Characteristic of prairies, hence "prairie gentian" (or "downy gentian", a translation of *puberula* which is a misnomer the plant being essentially glabrous), especially common in dry sandy prairies, rich dry-mesic prairie relics along railroads, in very dry steep calcareous "goat prairies", there with *Anemone patens, Dodecatheon meadia, Castilleja sessiliflora,* etc., less often in damp but then strongly calcareous prairies (e.g. the Kenosha Prairie underlain by dolomite, there with *Aster ptarmicoides, Parnassia glauca, Gentianopsis procera, G. crinita,* etc.; cf. Illtis 1965), on prairies at Swan Lake, Columbia Co., with *Gentianella quinquefolia, Gentiana andrewsii* and its *G. puberula* hybrids (*Mason 1457,* WIS; cf. Pringle 1964), rarely in open woods (e.g. dry oak woods, top of Observatory Hill, Marquette Co., a quartzite monadnock). Flowering from (mid-August) early September to mid-October, with a peak in the third week of September, the last-blooming of our perennial gentians.

Of this gorgeous species, which deserves protection, as well as cultivation in the sunny limestone rock garden, Curtis (1959) writes admiringly in his discussion of the prairie:

> "Many of the xeric prairies support large populations of the downy gentian which is by all odds the most beautiful member of this famed genus in Wisconsin, and which at its best compares favorably with the species from the high Himalayas that are so prized by rock gardeners."

5. Gentiana Hybrids in Wisconsin.

Hybridization in perennial *Gentiana* is well-known from field, garden and herbarium studies. Mason (1959) demonstrated in the greenhouse that some Wisconsin species, e.g. *G. andrewsii* and *G. puberula,* hybridize freely, producing plants strongly resembling *G. saponaria* of the Southeastern United States. The extensive notes and population samples of hybrids gathered over many years by

J. T. Curtis from the wild and from his garden were recently studied by Dr. James Pringle (1964, 1965b), to which the reader is referred.

As *Gentiana* hybrids are as a rule morphologically intermediate between their parents, it is often very difficult to assign a hybrid specimen to one species or another. Since hybrids often occur in areas where two or three *Gentiana* species occur together it is therefore important to carefully study in the field many plants of such a population to determine parentage and putative hybrids (but without pulling up stems and roots!). The following list of specific morphological traits of our *Gentiana* species will be useful in determining probable parentage of hybrids (from Pringle 1964: 274).

Trait	Species
Stems minutely puberulent	*G. puberula*
Upper internodes long	*G. rubricaulis*
Leaves glaucous, pale bluish- or grayish-green	*G. rubricaulis*
Leaves yellowish-green, relatively large	*G. alba*
Involucral leaves ascending, folded, enveloping calyces	*G. rubricaulis*
Lower leaves linear-oblong	*G. rubricaulis*
Calyx tubes hyaline	*G. rubricaulis*
Calyx lobes keeled, pushed to one side in pressing	*G. alba*
Corolla pale, whitish or yellowish	*G. alba* (albinos of *G. andrewsii*)
Corolla banded or suffused externally with green	*G. puberula*
Corolla spreading (open), the lobes large, ovate	*G. puberula*
Corolla closed, the lobes very small	*G. andrewsii*
Corolla appendages (plaits) bifid	*G. puberula* and *G. andrewsii*
Corolla appendages with attenuate divisions	*G. puberula*
Corolla appendages symmetrical, broad, truncate	*G. andrewsii*
Corolla appendages low, asymmetrically triangular	*G. alba* and *G. rubricaulis*
Anthers separate	*G. puberula* (sometimes *G. alba*)

The following four *Gentiana* hybrids have been recognized to occur in Wisconsin (cf. Pringle 1964 and 1965b, for complete specimen citations, illustrations, and a taxonomic key to hybrids):

5a. GENTIANA X BILLINGTONII Farwell, *pro species*. Map 6; Fig. 6.

Gentiana puberula Michx. x *G. andrewsii* Griseb.

The commonest hybrid, illustrated here (Fig. 6), as well as by Mason (1959) and by Pringle (1964), has more rounded, broader and more abruptly constricted leaf-bases than *G. andrewsii*, and deep blue flowers with ± erect corolla lobes (2–7 mm long) that are well-developed and equal to, to somewhat longer than, the bifid-laciniate plaits (but shorter than in *G. puberula*) (cf. also Pringle 1965, this volume, pp. 284–287, figs. 1–15).

Wisconsin hybrid swarms show the whole range of intermediates (cf. Figs. 1–6 in Pringle 1964). The type collection, from Ontario, Canada, is apparently an F_1. The seasonal isolation of the parents (q.v.) is evidently reinforced by sharp ecological isolation. Thus, in Springvale Township, Columbia Co., Curtis collected "within 10 feet of one another, *G. puberula* on dry sand, *G. andrewsii* in wet peat, and the hybrid in between . . ." (herbarium label, WIS). Our collections come mostly from prairie relics on railroad rights-of-way, the disturbance and ecological "openness" of this habitat possibly an important factor in the production and establishment of this and other *Gentiana* hybrids (cf. 5c). Steyermark (1963: 1188) reports a spontaneous hybrid in his wildflower garden near Barrington, Illinois.

5b. GENTIANA X CURTISII Pringle, Transact. Wisc. Acad. Sci. Arts and Letters 53:277–8. 1964. [Type: Along Chicago & Northwestern Railroad, 34, T. 2N, R. 13E, Rock Co., Wisc., 20 Sept. 1951, *Mason 1470* (WIS)]. Map 6.

Gentiana puberula Michx. x *G. alba* Muhl. (*G. flavida* Gray)

Intermediate between the parents; stem essentially glabrous; leaves broader and much longer than in *G. puberula;* flowers a pale blue, sometimes very large, in the type to 6 cm, the narrowly lanceolate calyx lobes 9–27 mm long, in other Wisconsin specimens smaller; corolla lobes suberect, triangular, conspicuously reticulate-veined as in *G. alba,* 5–10 mm long; corolla appendages obliquely triangular, much shorter than lobes.

Pressed corollas from hybrid swarms involving such parents (as well as *G. andrewsii* ?) are illustrated by Pringle (1964. Figs. 7–12); their whole plant vouchers are in WIS. The parental species show strong seasonal isolation (*G. alba,* the earliest, *G. puberula* the last gentian to bloom in Wisconsin), moderate ecological isolation (mesic vs. dry prairies), as well as probably floral isolation, the white *G. alba* vs. deep blue *G. puberula* corollas very likely attracting somewhat different pollinators (Suggestion of Dr. Pringle, in correspondence).

5c. GENTIANA X PALLIDOCYANEA Pringle, Transact. Wisc. Acad. Sci. Arts and Letters, 53:279. 1964. [Type: Waukesha Co.: In black sandy loam and cinders, growing with *G. flavida, Celastrus scandens* and grasses, along railroad, SE¼, SE¼, Sec. 1, T. 7N, R. 18E, between Hartland and Pewaukee, Sept. 23, 1945, *Irene Cull s. n.* (WIS)]. Map 6.

Gentiana andrewsii Griseb. x *G. alba* Muhl.

Intermediate between the parents; leaves basally rounded and wide, almost clasping, similar to those of *G. alba;* corollas pale blue, barely open, with white plaits suggesting *G. andrewsii;* lobes 2–3 mm long, the appendages sub-equal or shorter; sepals eciliate.

In addition to the type, the following are known from Wisconsin (fide Pringle 1964): Vic. of Kilbourn [Wisconsin Dells] on Wisconsin River, 25 Aug. 1909, *Steele 19* (US). Sheboygan Co.: Plymouth, 29 Aug. 1930, *Goessl s.n.* (MIN).

Dr. James Zimmermann, Arboretum Botanist, University of Wisconsin—Madison, recognized the correct parentage and hybrid nature of the holotype, as indicated by an annotation dated 1950. The nearby presence of the much rarer of the two parents *(G. alba)* and the open, evidently disturbed and recent habitat of the type locality should be noted.

5d. GENTIANA X GRANDILACUSTRIS Pringle, *loc. cit.* 53:279. 1964. Map 6.

Gentiana andrewsii Griseb. x *G. rubricaulis* Schwein.

Intermediate between the parents; stems dark reddish-purple, the uppermost internode relatively long; upper leaves and outer involucral bracts broadly lance-ovate, abruptly constricted and broadest near the base; bracts enveloping the lower portion of the flowers, these purple or purplish-blue, somewhat barrel-shaped but open; corolla lobes 1–2 mm long, slightly longer than plaits; calyx tubes hyaline.

Aside from the type (Clearwater Co., Minn., in MIN) a Wisconsin collection of 7 specimens represents a hybrid swarm of *G. rubricaulis* back-crossing to *G. andrewsii.* One of these plants appears to be an F_1 and is described above, 4 appear to be (almost ?) pure *G. andrewsii*, and 2 seem to be backcrosses very close to *G. andrewsii.* Bayfield County: Popple-White Cedar and sandy beach of Lake Superior, along Boyd Creek E. of Wisc. Hgw. 13, S. of Barksdale (T 48N, R. 5W, S.25), Sept 3, 1959, *Zimmerman, Weber, & Ugent s.n.* (WIS).

3. GENTIANELLA MOENCH. GENTIANS

Gentiana L. Sp. Pl. ed. 1. 1753, *pro parte.*

[Gillett, J.M. 1957. A revision of the North American species of *Gentianella* Moench., Ann. Missouri Bot. Gard. 44:195–269; cf. Iltis 1965].

Annual or biennial herbs, often with square angle-winged stems. Flowers 5-merous, lilac or blue, small, short-pedicelled. Calyx lobes contorted, with green margins, the sinuses without inner membranes. Corolla lobes entire, each with a solitary interstaminal gland at very base; plaits lacking. Ovary sessile, the placentae confined to the sutures; seeds smooth, round.

One of the largest genera in *Gentianaceae,* common in the arctic, montane Western North America, and particularly the Andes of South America, related to *Gentianopsis* (but not to *Gentiana, sensu stricto*), our species the only truly Eastern North American taxon.

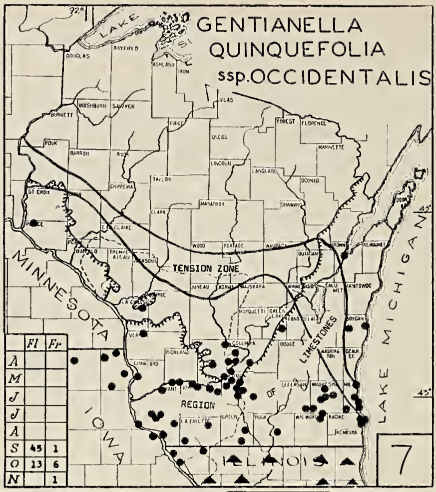
1. GENTIANELLA QUINQUEFOLIA (L.) Small ssp. OCCIDENTALIS (Gray) Gillett. Ague-weed, Five-flowered Gentian. Map 7; Fig. 7.

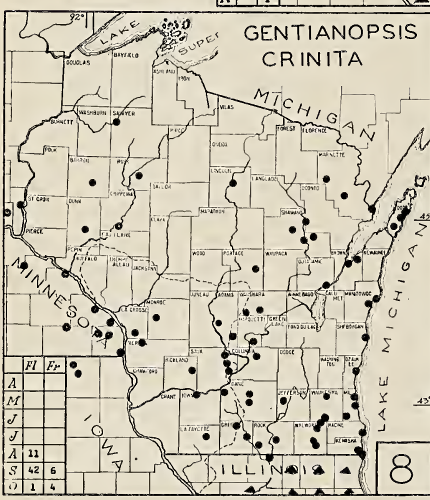
Gentiana quinquefolia L. var. *occidentalis* A. Gray

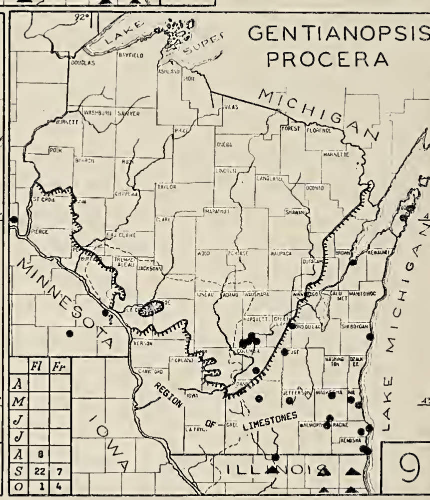
Biennial or annual (?) 1–9 dm tall, commonly much-branched above, simple at base and throughout when slender; stems square, winged. Basal leaves spatulate, withering and seldom collected, the median ovate, 5-veined, at base cordate to rounded, clasping, 1–4(–6) cm long. Flowers few to several hundred, 1–6(–10) in each compact umbelliform cymose terminal cluster, the bracteate pedicels short (3–25 mm). Calyx 5-parted, (6–)8–15 mm long, the lobes lanceolate, 4–9 mm, longer than tube. Corolla 15–25 mm long, "lake blue" (J. T. Curtis) to a deep lilac, narrowly funnelform, the 5 triangular acuminate-caudate lobes ½ to ⅓ as long as the tube, the orifice naked without any fimbriae or plaits. Seeds round, 0.6 mm diam., smooth, wingless, light brown. $2n = 36$ (Rork 1949).

In Wisconsin in the limestone regions, in a variety of habitats, from dry, S-facing, steep, rocky, calcareous "goat prairies" and bluffs (reported as characteristic of xeric prairies; Curtis 1959), mesic lime prairies and even well-drained ridges in deep-soil prairies (e.g. Faville Prairie Sci. Area, Jefferson Co. or Juda Prairie, Green Co.), to moist calcareous prairies and marshy, gravelly places (e.g. near L. Michigan, Kenosha Co.), in moist clay soil and seepage on the L. Michigan Bluffs, edges of oak-hickory woods, in oak openings, rocky wooded ridges and hillsides, and rarely on damp calcareous sandstone cliffs (e.g. across from Lone Rock, Iowa Co.) or shaded earth banks along roads, the species apparently requiring calcareous soil, and an "ecologically open" or slightly disturbed, unstable local habitat without too much competition. Flowering from early September to late October, one of the very last species to bloom in our flora.

Gentianella q. ssp. *quinquefolia* is an Appalachian element, while ssp. *occidentalis* is an element of the Ozark and Cumberland Plateaus. whence our plants must have come post-glacially. Is it an annual or a biennial? Some 200 plants were observed on Oct. 16, 1960 in full flower (the melancholic last flowers of the season!) on a steep, dry, SW-facing, high lime prairie and adjoining dense *Juniperus virginiana* glade near the top of Lodde's Mill Bluff Nature Preserve,







Sauk Co. (*Iltis 17087,* WIS). Interspersed among the flowering plants were sterile green rosettes ca. 3–5 cm in diam., these with rounder leaves than flowering *G. quinquefolia,* yet unquestionably that species. The nearly full grown tap roots and large size of the rosettes suggested at least a good season's growth. Here the species thus appears to be a biennial.

4. GENTIANOPSIS MA FRINGED GENTIANS

Gentiana L. Sp. Pl. ed. 1, 1753, *pro parte.*
Anthopogon Neck. ex Raf. Fl. Tellur. 3:25. 1837, *pro parte.*
Gentianella Moench, Meth. Pl. 487, 1794, *pro parte.*
Gentiana **** *Crossopetalae* Froel., Gent. Diss. 109. 1796.

7 Gentianella quinquefolia

8 Gentianopsis crinita

9 Gentianopsis procera

Crossopetalum Roth, Enum. Pl. Phaen. Germ. 1:516. 109, 1827, *non* P. Br. 1756.

Gentianella subg. *Eublephis* (Raf.) Gillett, Ann. Missouri Bot. Gard. 44:210. 1957.

[Gillett, J. M. 1957. A revision of the North American species of *Gentianella* Moench. *Ann. Missouri Bot. Gard.* 44:195–259; Iltis,

H. H. 1965. The genus *Gentianopsis* (Gentianaceae): transfers and phytogeographic comments. *Sida* 2:129–154.]

Small annual or biennial herbs unbranched at base, often above, with slender roots (ours). Flowers 4-merous, blue, fading to purple, large and showy, solitary on long pedicels. Calyx 4-angled, compressed, the lobes large, keeled, distichously imbricate, their margins, thin, transparent, the outer pair narrower, each sinus with a minute ciliated inner membrane. Corolla campanulate to funnelform, the ciliate to fimbriate lobes without plaits or epipetalous nectaries except for a gland at the very base of each petal. Ovary stipitate, the stigma large, the parietal placentae extending over most of inner surface. Seeds oblongoid-angular, papillose.

A small Northern Hemisphere boreal and montane genus of ca. 26 taxa, originally placed into *Gentiana,* later *Gentianella* (or considered as *Crossopetalum* or *Anthopogon,* invalid or unavailable names), but on morphologic and cytologic grounds (Löve 1953) best considered as a distinct genus most closely related to the scandent E. Asiatic *Pterygocalyx* Maxim. (cf. Toyokuni 1963; Iltis 1965). Their annual or biennial habit and ecological specificity, their celebrated beauty and man's desire to pick the flowers (and thus in this genus generally whole plants) and, for other reasons, man's draining of their habitats, all conspire to their present rarity and local extinction.

Key to Species (cf. Fig. 12)

A. Upper or median leaves lanceolate to ovate, rounded to subcordate at base, (5–)10–30 mm wide, 10–60 mm long; flowers few to many, 1–40 or more, the longest pedicels 2–12 cm long. Throughout Wisconsin ______________________1. *G. crinita.*

AA. Upper or median leaves linear or less often linear-lanceolate, 2–8(–10) mm wide, 10–110 mm long; flowers few, 1–10(–20), the pedicels (2–)10–20 cm long. S. and Eastern Wisconsin ____2. *G. procera.*

1. Gentianopsis crinita (Froel.) Ma, Acta Phytotax. Sinica 1:19. 1951. Eastern Fringed Gentian. Maps 8, 10, 12; Figs. 8, 10–14.

Gentiana crinita Froel.
Gentianella crinita (Froel) G. Don

Slender annuals or biennials 1–7 dm tall, often much branched above, the base and small plants unbranched. *Median leaves ovate to ovate-lanceolate* (cf. Figs. 12, 14), 10–60 mm long, (3–)*7–30 mm wide, with a broad clasping base.* Flowers usually several to many, 1–40(–125, fide Fernald), very showy, 28–56 mm long, deep blue (or rarely white in forma albina (Fern.) Iltis), the 4 petal-lobes prominently fringed; *pedicels relatively short, the longest 2–10(–12) cm long.* 2n = 78 (Rork 1949).

Widely distributed, and locally common to rare throughout Wisconsin, both in the region of limestones as well as of acidic rocks, in sunny or shady moist habitats, especially those that are flooded in spring, in marshes or sandy sedge meadows, along Lake Michigan in swales behind dunes, on moist dunes, seepage slopes, and on low, wet sandy or gravelly flats or rock pavements, rarely in damp open woods and shaded dolomitic sandstone cliffs (e.g. cliff across from Lone Rock, Iowa Co., with *Sullivantia* and *Gentianella quinquefolia*), apparently not requiring, but tolerating, as calcareous a habitat as *Gentianopsis procera* [with which it rarely grows, as on calcareous sedge meadows (fens) on Lake Wingra, U.W. Arboretum, Madison, and Ennis (Muir) Lake, Marquette Co. (cf. Iltis 1957); and on calcareous low prairies, Kenosha Co. on Lake Michigan]; flowering from mid-August into October, peaking in the 2nd and 3rd week of September, a little later than *G. procera.*

2. GENTIANOPSIS PROCERA (Th. Holm) Ma, Acta Phytotax. Sinica 1:19. 1951. Great Plains Fringed Gentian.
Maps 9, 11, 12; Figs. 9–14.

Gentiana procera Th. Holm.
Gentianella procera (Th. Holm) Hiit.
Gentianella crinita (Froel.) G. Donn, ssp. *procera* (Th. Holm) Gillett.

Similar to *G. crinita:* slender annuals or biennials, 1–4 (–5) dm tall, unbranched at base and in small plants. *Median leaves linear to linear-lanceolate,* 10–112 mm long, 2–8 mm wide (or in robust plants of certain SE Wisc. populations, narrowly lanceolate and to 12 mm wide; cf. fig. 12b), attenuate to abruptly contracted at base, ascending and ± arched outward. Flowers relatively few, 1–7 (–20), very showy, 30–70 mm long, deep blue, rarely white, the 4 (in one plant abnormally 8) petals prominently fringed, solitary *on very long pedicels, and longest* in depauperate plants (2–)*5–19 cm long.* 2n = 78 (Rork 1949).

Restricted to the region of limestones and more locally distributed in Wisconsin than *G. crinita,* in full sun in generally more distinctly alkaline habitats (judging from associated calcophiles), as marly, often springy sedge meadows, low prairies, or fens, moist calcareous gravels, sands, or limestone pavement on L. Michigan (Bailey's Harbor, Door Co., with *Gentianella quinquefolia,* pH 8, fide Fuller), spring seepage on the L. Michigan bluffs (pH 7, fide Pohl), often on bare sands, black soil, or clays without much competition, as well as on grassy shores, rarely growing with *Gentianopsis crinita* (q.v., if so, then like in Indiana (Deam 1940) probably in moister microhabitats). Flowering from (mid-) late August into early October, with a peak in the 2nd week of September, though their blooming dates do overlap, a little earlier than *G. crinita,* this also noticed for Indiana by Deam (1940) and for the N.E. U.S. by Fernald (1950).

These, usually wet calcareous sedge prairies or fens occur on drift derived from E. Wisconsin's Niagara Dolomite, on the dolomite itself, or around calcareous springs, and are characterized by a distinctive assembledge of calcophiles whose distribution pattern often very closely match that of *G. procera,* incl. *Solidago ohioensis, S. ridellii,* and perhaps *S. patula* (Salamun 1963), *Salix candida* (Argus 1964), *Lysimachia quadriflora* (Iltis and Shaughnessy 1960:133), *Lobelia kalmii, Aster junciformis, Parnassia glauca, Potentilla fruticosa* (Mason & Iltis 1958; Map 16), *Valeriana ciliata (V. edulis),* the rare *Scleria verticillata* (cf. Iltis 1957) and others. All these, together with *G. procera,* are rare or absent from the "Driftless Area" of SW. Wisconsin, not because of historical factors or absence of calcareous rocks, but of deficiency in appropriate moisture (i.e. flat marly springs, calcareous seepage and glacial till).

The Fringed Gentians East of the Rocky Mountains

The Eastern and Middle-western Fringed Gentians, *Gentianopsis crinita, G. procera, G. victorinii* and *G. macounii* (incl. *G. tonsa* and *G. gaspensis*) have recently been treated in several fashions. Fernald (1950) recognized all as valid species of *Gentiana,* while Gleason (1952), in listing *G. crinita, G. procera, G. victorinii* and *G. tonsa* (incl. *G. gaspensis*), comments (3:62) that ". . . [*procera*] and the next two species [*victorinii, tonsa*] are so closely similar that they might well be reduced to varieties of a single widely varying species." Gillett (1957, 1963) visualized an all-inclusive *Gentianella crinita,* composed of 4 *equivalent* subspecies, with *G. gaspensis* and *G. tonsa* synonymized under *G. macounii.* The morphological patterns of these gentians make it evident, however, that neither such "splitting", nor such "lumping", properly reflect the natural relationships of these taxa. On the other hand, a reconsideration of ecology, geography and morphology suggests a synthesis of the above viewpoints into a taxonomy closely resembling that of Gleason, one that is more compatible with evolutionary and historical factors, in which but two species are recognized: namely, the uniform *G. crinita,* and the variable *G. procera.* The latter species includes all other taxa mentioned above, some as clinal geographic subspecies, others as discrete local populations here recognized as weak varieties.

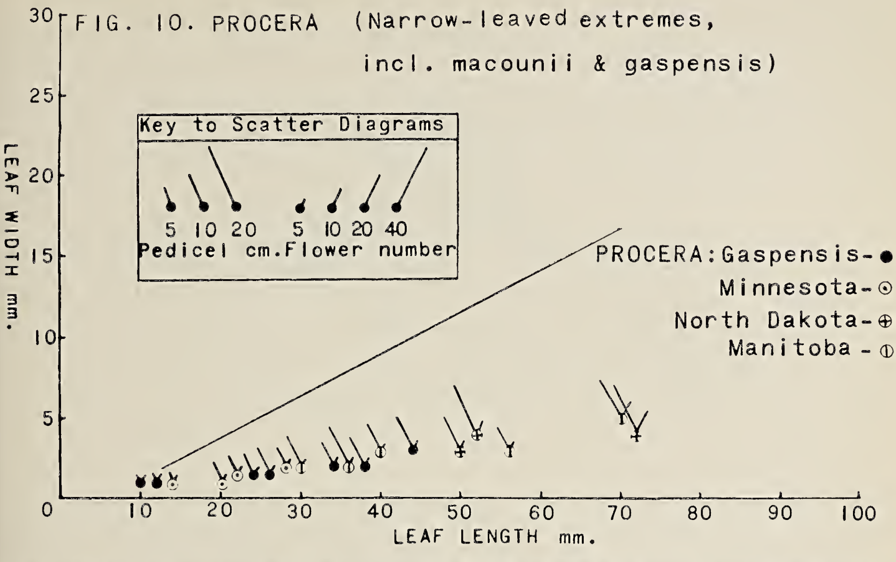


FIGURE 10. *G. procera* ssp. *macounii.* Solid dots are the very local, geographically isolated, morphologically only slightly differentiated var. *gaspensis (Victorin et al. 4008)*, the hollow dots collections of var. *macounii*, one each from Minnesota, North Dakota, and Manitoba. The Gaspé plants (star on Map 11) tend to be smaller, to branch from the base and have narrower, shorter leaves. However, the variation pattern is continuous with that of plants from Minnesota and further west (cf. Fig. 14). All plants have very few flowers, and most, except some very slender, depauperate ones, have long pedicels. These are the narrow-leaved extremes of the *G. procera* complex. *G. p.* var. *victorinii*, from the St. Lawrence River estuary, not graphed here (cf. Iltis 1965:Fig. 5a), has glyphs distributed much like those from Manitoba and Minnesota. All plants in Figs. 10–14 are from the University of Wisconsin Herbarium, the largest median leaf of each being used for measuring.

Thus, though Iltis (1965) recently transferred all of these taxa to *Gentianopsis* as full species, it seems on further consideration better to treat them as follows:

1. GENTIANOPSIS CRINITA (L.) Ma.

2A. GENTIANOPSIS PROCERA (Th. Holm) Ma, ssp. PROCERA.

2B. GENTIANOPSIS PROCERA (Th. Holm) Ma, ssp. **macounii** (Th. Holm) Iltis, **comb. nov.**
Gentiana macounii Th. Holm, Ottawa Naturalist 15:110. 1901.

a. var. *macounii*
b. var. **victorinii** (Fern.) Iltis, **comb. & stat. nov.** *Gentiana victorinii* Fern. Rhodora 25:87. 1923.

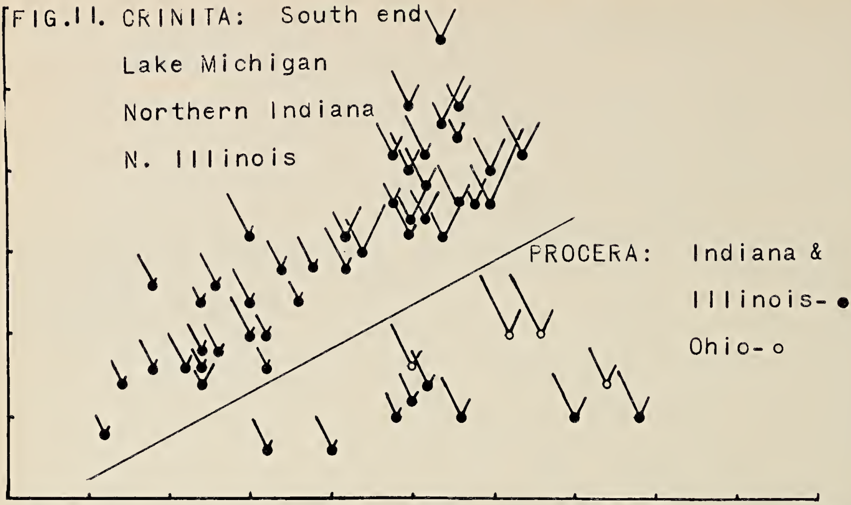


FIGURE 11a. *G. crinita* from the south end of Lake Michigan (mostly Northern Indiana collections of L. M. Umbach). The distribution of glyphs is nearly identical to those from Wisconsin or New England.

FIGURE 11b. *G. procera* ssp. *procera* from Indiana, Illinois (black glyphs) and Ohio (hollow circle glyphs). Note the often larger leaf-width of the *G. procera* collections as compared with those from further west (Fig. 10). The Ohio specimens, especially, are very robust (collections of C. W. Short, "Columbus" 1835, "Prairies of Ohio" 1836). The glyph position on the diagram should be related to the robustness of these plants (flowers to 8 cm long! pedicels to 19 cm long!).

c. var. **gaspensis** (Vict.) Iltis, **comb. & stat. nov.** *Gentiana gaspensis* Vict. Contr. Lab. Bot. Univ. Montreal 20:10. 1932.

The morphological relationships of these taxa are well shown by scatter diagrams (Figs. 10–14) based on specimens in the University of Wisconsin Herbarium and representing dimensions for the largest median leaf of each plant, as well as for certain characters of pedicel length and flower number (cf. Iltis 1965, for detailed discussion of these and other diagrams). *Gentianopsis crinita has lanceolate to ovate leaves* and shows great *uniformity* throughout its range. Thus the glyphs are distributed in roughly the same pattern, whether the plants come from Wisconsin (Fig. 12a), Northern Indiana (Fig. 11a), or New England (Fig. 14, dot-dash-dot-line) *Gentianopsis procera typically has linear to linear-lanceolate leaves* as shown by the solid black glyphs in Figs. 11b and 12b, the hollow circle glyphs in both representing particularly robust plants (these perhaps introgressants with genes from *G. crinita,* or simply plants growing in a more favorable environ-

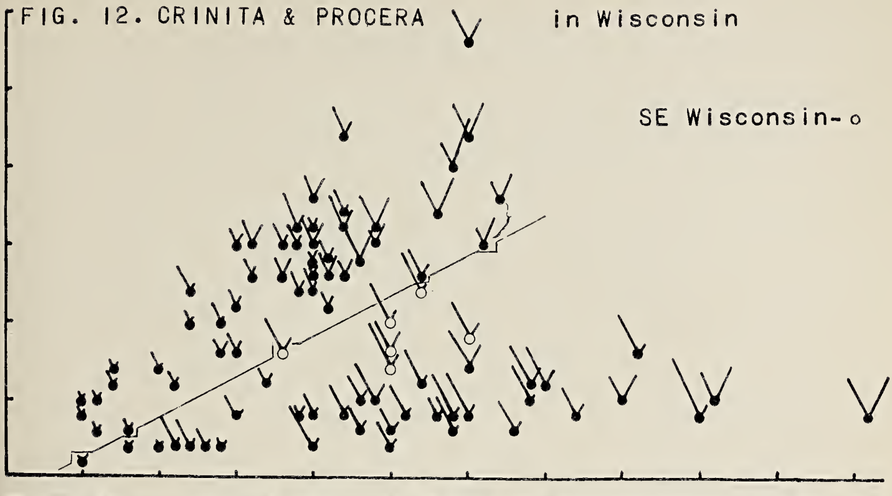


FIGURE 12a. *G. crinita* in Wisconsin follows the same distribution as in other parts of Eastern North America (see Fig. 14), and shows no perceptible influence (either climatic or genetic) of *G. procera* on its phenotypic expression. The glyphs in the far left-hand corner belong to the particularly depauperate "Lone Rock" cliff population of Fig. 13.

FIGURE 12b. *G. procera* in Wisconsin is complex. While there are many plants that are nearly as narrow-leaved and few-flowered as some of the ssp. *macounii* specimens plotted in Fig. 10, most plants have much wider leaves and are similar to those shown in Fig. 11b. A few very robust plants, all from Milwaukee, Racine and Kenosha Counties are plotted as hollow circles (see text).

ment, e.g. wet prairies in S.E. Wisconsin near Lake Michigan, and at the very southeastern edge of its range in Ohio). In Minnesota, North Dakota and northwestward into Canada, as well as in three highly local populations, two in eastern Quebec and one on the south end of Hudson Bay (Map 11), occur linear-leaved plants of ssp.*macounii* (Fig. 14, dots-dash-dots-line), the var. *gaspensis* (Fig. 10) and var. *victorinii* distinguished from var. *macounii* on but very minor morphological grounds, as well as by geographic isolation (Map 12) and ecological peculiarities (cf. Rousseau 1932; Raymond 1951). It is clear that while the subspecies of *G. procera* grade into each other, and its varieties are weak and mostly taxonomic conveniences maintained for purposes of discussion, *the two species are quite distinct morphologically,* with clearly different modes of variation (Fig. 14), the three or four robust plants in S.E. Wisconsin (Fig. 12b, hollow glyphs) notwithstanding. Distinctions between the two species seem to break down only in the smallest depauperate plants (Figs. 12 & 13, glyphs in lower left-hand corner), whose identification is often only possible in conjunction with more normal plants of the same population.

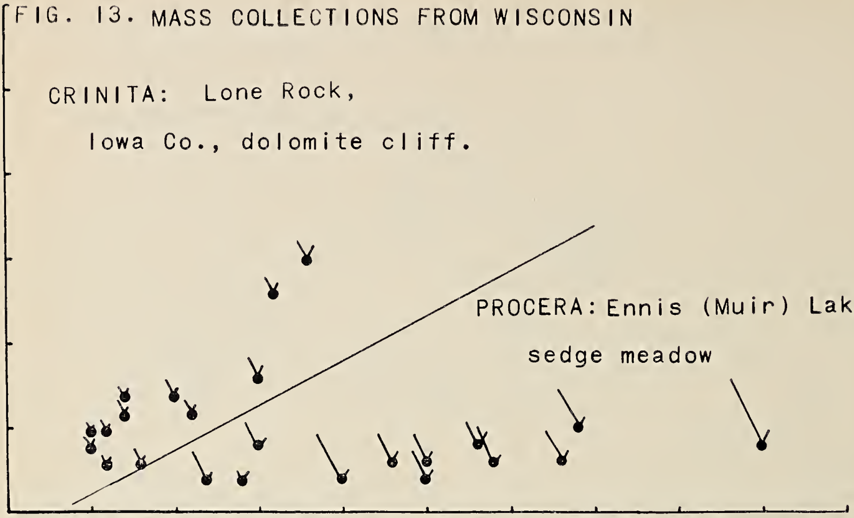


FIGURE 13. *G. crinita* and *G. procera* in Wisconsin: Mass collections to show variability within single populations. Fig. 13a. *G. crinita* from Iowa Co., across the Wisconsin River from Lone Rock, Wisc., is peculiar in that these mostly depauperate plants grow on a vertical north-facing dolomitic sandstone cliff. Collections in 1925 by N. C. Fassett and in 1958 by Brian McNab show precisely the same morphological distribution.

FIGURE 13b. *G. procera* population from an alkaline sedge meadow ("fen") on Muir (Ennis) Lake, Marquette County: note large spread of glyphs within this local population.

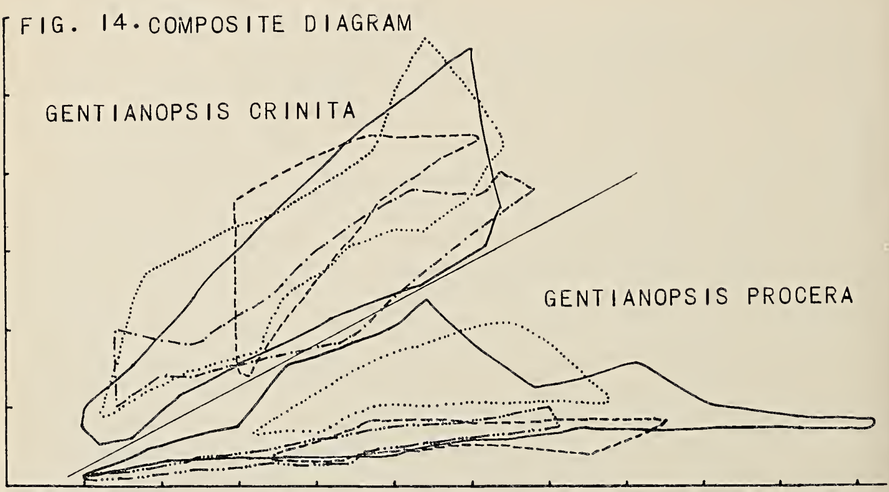
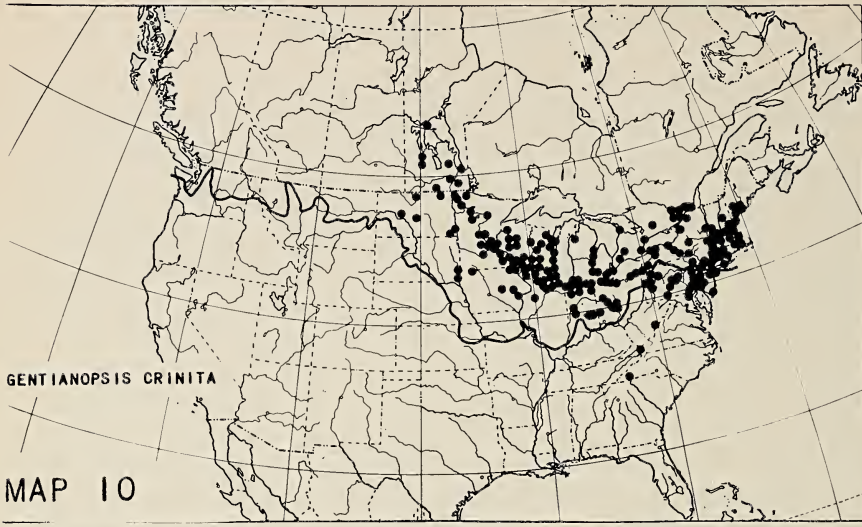


FIGURE 14. Composite of all graphs of *G. crinita* and *G. procera*. See discussion especially of Figs. 11 and 12. Var. *victorinii* is not shown since its limits are essentially congruent with those of the western plants of *G. procera* (dashes).

Probable History of Gentianopsis in the Eastern United States

Since the modern ranges of *Gentianopsis crinita* (Map 10) and *G. procera* (Map 11) must be related to Pleistocene glaciation, we can visualize their post-glacial emigrations from glacial refuges or "*refugia*" or, better, survival centers which we may call "*survivia*", and attempt to reconstruct their post-glacial history (Map 12). All factors of geographic distribution, ecology, phenology and even morphology, suggest that these two taxa are the result of separation by the Pleistocene glaciers of a once widespread ancestral species into two populations whose subsequent history we may postulate to have been as follows: One population survived in the moister, more acidic, wooded, Appalachian region of the southeastern United States, a region with a mild long growing season, eventually evolving into a broad-leaved, many-flowered, late-blooming, shade tolerating, circum-neutral to somewhat calcophilic *G. crinita*. The other population survived in the dry, treeless, more calcareous (alkaline) upper Great Plains (and Northern Rocky Mountains?) in the West, a region with a severe climate and short growing season, eventually evolving into a narrow-leaved, early-blooming, few-flowered, heliophilic, distinctly calcophilic *G. procera*. Upon retreat of the glaciers, the eastern *G. crinita* spread into the glaciated region of the "White Pine—Hemlock—Northern Hardwoods" and beyond, while the western taxon (or were there several, morphologically slightly differentiated, geographically isolated surviving populations?), which, in its more depauperate, xeromorphic Northern Great Plains phase is known as ssp. *macounii*, migrated eastward, especially on damp, but physiologically dry, calcareous habitats, to eventually invade and overlap the range of *G. crinita*. In Wisconsin and Michigan, perhaps as a consequence of the higher precipitation, there evolved, through selection or phenotypic responses, generally larger, bigger-leaved plants which have been distinguished from ssp. *macounii* as ssp. *procera*. Some of these resemble *G. crinita*, suggesting the possibility of introgression from that species. While scatter diagrams (Fig. 12) reflect this similarity, it seems equally or more reasonable to suppose increased leaf size to be a phenotypic response to moister habitat, less alkaline soil, and/or longer growing season.

The Wisconsin and Indiana *G. procera* populations are variable, suggesting "broad dispersal" migration and many genotypes. The Eastern Canadian populations, in contrast, are highly uniform. As is characteristic of many other Western elements, *G. procera* ssp. *macounii* spread as far east as the Gaspé Peninsula and Hudson Bay, very probably by sporadic, single-seed "long range" dispersal,



since the intervening acidic rocks (cf. Map 11; Wynne–Edwards 1937, 1939) would make establishment all but impossible. These isclated and highly local, ecologically specialized, genetically evi-

MAP 12

GENTIANOPSIS

Hypothetical post-glacial migrations

dently impoverished, homogenic populations have been taxonomically recognized as var. *gaspensis* and var. *victorinii,* two neoendemics perhaps best considered simply as local populations of *G. procera* ssp. *macounii.*

There are, of course, examples of quite distinctive species or subspecies evolving in as short a time as 10,000 years or less in the Northeastern United States. One need only examine some of the

Great Lakes endemics, e.g. *Iris cristata* ssp. *lacustris*,[6] *Hypericum kalmianum*, *Cirsium pitcheri* (cf. Johnson and Iltis 1963: 290–292), *Calamovilfa longifolia* var. *magna* (Thieret 1960), or *Agropyron psammophilum* (Senn and Gillett 1961). However, by comparison, especially to some of the beach and dune endemics, the fringed gentian populations are not nearly as clearly differentiated. Thus, in the formation of these post-glacial neo-endemics, evolutionary rates appear to have differed greatly, depending on the nature of the plants themselves, the type of habitat, the kind of selection and the original variability and size of the population.

The great taxonomic-phytogeographic difficulties which the *G. macounii—G. procera* pheno-cline engendered, and its relationship to the Gaspe endemics and to *G. crinita*, can thus be resolved by realizing that *the two major taxa fall into the standard pattern of Eastern North American–Western North American vicarious species pairs*, their post-glacialy produced modern ranges *overlapping only in glaciated Northeastern North America. This pattern is much more prevalent than is generally appreciated*, and is exemplified by the ranges of many of our commonest as well as rarest, by some of the most distinct as well as taxonomically most difficult species in the Northeastern United States.

The difficulties that one encounters in distinguishing the components of poorly differentiated, post-glacially confluent species

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[6]*Iris cristata* Ait. ssp. **lacustris** (Nutt.) Iltis, **stat. nov.**

Iris lacustris Nutt. Gen. Am. Plants 1:123. 1818.

Iris cristata Ait. var. *lacustris* (Nutt.) Dykes, The Genus Iris 106. 1913.

This attractive Great Lakes Endemic (cf. Guire & Voss, Mich. Botanist 2: 100–101, 1963 for an excellent discussion of its range) is distinguished from some plants of the southern paternal species *I. cristata* by the shorter perianth tube (short due to selection by strong Great Lakes shore winds, which would knock a long tube like that found in typical *I. cristata* to the ground??) and by such minor quantitative characters as petal, sepal, and capsule shape, laxness of leaves, smaller size, and supposed lack of flower odor. Foster (Contrib. Gray Herb. 119: 10–13. 1937), who carefully reviewed much information, places emphasis on previously reported, apparently erroneous chromosomal differences ($2n = 42$, *fide* Simonet; cf. Foster, *loc. cit.;* probably based on a plant of *I. verna*). Material from near Baileys Harbor, Door Co. (*H. H. Iltis 17675*, 1961) counted by Dr. Shoichi Kawano (MS) showed the chromosome number to be $2n = 32$, the same as reported for *I. cristata* by Foster (*loc. cit.* 119:11), Foster also emphasized Fernaldian ideas of pre-Wisconsin glacial survival, citing many associated supposed "glacial relics" that also grow on the alkaline sands and gravels of the Niagara dolomite. However, a) its restriction to glaciated territory, b) its allopatric distribution in respect to *I. cristata* (cf. Guire & Voss, *loc. cit.*), c) its ecological restriction to shore habitats that are alkaline, often unstable and ecologically "open", and rich in many disjunct southern and western taxa like *G. procera*, d) its great morphological uniformity as compared with the quite variable *I. cristata*, noticed by Anderson (cf. Foster, *loc. cit.* and personal observation), and e) its truly minor morphological differentiation from *I. cristata*—all speak for *I. lacustris* as a post-glacially evolved "founder population" (E. Mayr) of much the same character as the isolates of *G. procera* ssp. *macounii* in Eastern Quebec discussed above, which, due to both limited original variability (being "founded" as it were by one seed?) as well as rather rigorous selection by the Great Lakes shore environment, had undergone slight morphological divergence. The lesser size of many morphological characters in *I. lacustris* could well be understood as the effect of climate on this population which, after all, represents the southern *I. cristata* at the very limit of its range as a northern, poorly differentiated geographic subspecies. (H.H.I.)

pairs were well known to Hultén (1937), who was among the first to appreciate the dynamics of such a situation: . . . "As long as those races are separated from one another geographically, they may be distinguishable, but when migration has proceeded so far that the radiants from two elementary areas meet, hybridization and thereby an intergradation of the differences must be expected to occur." The taxonomic-phytogeographic significance of this pattern, which is enormous in the Upper Middle Western flora, has been preliminarily discussed elsewhere. (Iltis 1965)

5. HALENIA Borkh. Spurred Gentian

[Allen, Caroline K. 1933. A Monograph of the American species of the genus *Halenia*. Ann. Missouri Bot. Gard. 20: 119–222.]

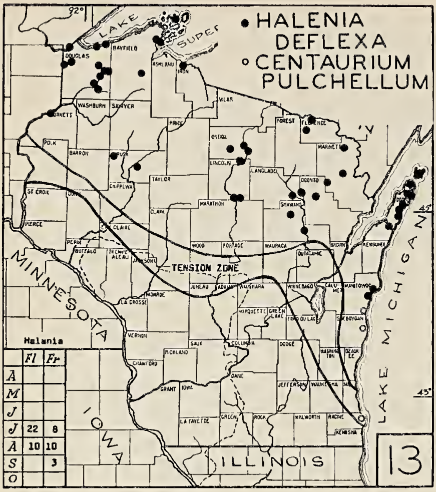
1. Halenia deflexa (Sm.) Griseb. Spurred Gentian

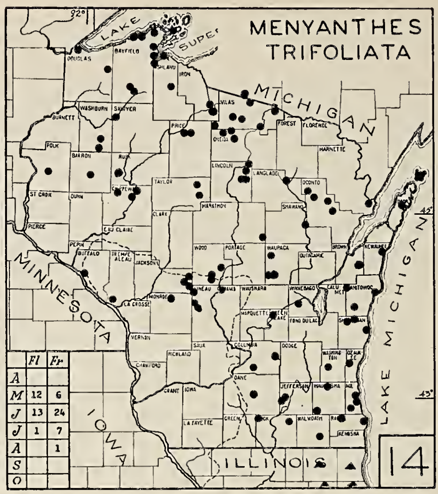
Map 13; Fig. 15.

Biennial (?) or winter annual (?) 1–4(–9) dm high. Stems simple or branched above, slender with 6–8 cm. long internodes. Leaves 3- or 5-nerved. Basal leaves suborbicular- to oblong-spatulate, petiolate, 1–2 cm long, cauline oblong-lanceolate to ovate, acuminate, 1–5 cm long. Flowers 4-merous in terminal or axillary, loose umbelliform cymes. Calyx 4–8 mm long, the segments ovate-lanceolate, acuminate. Corolla 8–15 mm long, yellowish or greenish to greenish-purple, often pronouncedly reddish purple when in bud, marcescent, the lobes lanceolate to ovate acute, erect, each prolonged at base into a divergent slender 3–5 mm long spur (in forma heterantha (Griseb.) Fern. these spurs occasionally lacking in lower flowers or in flowers developing late in the season). Capsule lancoblongoid, falcately curved upward, septicidal, thin-papyraceous the seeds oblong-ovoid, greenish-brown.

In Wisconsin North of the "Tension Zone", locally abundant in cool moist shady or open forests, especially in wet and mossy coniferous *Picea glauca-Abies balsamea-Thuja occidentalis* woods, in open sphagnum or *Thuja* bogs, on black organic "muck", gravelly or clayey shores of lakes, mesic lumber-roadsides and old clearings, but rarely on dry sites. Flowering from early July to the 3rd week of August; fruiting from end of July to mid-September.

Halenia includes few Asiatic, and only two northern North American taxa, the remainder all western hemisphere species [highly fragmented into 69 taxa by Allen (1933)] local in the montane or alpine zone from Arizona and Mexico to Peru and Chile. With a very wide range characteristic of invaders to glaciated territory, *Halenia deflexa* occurs from Alberta to Hudson





Bay, Quebec, and New York, with its only non-glaciated stations in western Nebraska [unless one should care to accept the two incongruously disjunct central Mexican stations cited by Allen (1933)]. Generically it is thus a "Neotropical Alpine Element", but specifically a western "Northern Great Plains" element, its range, and probably its migratory history, very similar to that of *Gentianopsis procera* (cf. Map 12).

Allen (1933) notes that some very early or late flowers of *H. deflexa* may be spurless. In addition, some plants may produce almost nothing but spurless flowers, recognized as *H. deflexa* f. *heterantha* (Fernald 1899, 1938). Of the sixty collections studied from Wisconsin, none could be definitely assigned to forma *heterantha*.

6. CENTAURIUM Hill CENTAURY

1. CENTAURIUM PULCHELLUM (SW.) DRUCE. Centaury

Map 13; Fig. 16.

Slender annuals with simple or usually much-branched stems (2–)8–16 cm tall. Leaves opposite, sessile, lanceolate to ovate, 9–15 mm long. Inflorescence cymose; calyx (2–)4–8 mm long, with 5 narrow lobes about 3 times as long as the tube. Corolla salverform, the tube exceeding the calyx, the 5 *pink lobes* 3–4 mm long. Capsule elongate, exceeding the calyx, and invested by a marcescent corolla. Seeds minute, irregularly spherical with a rough brown surface. 2n = ca. 38 (Rork 1949).

Naturalized from Europe, so far collected from only two localities: SHEBOYGAN CO.: On limestone [Niagara Dolomite] at level

15 Halenia deflexa

16 Centaurium pulchellum

17 Menyanthes trifoliata

of Lake Michigan, E. end of Lincoln Ave., Sheboygan, 1935, *Fuller & Reeder 4532* (MIL) ; Sheboygan, 1930, *Goessl s.n.* (WIS) ; Sheboygan, Beach, 1935, *Goessl s.n.* (WIS). MANITOWOC CO.: Cleveland, 1907, *Goessl s.n.* (MIL). RACINE CO.: Weed in railroad track, vic. Modine Company, Racine, July 24, 1965 (fl), *Swink 228* (WIS).

Flowering as early as August, with all stages of development from buds to mature capsules found on the same plant throughout September and into October.

Excluded Genera

Fernald (1950) records *Swertia caroliniensis,* the American Columbo, and *Sabatia angularis,* the Rose Gentian, for Wisconsin; however, no known herbarium specimen of the former is available, the species being way out of range (north to Central Illinois with one record from Cook Co. Ill.; cf. Card 1931; Winterringer and Evers 1960). The only Wisconsin specimen of *Sabatia,* a showy pink-flowered relative of *Centaurium,* is deposited in the Gray Herbarium: "WIS. J.J. Hale", without specific locality. Wilbur (1955) annotated Hale's specimen [collected ca. 1860], but did not recognize Wisconsin within the species range (i.e. did not cite it in his monograph). There are other, reputedly Wisconsin records based on *Hale* collections, as *Filipendula rubra,* (cf. Mason & Iltis 1958: 80) in 1865 at Mazomanie. These low sandy flats still house many plants that are rare or occur nowhere else in Wisconsin (e.g. *Krigia virginica, Diodia teres*), and it is possible that the species might have occurred locally in southern Wisconsin. Its closest stations are in North-central Illinois to Gary, Indiana, less than 100 miles from the Wisconsin border.

MENYANTHACEAE Moench. Buckbean Family

[Lindsey, A. A. 1938. Anatomical Evidence for the Menyanthaceae. Am. Jour. Bot. 25:480–485]

The relationship and position of *Menyanthes* has been discussed by Lindsey (1938), who showed that *Menyanthes* is anatomically distinct from Gentianaceae and should be considered, together with *Nymphoides,* in the separate family Menyanthaceae.

The Menyanthaceae, a small but widely distributed family of aquatics and marsh plants is represented in Wisconsin by the single circumpolar genus and species *Menyanthes trifoliata* L. The description of the family, therefore, is also the description of the genus and species.

1. MENYANTHES L. Buckbean

1. Menyanthes trifoliata L. Buckbean Map 14; Fig. 17.
Menyanthes trifoliata var. *minor* Michx. ex Raf. (cf. Fernald 1929).

Perennial succulent semi-aquatic marsh or bog herbs with alternate 3-foliolate leaves from a creeping rootstock; petioles 5–20 cm long with enlarged sheathing bases; leaflets oval or oblong, 2–8 cm long, entire, with acute to obtuse apices. Inflorescences erect racemes ca. 10–20 cm long with elongated naked peduncles. Flowers on slender pedicels, dimorphic, in Wisc. 43% of the plants with flowers that have long styles (10–16 mm) and short stamens (7–11 mm), and 57% very short styles (7–11 mm) and long stamens (9–16 mm). Calyx lobes 5, 3–5 mm long. Corolla white, 10–15 mm wide, 7–11 mm long, the tube exceeding the calyx to twice as long, the 5 lobes about 5–8 mm long, the *inner surface bearded with many slender clavate hairs.* Stamens 5; anthers sagittate. Ovary 1-celled; stigma 2-lobed. Capsule 2-valved, ovoid, 6–10 mm long. Seeds 9–30, shiny (varnished), light brown, ovoid to subglobose, 2.2–2.9 x 1.7–2.4 x 1.1–1.4 mm. $2n = 54$ in both Eurasian and American plants (Rork 1949).

A characteristic circumboreal species of sphagnum bogs and wet coniferous forests, not uncommon in Wisconsin north of the "Tension Zone", lacking due to absence of bogs from most of the "Driftless Area", in wet portions of acid sphagnum bogs (with *Smilacina trifolia, Chamaedaphne, Kalmia, Andromeda*), in boggy sphagnous *Larix* woods (with *Picea mariana, Sarracenia purpurea, Trientalis*), in the far north in various wet cold habitats of woods or shores of streams and acid lakes. Flowering from the 2nd week in May (S. Wisc.) to late June (rarely into July); fruiting from June to August.

Fernald (1929) referred the specimens from Eastern North America, including Wisconsin, to var. *minor* Michx. ex Raf., with smaller, more nearly white and not as conspicuously bearded flowers compared with European material. These supposed differences are hard to see, and some careful analysis is needed here to verify Fernald's suppositions. Ronald Liesner, a student at the University of Wisconsin, made preliminary measurements of our collections, which in no way seem to differ from the European or Japanese collections here available, except for a rare Old World plant that is more robust and larger-flowered. Stamen and style length measurement are exactly alike. One may say that Old World *Menyanthes* appears somewhat more variable, that of the New World well within the flower size distribution of the former, but more uniform.

NYMPHOIDES PELTATA (Gmel.) Kuntze, the Yellow Floating Heart, a rooted aquatic introduced from Europe, is an additional representative of Menyanthaceae to be looked for in Wisconsin. Reported just south of Wisconsin in Winnebago County, Illinois (Fuller, Fell and Fell 1949), it has alternate suborbicular floating leaves nearly identical to those of the waterlilies *(Nymphaea* and *Nuphar)* and 1 or more umbels of 5-merous fringed-petaled yellow flowers.

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PRELIMINARY REPORTS ON THE FLORA OF WISCONSIN. NO. 54. *EQUISETACEAE*—HORSETAIL FAMILY

Richard L. Hauke
Department of Botany, University of Rhode Island

The monogeneric family Equisetaceae, one of the so-called "Fern Allies", is well-represented in the flora of Wisconsin. Five species and one hybrid of the subgenus *Equisetum,* and four species and three hybrids of the subgenus *Hippochaete* have been collected in the state. Although the genus is unmistakable, and several of the species are readily recognizable, the species of *Equisetum* are frequently subject to misidentification. A study of the subgenus *Hippochaete* (Hauke 1960, 1961, 1962a, b, c, 1963) has shown that several factors contribute to this. First is an extreme morphological plasticity under environmental stress. Thus, a single rhizome system of, for example, *Equisetum arvense* can bear aerial stems of radically diverse appearance. Second is the occurrence of hybridization, obscuring species boundaries. Third is the subtlety of those characters which are reliable for taxonomic determination.

The practice, an unfortunate one, of giving formal taxonomic recognition to essentially descriptive names has arisen in the nomenclature of *Equisetum.* Since the taxonomic categories of *subspecies, varietas,* and *forma* are intended for use with genetic variants from a species type, their use to describe environmental variation is misleading. In the treatment which follows, the plethora of forms usually listed for several of the species (Tryon *et al.,* 1953) are not accorded taxonomic status.

This treatment is based upon specimens in the herbarium of the University of Wisconsin–Milwaukee (WIS), University of Minnesota (MINN), and the Milwaukee Public Museum (MIL), for the loan of which I thank the curators. A few specimens from other herbaria [Missouri Botanical Garden (MO), University of Michigan (MICH), Ohio State University (OS), University of California (UC), New York Botanical Garden (NY), and the United States National Herbarium (US)] are included. The assistance of Dr. Hugh Iltis and Miss Carol Michelson in preparing this paper is particularly appreciated. Dots on the maps indicate specific localities and triangles county records only.

EQUISETUM L.

Rhizomatous perennials with stems characterized by a jointed appearance with leaves small, whorled, and fused into a nodal sheath. A series of ridges and grooves traverse the internodes and continue up into the nodal sheaths. These ridges and grooves alternate in each successive internode. Stem in cross-section usually with a prominent central canal (centrum) and smaller vallecular (under the grooves) and carinal (under the ridges) canals. Reproduction by spores borne in a cone terminal on the vegetative stem or in some species on a specialized fertile stem.

Key to Species

A. Stems with regular whorls of branches.
- B. First internode of branch shorter than or about equal to subtending stem sheath, at least in lower portion of plant.
  - C. First internode always shorter than stem sheath.
    - D. Sheath teeth few, large. Stem prominently angled ---------------------------------- 3. *E. palustre.*
    - DD. Sheath teeth numerous, small. Stem nearly smooth ---------------------------------- 1. *E. fluviatile.*
  - CC. First internode of upper whorls longer than stem sheath.
    - E. Stem teeth long and narrow. Branches 3-sided, with deltoid teeth ---------------------- 4. *E. pratense.*
    - EE. Stem teeth short and wide. Branches 4–5 sided, with pointed teeth -------------------- 2. *E. X litorale.*
- BB. First internode of branch longer than subtending stem sheath.
  - F. Teeth dark, coarse, separate. Branches usually simple. Stem ridges lacking conspicuous ornamentation ------ -- 6. *E. arvense.*
  - FF. Teeth red, membranous, coherent. Branches with 3–5 pairs of lateral branches. Stem ridges with prominent silica spicules ---------------------- 5. *E. sylvaticum.*

AA. Stems normally unbranched, occasionally with a few branches.
- G. Stems soft, deciduous (occasionally forms of *E. palustre, E. X litorale* will fit here).
  - H. Sheaths as long as wide, retaining teeth. Plants of wet places ------------------------------ 1. *E. fluviatile.*
  - HH. Sheaths about twice as long as wide, usually shedding teeth (except species 12). Plants of grassy, sandy places.

I. Plants with many ridges, the teeth deciduous. Rhizome dull.
J. Cones blunt, with green, plump spores. Sheaths green .... 7. *E. laevigatum.*
JJ. Cones apiculate, with aborted spores. Sheaths often black-girdled .... 8. *E. X ferrissii.*
II. Plants with few ridges, teeth retained. Rhizome shiny .... 12. *E. X nelsonii.*
GG. Stems firm, evergreen. Cones apiculate.
K. Large plants with numerous ridges.
L. Sheaths about as long as wide. Spores green .... 9. *E. hyemale* var. *affine.*
LL. Sheaths about 1½ times as long as wide. Spores aborted .... 8. *E. X ferrissii.*
KK. Small plants with 14 or fewer ridges.
M. Stem with six angles but only three teeth .... 13. *E. scirpoides.*
MM. Stem with angles and teeth of same number, more than 3.
N. Ridges in cross-section deeply furrowed. Spores green .... 11. *E. variegatum.*
NN. Ridges in cross-section mostly biangulate. Spores aborted .... 10. *E.* X *trachyodon.*

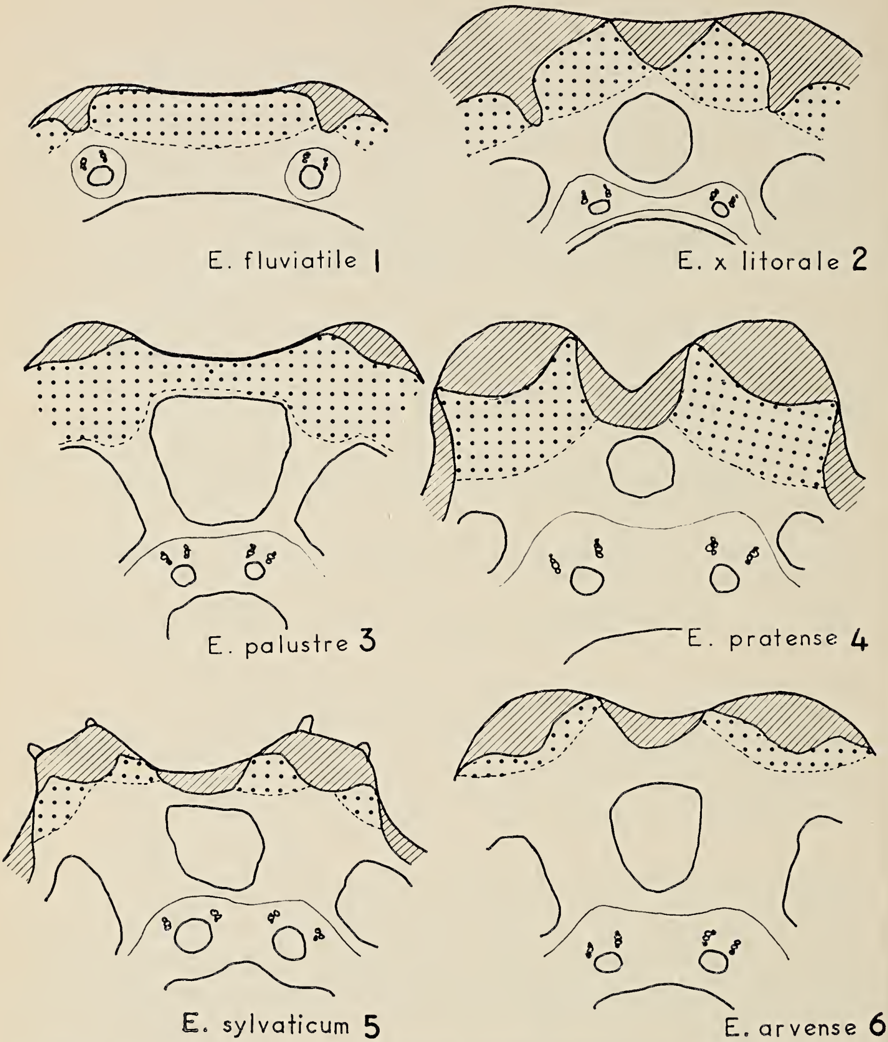
I. SUBGENUS EQUISETUM

Plants usually with regularly branched deciduous stems and blunt cones. Stomata superficial, in bands.

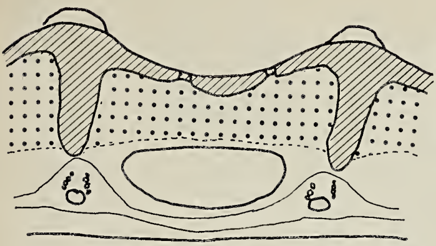
1. Equisetum fluviatile L. Water Horsetail, Pipes.
Map 1; Figs. 1, 14, 15.

Rhizome shiny, light brown, unfelted. Stem smooth, with thin wall and very large centrum, usually lacking vallecular canals. Sheaths about as long as wide, with 12–20 short (2–3 mm) narrow black teeth. Branches, when present, with first internode shorter than or equal to subtending stem sheath, 4- to 6-angled. Cones present. Late May to early July.

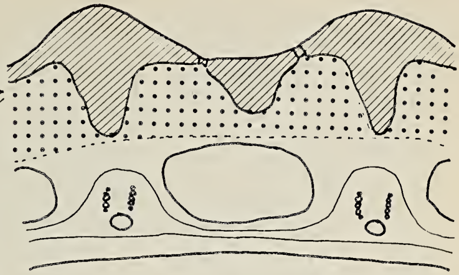
A common and widespread species in wet places, the Water Horsetail tends to come up in May as simple unbranched stems, and to become branched as the season progresses. Hence in May all collections tend to be of the unbranched form (f. *linnaeanum* (Döll) Broun. of Tryon *et al.*, p. 128, 1953), whereas by July most are of the forms with regular whorls of branches (typical form of Tryon *et al.*). Occasionally small or irregularly branched forms are found.



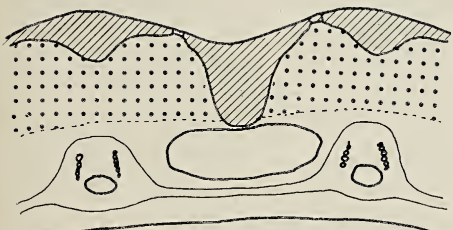
FIGURES 1–13. Diagrams of *Equisetum* stem cross-sections. Lined areas are supporting tissue, dotted areas chlorenchyma. Heavy lines mark canals—vallecular under the grooves, carinal under the ridges, and the centrum in the center. The light lines indicate the endodermis. 1. *E. fluviatile.*—2. *E. X litorale.*—3. *E. palustre.*—4. *E. pratense.*—5. *E. sylvaticum.*—6. *E. arvense.*—7. *E. hyemale* var. *affine.*—8. *E. X ferrissii.*—9. *E. laevigatum.*—10. *E. X trachyodon.*—11. *E. variegatum.*—12. *E. X nelsonii.*—13. *E. scirpoides.*



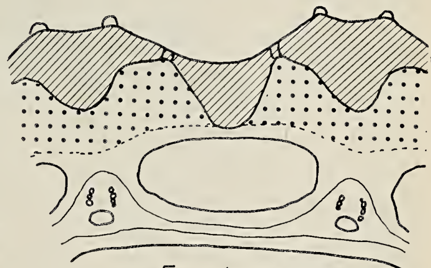
E. hyemale var. affine 7



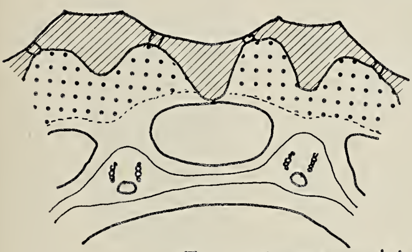
E. x ferrissii 8



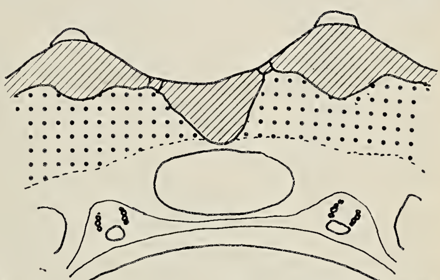
E. laevigatum 9



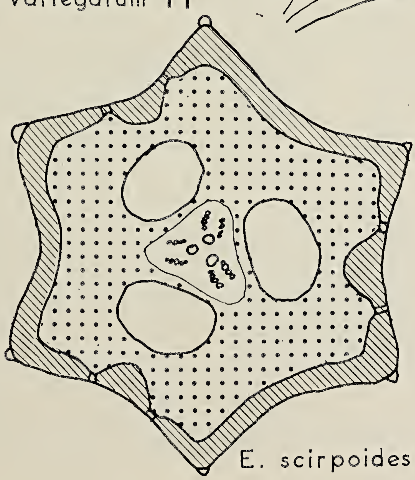
E. x trachyodon 10



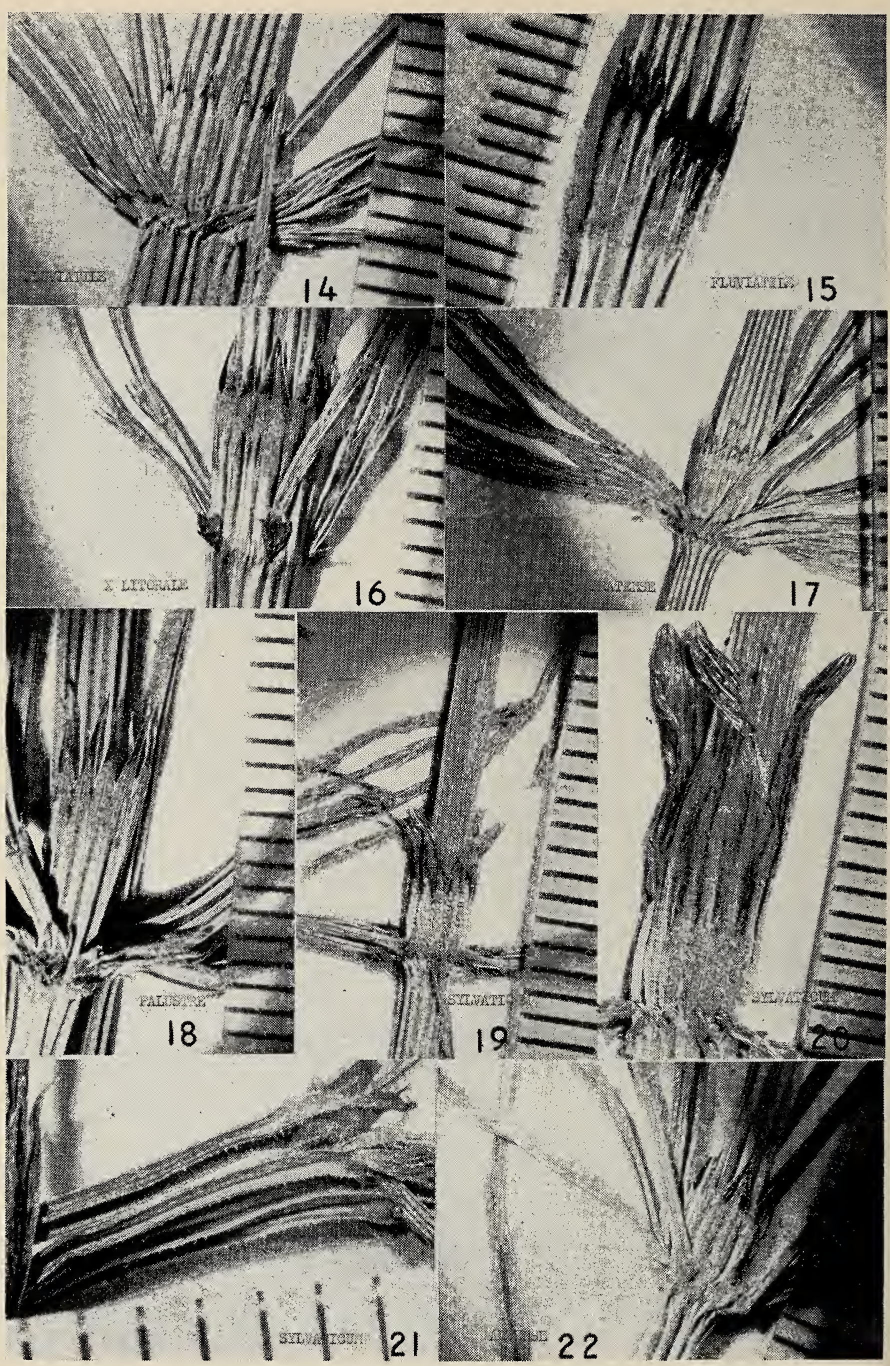
E. variegatum 11

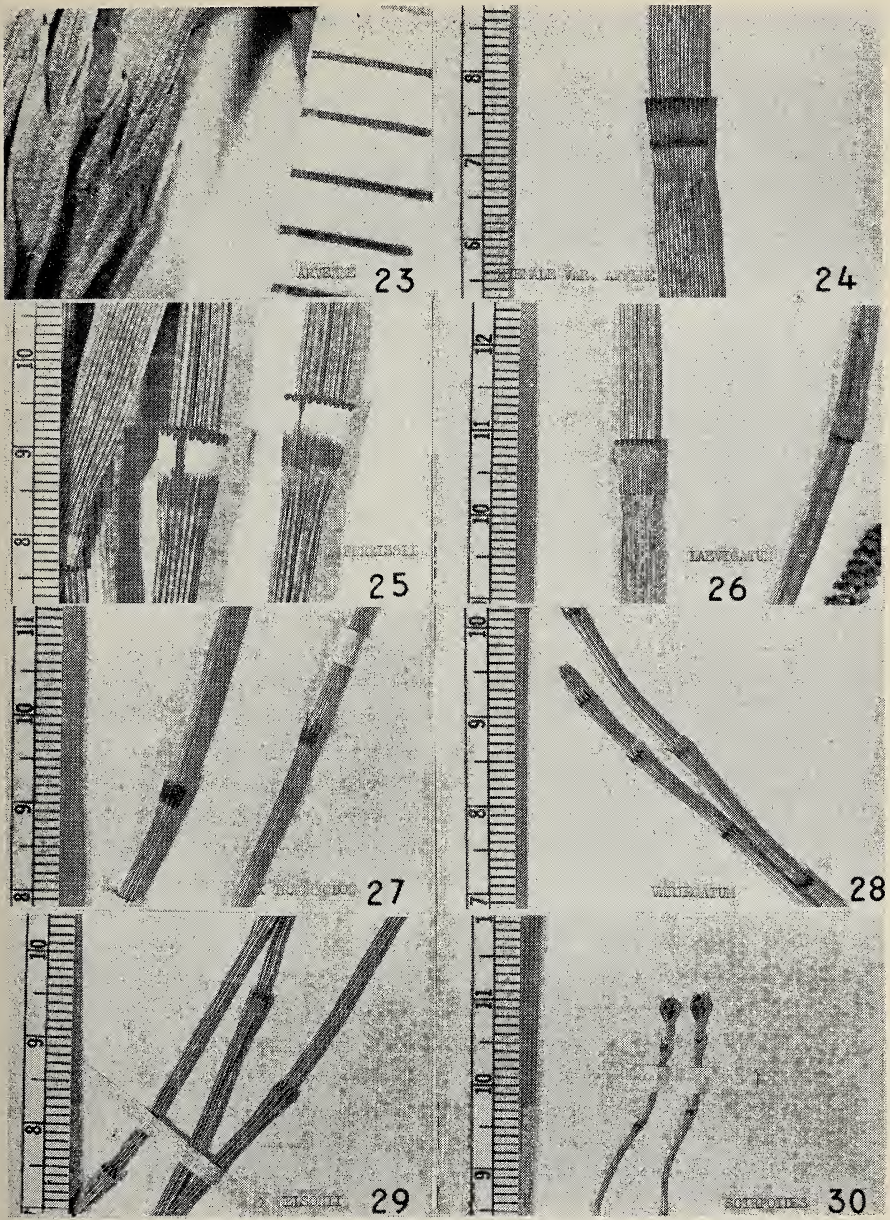


E. x nelsonii 12



E. scirpoides 13


14
FLUVIATILE
15
X LITORALE
16
17
PALUSTRE
18
19
20
21
22



FIGURES 14–30. Photographs of nodal sheaths and branches of *Equisetum*. Scales are all millimeter rulers. 14. *E. fluviatile*, branched.—15. *E. fluviatile*, unbranched.—16. *E. X litorale*.—17. *E. pratense*.—18. *E. palustre*.—19. *E. sylvaticum*, vegetative.—20. *E. sylvaticum*, fertile.—21. *E. sylvaticum* branches with silica spicules.—22. *E. arvense*.—23. *E. arvense* branches with 3 angles. —24. *E. hyemale* var. *affine*.—25. *E.* X *ferrissii*.—26. *E. laevigatum*.—27. *E. X trachyodon*—28. *E. variegatum*.—29. *E. X nelsonii*.—30. *E. scirpoides*.

2. EQUISETUM X LITORALE Kuehl. Shore Horsetail.
Map 2; Figs. 2, 16.

Equisetum fluviatile L. X *E. arvense* L.

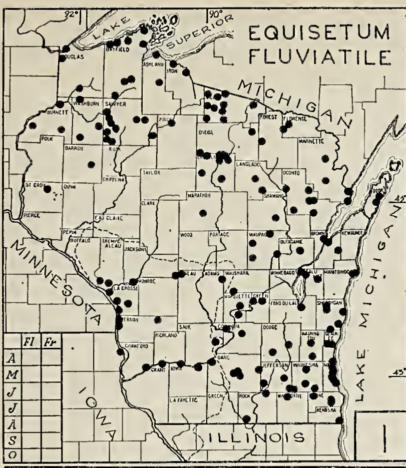
This hybrid is usually mistaken for *Equisetum fluviatile,* but differs in having definite vallecular canals, fewer (8–14) teeth, and 4- to 5-angled branches with the first internode shorter than the subtending sheath at the lower nodes, but definitely longer than the sheaths at the upper nodes. The cones contain aborted spores, which are readily recognizable because they are colorless, without elaters, and are never shed from the cone.

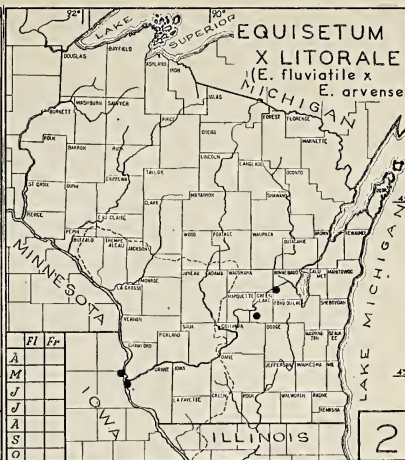
Milde first considered *E. X litorale* as a hybrid in 1851, but later (1867) decided it was a species becoming extinct. Only four localities are known for *E. X litorale* in Wisconsin, but it probably occurs elsewhere and has been bypassed as *E. fluviatile.* Grant Co.: Wyalusing State Park, 19 June 1959, *Patman s.n.* (WIS). Green Lake Co.: Marsh, north shore Lake Puckaway, Marquette, 18 Sept. 1929, *Fassett 8799* (WIS). Richland Co.: shallow water of springhole, Gotham, 11 Aug. 1958, *Hartley 5266* (WIS). Winnebago Co.: springy shore of Fox River, Eureka, 14 Sept. 1931, *Fassett 13243* (WIS).

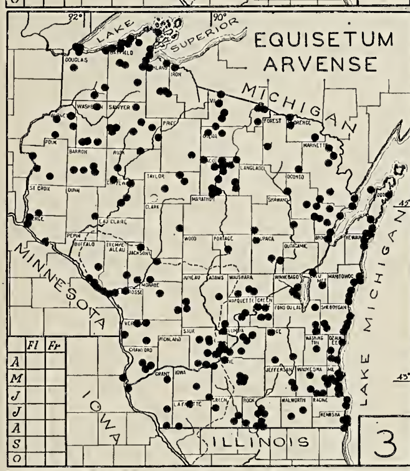
3. EQUISETUM PALUSTRE L. Marsh Horsetail. Map 4; Figs. 3, 18.

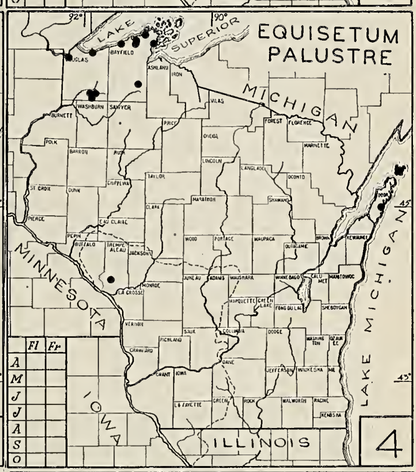
Rhizome shiny, dark brown, unfelted. Stem prominently angled, with a small centrum and vallecular canals as large as the centrum. Sheaths definitely longer than wide, with 8 to 12 long (3- to 6 mm) dark, white-margined teeth. Branches 6- to 7 angled, with the first internode only ½ as long as the stem sheath or shorter.

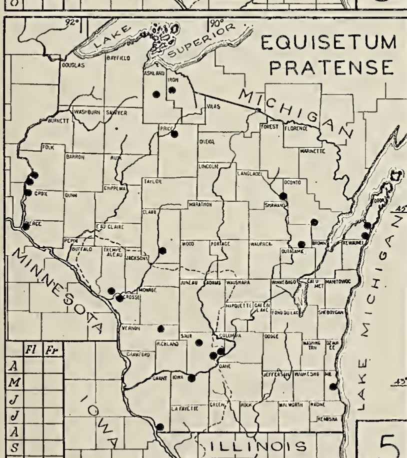
The Marsh Horsetail, a plant of wet places, is usually easily recognizable because of its few, large sheath teeth. Though normally a handsome plant with regular whorls of branches (f. *verticillatum* Milde of Tryon *et al.*, p. 127, 1953), it may occur in sparsely branched or unbranched forms. Tryon, *et al.* (1953) call this the typical form, following apparently Victorin (1927). (In the first edition they had used Victorin's names.) Typification of the name *E. palustre* L. is difficult since there is no specimen of this species in the Linnaean herbarium in London. (The sheet so labeled contains two specimens of *E. arvense,* one a robust, well-branched form, the other a rather depauperate specimen.) The Linnaean description is minimal *(Equisetum caule angulato, frondibus simplicibus,* i.e. Equisetum with angular stem, simple branches.), but Linnaeus would hardly have said *frondibus simplicibus* if he wished to indicate a plant with *caule nudo,* an expression he used in descriptions of unbranched species.

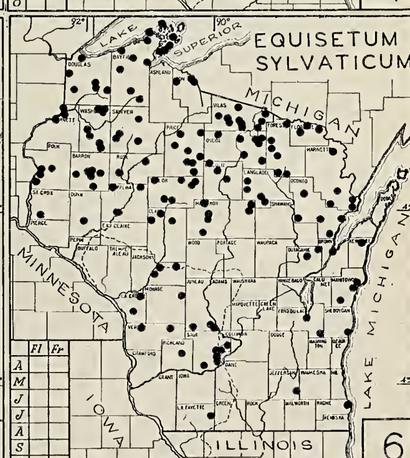

EQUISETUM FLUVIATILE
LAKE SUPERIOR
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
1


EQUISETUM X LITORALE (E. fluviatile x E. arvense)
LAKE SUPERIOR
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
2


EQUISETUM ARVENSE
LAKE SUPERIOR
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
3


EQUISETUM PALUSTRE
LAKE SUPERIOR
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
4


EQUISETUM PRATENSE
LAKE SUPERIOR
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
5


EQUISETUM SYLVATICUM
LAKE SUPERIOR
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
6

The Marsh Horsetail is uncommon in Wisconsin, being found mostly in the northern part of the state. It bears cones in June and July.

4. EQUISETUM PRATENSE Ehrh. Meadow Horsetail.
Map 5; Figs. 4, 17.

Rhizome black, dull, with light brown felting on the nodal sheaths. Stems slender, roughened with silica dots along the ridges, with a relatively large centrum and well-developed vallecular canals. Sheaths of sterile stems slightly longer than wide, with a slight furrow in the middle of each segment, and with 8–16 thin-textured teeth having a dark center and colorless margins. Branches spreading or somewhat recurved, 3-angled, with deltoid teeth. First internode about equal to the subtending sheath on lower whorls, longer on upper whorls.

Fertile stems developing in May and June, with yellow or brown internodes and large, green, prominently flaring sheaths (2–3 times the diameter of the stem) with long (4–6 mm) teeth. At first unbranched, but persisting after the cone shrivels, becoming green and branched.

This species is found occasionally throughout the state in moist, wooded areas. It is often mistaken for *E. arvense*, but the roughened stems, furrowed sheaths, papery teeth, and deltoid branch teeth are all distinctive. It appears to be less variable than the other species of this subgenus.

5. EQUISETUM SYLVATICUM L. Wood Horsetail.
Map 6; Figs. 5, 19, 20, 21.

Rhizome dark brown, felted all over. Stems roughened with a double row of prominent silica spicules along the ridges; centrum large and vallecular canals prominent. Sheaths about as long as wide, with 8–16 long (to 1 cm) papery, reddish brown teeth, usually coherent into 3 or 4 lobes. Branches 3–4 angled, spreading, branched, giving the plant a delicate, lacy appearance. First internode longer than the subtending sheath. Fertile stem developing in May, at first lacking chlorophyll and unbranched, with very long (to 15 mm) papery teeth (Fig. 20), becoming green and branched as the cone shrivels.

The Wood Horsetail is the most beautiful species of *Equisetum*. It occurs throughout the state in moist, shaded areas, being quite common northward. Two forms of this species have received considerable attention. One has the first internode of the branches scabrous with silica spicules (typical *E. sylvaticum* in Europe) (Fig. 21), the other has the first internodes of the branches without silica spicules (var. *multiramosum* (Fernald) Wherry of Tryon *et al.*, p. 131, 1953). Fassett (1944) studied mass collections from various areas and showed that the scabrousity of the branches is a clinal character, occurring more frequently in plants from the western part of the range. It is also a variable character, some plants having completely smooth branches, others having branches scabrous only near the sheath, and others being completely scabrous. Fassett concluded that since this character shows geographic correlation, it merits varietal recognition. It is my belief, however, that a single, variable character with a gradual increase in frequency across a vast area and with no associated characters provides insufficient grounds for segregating the Wood Horsetail into two varieties.

6. EQUISETUM ARVENSE L. Field Horsetail.
Map 3; Figs. 6, 22, 23.

Rhizomes dark brown to black, felted along their length. Stems smooth, with a large centrum and well-formed vallecular canals. Sheaths about as long as wide, with slightly furrowed segments and 8–12 dark, often incurved teeth. Branches 3- to 4-angled, erect or ascending, the first internode definitely longer than the subtending sheath.

Fertile stems developing in April and early May, brown, thick, and fleshy, with large, flaring sheaths bearing long (to 15 mm) teeth and lacking branches. These die back as soon as the spores are shed, just when the young vegetative shoots are beginning to develop.

The Field Horsetail is by far the most common *Equisetum* throughout Wisconsin, growing in all sorts of disturbed places—cultivated fields, roadsides, railroad beds, sand dunes, river banks, lake shores, and even along the edge of woods. Perhaps this diversity of habitat and association with disturbed places account for its extreme variability. It occurs in depauperate forms and robust forms, in procumbent, decumbent, and erect forms, in forms with short, erect branches and forms with long, ascending to spreading branches. All of these have been named, but purely for descriptive purposes with no indication that any of them are genetically based. Plants with three-angled branches [var. *boreale* (Bong.) Rupr. of Tryon *et al.*, p. 123, 1953] (Fig. 23), are found throughout the range of *E. arvense*, but do seem to be more common in the northern part of the range, and there in shaded, quite undisturbed habitats. (See maps 55 and 56 in Tryon *et al.*, p. 124, 1953.) However, in the absence of a correlation with other characters, and considering its poorly defined geographic correlation, this character hardly merits varietal distinction. Even granting it *forma* status can, as far as I know, serve no useful purpose.

II. SUBGENUS HIPPOCHAETE (MILDE) BAKER

Plants usually with unbranched, evergreen stems bearing apiculate or acute cones. Stomata sunken.

7. EQUISETUM LAEVIGATUM A.Br. Smooth Scouring-Rush.

Map 7; Figs. 9, 26.

Equisetum kansanum Schaffner of Tryon *et al.*, p. 119, 1953.

Rhizome dull black, felted on sheaths. Stems medium to tall (to 8 dm) smooth, deciduous, with large centrum, prominent vallecular canals, and supporting tissue massed under the grooves. Sheaths twice as long as wide, slightly flaring upward, green with a black rim, with 18–24 segments, the teeth deciduous. Cones blunt to slightly apiculate, sporulating mostly in June.

This is a species of open fields, and occasionally of railroad beds, roadsides, and lake shores. It hybridizes with *E. hyemale* and because of this and a confusion of types, this species is commonly misnamed *E. kansanum* Schaffner (Tryon *et al.*, 1953; see Hauke, 1960). Plants may develop branches with age or following injury, and these sometimes grow from the base, producing a cluster of small stems mimicking *E. variegatum*. Occasionally forms are found with teeth retained, these being whitish. The smooth scouring rush is found mostly in the southeastern part of the state.

8. EQUISETUM X FERRISSII Clute. Map 8; Figs. 8, 25.

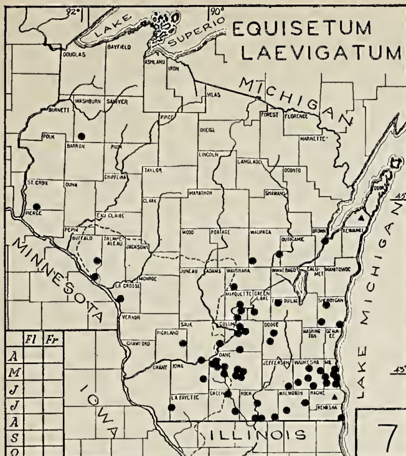
Equisetum laevigatum A. Br. X E. hyemale var. *affine* (Engelm.) A. A. Eat.
Equisetum laevigatum A. Br. of Tryon *et. al.*, p. 118, 1953.

This hybrid is intermediate between its parents *E. laevigatum* and *E. hyemale* in many characters, and is often called *E. hyemale* var. *intermedium* A. A. Eat. It has supporting tissue massed under both the grooves and the ridges, sheaths about 1½ times longer than wide, is half-evergreen, and develops a black girdle on the sheaths of the lower part of the stem. Cones appear mature in July, but contain aborted spores. This hybrid occurs mostly in the southeastern part of the state, but occasionally shows up in northern Wisconsin, where one parent is absent. Vegetative dispersal can account for this (see Hauke, 1960, 1963).

9. EQUISETUM HYEMALE var. AFFINE (Engelm.) A. A. Eat.

Scouring-Rush. Map 9; Figs. 7, 24.

Rhizome dull black, felted at the sheaths. Stem tall (to 12 dm)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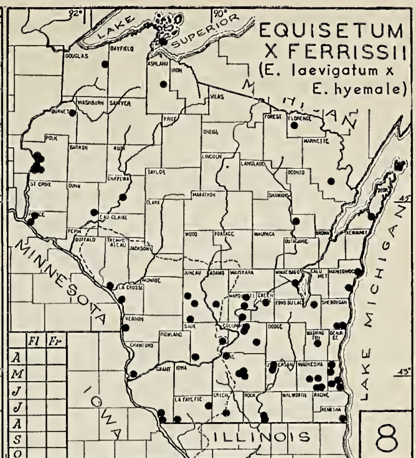
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X FERRISSII
(E. laevigatum x
E. hyemale)
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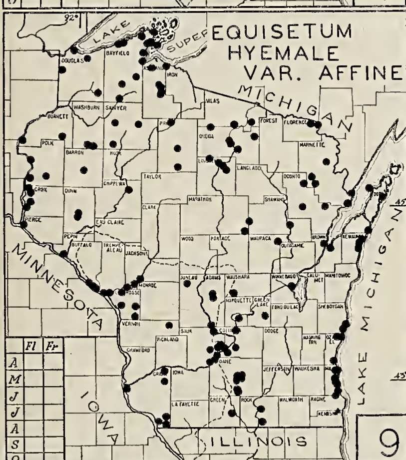
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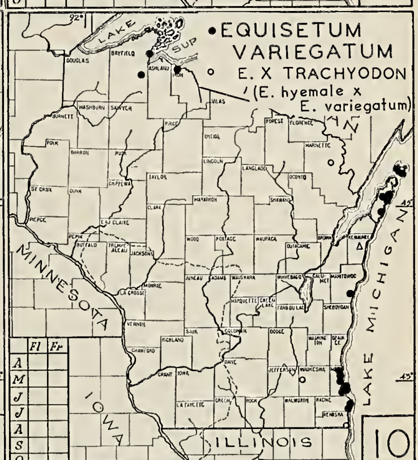
• EQUISETUM
VARIEGATUM
○ E. X TRACHYODON
(E. hyemale x
E. variegatum)
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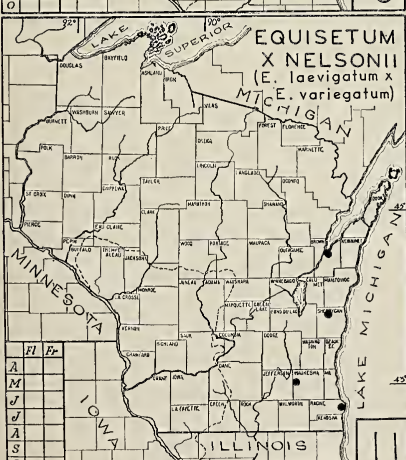
EQUISETUM
X NELSONII
(E. laevigatum x
E. variegatum)
LAKE SUPERIOR
MICHIGAN
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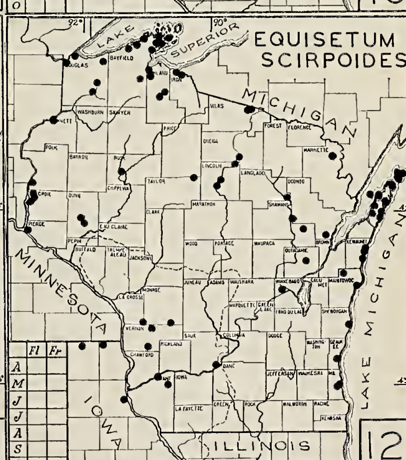
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rough, with a row of silica tubercles along the ridge, evergreen. Centrum and vallecular canals large, and supporting tissue massed under the ridges. Sheaths about as long as wide, dark-girdled around the middle and ashy white above, with 18–40 segments, the teeth usually shed. Cones sharply apiculate.

The Scouring-Rush is so called because its rough stems were used to scour pots and pans. They still are used by musicians to polish reeds for woodwinds. This species is common throughout the state and occurs in a variety of places—woods, fields, roadsides, railroad beds, lake and river margins. Branched forms result from injury, and often short, cone-bearing branches develop from the upper nodes of the previous year's stems. Occasionally it retains or tardily sheds the sheath teeth [var. *robustum* (A. Br.) A. A. Eat. of some authors]. Some apparent forms are actually hybrids with other species (see above and below).

10. EQUISETUM X TRACHYODON A. Br. Map 10; Figs. 10, 27.

Equisetum hyemale var. *affine* (Engelm.) A. A. Eat. *X E. variegatum* Schleich.

This hybrid is intermediate between the parents in size and ridge number. The ridges are biangulate, with a double row of silica tubercles. *Equisetum X trachyodon* frequently has the sheath coloration of *E. hyemale*, but the general low, clumped aspect and teeth structure of *E. variegatum*. Rare in Wisconsin, it is known from only four eastern counties: Kewaunee Co.: New Bay, on sawdust piles, borders of Lake Michigan, 15 Sept. 1925, *E. J. Palmer 28807* (MO). Kenosha Co.: flat prairie on banks of drainage ditch, Pleasant Prairie, 12 Aug. 1941, *Kruschke s.n.* (MIL). Marinette Co.: Pike River, Amberg, 14 Sept. 1937, *Tryon 3384* (WIS). Waukesha Co.: wet sandy shore, Golden Lake, 9 Oct. 1927, *Fassett 7563* (WIS).

11. EQUISETUM VARIEGATUM Schleich. Variegated Horsetail

Map 10; Figs. 11, 28.

Rhizome shiny black, unfelted. Stems small (to 3.5 dm) and clumped, with small centrum and vallecular canals, supporting tissue more prominent under the grooves, and ridges bearing two rows of silica tubercles with a well-developed furrow between them. Sheaths about 1½ times longer than wide, with segments having two ridges separated by a central furrow. Teeth persistent, obtuse, with a dark center and wide white margins, occasionally retaining also a filiform tip. Cones small, sporulation from July to September or overwintering and shedding the next spring.

This small, attractive species of wet sandy places, like river banks, lake shores, and ditches, is found in Wisconsin only near the shores of Lake Michigan and Lake Superior. It is very distinctive because of the variegated teeth and furrowed ridges, but the hybrids that occur with *E. hyemale* (see above) and *E. laevigatum* (see below) tend to obscure its distinctiveness.

12. EQUISETUM X NELSONII (A. A. Eat.) Schaffner

Map 11; Figs. 12, 29.

Equisetum laevigatum A. Br. *X* *E. variegatum* Schleich.

This hybrid has small, deciduous stems with sheaths much longer than wide. It is readily mistaken for small forms of *E. laevigatum,* but the shiny black rhizome, furrowed sheath segments, teeth coloration, and aborted spores reveal its hybrid nature. It is rare in Wisconsin, with specimens collected from only four southeastern counties. Brown Co.: Green Bay, 21 June 1881, *Schuette s.n.* (WIS). Racine Co.: Racine, 12 Sept. 1933, *Hicks s.n.* (OS). Sheboygan Co.: Elkhart Lake, 29 June 1879, *Schuette s.n.* (WIS). Waukesha Co.: Silver Lake, *Wilson, s.n.* (WIS).

13. EQUISETUM SCIRPOIDES Michx. Dwarf Scouring-Rush.

Map 12; Figs. 13, 30.

Rhizome rough, black, with felted sheaths. Stems very slender, wiry, and small (to 2 dm), flexuous, matted, with no centrum, 3 vallecular canals, and 6 ridges. Sheaths with 3 deeply furrowed segments and a black band around the base of 3 papery white teeth, which often bear a filiform tip. Cones small, sporulating in late summer, or overwintering and shedding the following spring.

The dwarf Scouring-Rush forms a loose turf of twisted wiry stems, generally in cold, moist, shaded places throughout N. Wisconsin, much rarer S. of the "Tension Zone", in cold wet muck of *Thuja* or *Abies balsamea-Betula papyrifera* woods, on and near rotten logs in *Tsuga-Acer saccharum-Fagus* forest, on the edges of rivers and lakes, less often in sandy, dry, ± open Oak–Hemlock–White Pine forests, or rocky canyons with *Taxus canadensis* or on sandstone cliffs, in S. Wisconsin in shaded edges of springs, limestone talus on N-facing bluffs, and on cold, mossy, moist, sandstone bluffs beneath white pines. With its curly stem and 6 ridges but only 3 teeth, it is an unmistakable species, easily overlooked because of its small size.

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Volume LIV

Part A

1965

GOODWIN F. BERQUIST, JR.

Editor

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SCIENCES, ARTS AND LETTERS IN WISCONSIN HISTORY

A special monograph based upon a series of addresses presented at the 95th Annual Meeting of the Wisconsin Academy of Sciences, Arts and Letters.

Madison, Wisconsin

May 7–9, 1965

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Preface

In 1964, the Wisconsin Academy of Sciences, Arts and Letters published its first special monograph, *The Wisconsin Academy Looks at Urbanism.* This innovation was so well received that in the following year, *The Natural Resources of Northern Wisconsin: A Wisconsin Academy Profile,* appeared. *Sciences, Arts and Letters in Wisconsin History* is the third monograph in this series.

Like its predecessors, this publication is a collection of addresses presented at the Academy's May meeting. Each paper focuses upon a special phase of the conference theme. Each is the work of a recognized leader in Wisconsin or in the nation. And each is designed to further our knowledge and stimulate our thinking about the remarkable state of which we are part.

The final paper in this collection deserves special mention for it is the work of Academy President Walter E. Scott. As Mr. Scott often says, water reserves are of timely concern to us all. In order to assess the evolution of government policy in this sphere in detail, the author has greatly expanded his Presidential remarks, both in substance and in documentation. Readers will find Mr. Scott's paper at the close of the present volume.

Goodwin F. Berquist, Jr. — Milwaukee, Wisconsin

Copies of *The Wisconsin Academy Looks at Urbanism,* the Academy's 1963 special monograph, are available at a cost of $2.00 each through: The University Bookstores, University of Wisconsin–Milwaukee, Milwaukee, Wisconsin 53211.

Copies of *The Natural Resources of Northern Wisconsin: A Wisconsin Academy Profile,* the Academy's 1964 special monograph, may be procured at a cost of $2.50 apiece by writing Walter E. Scott, 1721 Hickory Drive, Madison, Wisconsin 53705.

WISCONSIN'S CONTRIBUTION TO HUMANITARIANISM AND THE GOOD LIFE

Russel B. Nye

One thing which can be said, certainly, about the theme of this meeting, "Wisconsin's Contribution to Humanitarianism and the Good Life," is that it is sufficiently broad. The purpose of my part in it, as I have chosen to interpret it, is to serve as a generalized introduction to those papers which follow and which make up the major portion of the conference, dealing more specifically and exhaustively with selected examples of Wisconsin's contributions to humanitarianism and the good life. As we begin, it seems necessary as a base for our discussion to locate more precisely what it is we are exploring.

The phrase "humanitarianism and the good life" implies a consideration of both *social* and *individual* values—the promotion of the welfare of both humanity and of the person. It suggests society's obligation to improve itself, to provide for each individual the potentials for a *better* life. This is a strong, pervasive strain in the American tradition, stemming from our deep-seated American belief in progress, our native, optimistic conviction of the inevitable improvement of things. This is also an equally powerful strain in the pattern of American reform—from the generalized, rationalistic trend of humanitarian reform in the 18th century, from the romantic, personalized reform of the early 19th century, to the institutionalized, socialized reform of the later 19th and 20th centuries. When we talk about humanitarianism and individual "good life" we must place these terms within the broader context of this American tradition of optimism and individualism. To believe that a "good life" can be made, those who hope to make it must believe that the individual is *worth* it, and that it *is* obtainable. One of the great principles on which all Americans hope for the "good life" is based on the supposition that individual life *is* valuable.

Wisconsin, of course, shares this tradition with all other states. The "good life" we know, and the better life we hope for, is not Wisconsin's alone, and it would be unfair to imply that any single state, or group of states, has exclusive rights to the advancement of American society. This is not what this conference intends—what the topic for discussion means is that Wisconsin's contributions and achievements in attaining that kind of life have been often important, interesting, and in a broad sense original. It is this which provides us with the question which, it seems to me, really lies beneath the topic chosen for this conference.

How is it that a state with a relatively small population, comparatively modest natural resources, and a relatively brief history, has produced more than its share of humanitarian leaders and movements, and has attained such a high level of the "good life?" Why is it that Wisconsin has established, among its sister Midwestern states and in the nation at large, such a clear and identifiable personality? This is the question raised by this conference which is most interesting to me. For Wisconsin, quite early in its history, established a characteristic identity which it has maintained until the present day—something more than a state flower, or a song like *On Wisconsin*, or a state emblem like a badger, but a feeling of distinctiveness that one wishes one could define more precisely, but one most undeniably there. These are the questions to which we really address ourselves when we speculate abcut Wisconsin's contributions to humanitarianism and the good life.

First, we must establish Wisconsin's position within its regional and historical framework. Wisconsin is a *Midwestern* state. This means historically that it was never a colony, that it was a creation of the Federal government, that it never separated from that Federal government, that it had its own unique kind of frontier—different from those of East and South and Far West. Like other Midwestern states, it attained maturity swiftly, and developed its culture in an atmosphere of accelerated change.[1]

Wisconsin is a creation of the *later* 19th century, of that crucial century's *latter* half, which differentiates it in temper and personality from East, West, and South. Wisconsin received its territorial status and statehood during the Jacksonian era, was almost at once tempered in the Civil War, and matured in the postwar decades of wealth, expansion, and reconstruction. There was never an 18th century culture in Wisconsin and the upper Midwest—the roots of its society lie almost wholly in modern times. Of the Midwestern states (with the exception of Minnesota) Wisconsin is the only one settled largely by *direct* migrations from Europe. Half the people in the state of my generation were either foreign-born or born of foreign-born parents. Strong German and Scandinavian elements transplanted to the state without an intervening stage of American settlement, gave the state's ethnic background a distinctive flavor. There were New Englanders and New York Staters who came to Wisconsin, of course, like my grandfather who gave shape to the state's early institutions. The majority of delegates to both constituional conventions were Yankees; Eastern states furnished the lawyers, educators, merchants, and political leaders for early Wisconsin society.[2] This influence, however, can be overstressed. The great influx of imigrants, of fairly homogeneous groupings, who poured into Wisconsin in the later 19th and 20th centuries as the state reached maturity, added an overlay of a different culture, neither foreign nor Yankee, to Wisconsin's society that Ohio or Michigan, for example, did not possess.[3]

In the Eastern and Southern colonies the settlers brought their social and economic systems with them from Europe, since the country to which they came had none. They came into a wilderness which required a century to tame; their struggle to alter their patterns of living to fit the needs of an emergent society and a new country was long and arduous. This was not the case in Wisconsin. By the time the state was settled, Americans had already worked out a set of techniques for controlling the wilderness. The Eastern

[1]For a discussion of the background of the Midwest, see R. B. Nye, *Midwestern Progressive Politics*, (East Lansing, 1951), chapter 1.

[2]W. B. Furlong, "Wisconsin: State of Insurgents," *New York Times Magazine*, April 3, 1960, has an interesting discussion of early Wisconsin society.

[3]Leon Epstein, *Politics in Wisconsin* (Madison, 1958), contains an analysis of these elements. An excellent essay on the German contribution is Carl Wittke, "The German Forty-eighters," in O. F. Ander, ed., *The John H. Hauberg Memorial Essays*, (Rock Island, 1954), pp. 41–50.

emigrants who came brought with them social, political, and economic systems already formed; the process was one of transfer, not adaptation. The immigrants who came from Europe so soon after the state's admission to the Union, brought with them very few of their own institutions. They neither wanted nor needed much of Europe's way of life (in fact, in a good many cases they were escaping *from* it). They moved not into a wilderness but into a ready-made society, already viable, already well adapted to their aspirations.

Wisconsin possesses, as a result of its Midwestern past, a distinctive *state* culture which is not merely a miniature version of the national culture. A cross-section of Wisconsin is unrepresentative of the nation at large; there are too many variants for it to be called "typical," too many differences for it to be microcosmic. In it the strands of its ethnic and cultural heritage were never completely woven together, the components of Wisconsin society never merged into consistency. In my own youth, and I imagine it is still true today, one had the feeling in Wisconsin of a foreignness not yet blended, yet completely American. There were and still are islands of unabsorbed culture scattered about the state—Norse, Swiss, Amish, Dutch, German, Polish. These people, many of them present in the state for four generations, have fitted themselves perfectly into Wisconsin's social, political, and economic system without abandoning other cultural elements their forbears brought with them. I am not speaking here of the kind of giant melting pot that is, say, New York, but of something not at all urban and quite clearly unique to Wisconsin. John R. Barton, of the Sociology Department at the University of Wisconsin, put it well by saying in Wisconsin, "We are not a melting pot but a beef stew. We were all thrown together into the same pot but the beef remained the same and the carrots remained the same and the peas remained the same."[4]

These and other elements in Wisconsin's past have combined to produce in the state a particular kind of society, on which, I think, displays certain characteristics which we can call distinctively Wisconsin's. As one looks at the state's past, it is possible to identify a Wisconsin *character*, conditioned by its history, composition, and experience. It is equally possible to distinguish a characteristic way of doing things, a way of approaching and resolving issues —in other words, a *style*. If the study of the *character* of a society is an effort to establish a collective personality, then the examination of that society's *style* seeks to define how that collective personality reacts to and acts upon its environment. Wisconsin's search for the good life, it seems to me, has displayed at least four distinguishing traits which help to identify its particular *style*.

First, Wisconsin has consistently shown a distrust of strong, autonomous government. There has been in the state, since its beginnings, an individualistic and localistic tradition, a tradition of dissent, independence, and self-assertion. The editor of the Southport *American*, in 1845, when Wisconsin was determined on statehood, put this into stout resolve when he notified Congress that the people of the Territory were "fully convinced that they are old enough, and rich enough, and strong enough to take care of themselves," a feeling they have never hesitated to express ever since. Historically Wisconsin has been more sensitive than many states to the traditional Jacksonian principle

[4]Quoted by Furlong, *op. cit.*, p. 4.

of governmental responsiveness to and responsibility for public needs. Second, Wisconsin has always placed strong emphasis on planned progress through popular enlightenment. Wisconsin's leaders have almost always shown, sometimes reluctantly perhaps, respect for the application of popular intelligence to the development of its society. Third, Wisconsin has displayed rather consistently a kind of self-centeredness, often mistaken for and mislabelled "isolationism," that is distinctively its own. There is apparent in the state's past a concern for its *own* problems, within its *own* context, for finding solutions application in its *own* terms. Wisconsin has long considered itself an entity, and has developed a kind of positive localism that is not necessarily a turning away, but rather an inward focus.[5]

Fourth, and perhaps most important in terms of this meeting, Wisconsin has consistently tended toward reform based on an investigation of the facts of society and the subsequent use of those facts as a basis for action. This particular variety of reform is almost wholly a product of late 19th and early 20th century pragmatism, and Wisconsin has made it very much its own. It is a self-generated, self-imposed, adaptative type of reform which reflects the era in which it received its shape and purpose. I shall speak at greater length of this later.

Thus far I have tried to do two things: to establish Wisconsin's identity within its historical and regional context; and to indicate the board contours of its style. It is only by thus sketching the contexture of Wisconsin's search for the "good life" that some estimate of that search is understandable. At this point the possibilities of further exploration are limitless; we could talk about Wisconsin's achievements in law, or science, or the arts, of communications, or conservation, and almost any field of endeavor in which its contributions have been distinguished. However, I do not want to have this paper turn into a catalogue of names and achievements. I hope to be analytical, rather than descriptive, and I should therefore like to restrict my remarks to areas in which it seems to me Wisconsin's contributions to "the good life" have been *sui generis,* areas in which we can say, with some accuracy, "This is what *Wisconsin*, as compared to other states, has done."

I should like to explore, then, Wisconsin's contributions to the "good life" in the socio-economic field, in politics, and in education. These are fields in which, I believe, it can be said that Wisconsin has evolved a *style* of its own—fields which, in a sense, are inseparable, for in Wisconsin the educational, political, and socio-economic have been traditionally bound together.

Wisconsin has, for the most part, faced its social and economic problems with an attitude characterized by its own brand of pragmatic idealism. The state has always been ready to experiment, if we read its history right —ready to adapt, ready to pioneer. It has always focused its institutional aims on the single goal of producing a good life for its citizens. Wisconsin will be a success, the senior LaFollette once remarked,[6]

> if it can be shown that Wisconsin is a happier state to live in, that its institutions are more democratic, that the opportunities of all its people

[5]Thomas McAvoy, ed. *The Midwest: Myth or Reality?* (Notre Dame, 1961), pp. 53–75, has a discussion of this attitude in the Midwest.

[6]Larry Gara, *A Short History of Wisconsin,* (Madison, 1962), p. 202.

are more equal, that social justice more nearly prevails, *(and)* that human life is safer and sweeter.

This is a simple aim, but it is one which has provided the state with tremendous motive power in the field of legislation, long before LaFollette expressed it so neatly in 1909. What has been necessary to do, whatever group in power has usually done—and as a result, Wisconsin has pioneered in social and economic legislation in a way few other states have, and has provided models for those whose aims are the same but whose practical attainments less. One could make a long list of these here, either the first of their kind, or of such priority as to have influenced others to follow—pensions for the blind and dependent children (1907, 1913, 1919); hour and wage regulations (1909); female and child labor laws (1911); workman's compensation (1911); the apprenticeship law (1911); minimum wage laws (1913); unemployment compensation (1932); and many more. These are all manifestations, I think, of a principle traditionally associated with Wisconsin, that of deliberately using the *legislative* process to change and adjust the social and economic status.

The simplest way of illustrating Wisconsin's distinctive attitude toward its socio-economic problems is to list, as I have done, some of those laws which have in some way contributed to solutions. However, I should like to use two more specific examples of this principle of which I have spoken—of employing statutory means to accomplish social ends—which in my opinion are characteristic. These are the development of the cooperative system, and the organization and contributions of the Dairymen's Association, both of them typically Wisconsinian methods of approaching certain complicated socio-economic problems. They both represent good examples of Wisconsin's way of translating its aim at the good life into practical results through political and legislative means. I do not choose these two instances at random. I choose them to illustrate how it seems to me Wisconsin met two major challenges of the late 19th and early 20th centuries in its own style—that is, the challenge of change relationships among producer, marketer, and consumer arising from the economic shifts of the post-Civil War era; and the challenge of economic dislocation and disruption, brought on by the exhaustion of Wisconsin's natural resources and the opening of new lands to the west. All the Eastern states faced these challenges, of course, some successfully and some less so. How Wisconsin did is illustration of the State's own distinctive way of handling those problems which bore directly on its hopes for "the good life."

The history of the cooperative movement in Wisconsin has been treated in detail elsewhere and I have no need to repeat it here. What I wish to point out is that the cooperative, as Wisconsin used it, is a visible example of the kind of pinpointed reform that characterized the Wisconsin tradition. The first cooperative actually existed in Jefferson County in 1841, two years before the Rochdale weavers began their experiment in England. Throughout the latter half of the 19th century the Grange and other farm groups developed the cooperative principle with varying degrees of success. The Wisconsin legislature in 1887 even passed a law (later repealed, but the first of its kind) to assist the growth of cooperative societies. After 1900 the Society of Equity, and the Right Relationship League, with the assistance of leaders such as Charles McCarthy and Judge Dan Mahoney, succeeded in establishing the cooperative enterprise as a legitimately acceptable economic pattern, leading to the laws of 1911 providing for their incorporation as normal business ventures.[7] The history of the cooperative in Wisconsin is a good example of the highly pragmatic nature of Wisconsin's response to one of the major developments of the modern marketing world. It was a rationally-planned way, characteristic of such ventures in Wisconsin, of trying to get at the roots of those issues which affected the interests of producer, consumer, and marketer.

My choice of a second example may seem curious, but I believe it is descriptive and valid—the Wisconsin Dairymen's Association. By the 1870's Wisconsin's chief resource, its lumber, was almost gone, its wheatlands out-produced by the superior lands to the West, its cutover lands unadapted for farming, its mines depleted and unable to compete with those of the West. Wisconsin's economy was on the downgrade; a relatively simple agricultural economy, it did not have the means or the resources or the population to begin a transition to industrialism. The Wisconsin Dairymen's Association, formed in 1872, provides the only illustration I know of an organization which shifted the entire agricultural economy of a state from one base to another in a deliberately planned and promoted move.[8] William Dempster Hoard, Chester Hazen, and others determined to turn the state's economy from multipurpose farming toward dairying and livestock, and the Wisconsin Dairymen's Association became the chief instrument of the change. This meant introducing a number of new ideas into agriculture—the concept of specialization and industrialization, of agriculture as an economic science, of handling an agricultural product in an industrial manner. As a result, Wisconsin produced the first example of the modern farmer who is really an agricultural business specialist, different from the wheat farmer and the rancher. This shift to a dairy-based economy involved the adoption of whole new sets of agricultural techniques, the establishment of quality controls, of radically different marketing and production methods, and of productive and processing research. The dairy industry's close relations with the University Agricultural School, and its ready acceptance of new technological aids such as the silo and the separator. Henry's research in cattle feeding, the Babcock tester, and the work of Steenbock marked the successful completion of an agricultural revolution in which Wisconsin was foremost. From 1880 to 1920, when American agriculture was in deep trouble, Wisconsin's farm population was relatively stable and even prosperous. The interesting thing is, to me, that in the process of change there was a minimum of resistance offered by the agricultural population, traditionally conservative and resistant to change. The answer in Wisconsin was never to "raise less corn and more hell," as in Kansas, but to make practical adaptations of means to an end, through association and planning and execution.

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[7]See H. R. Austin, *The Wisconsin Story* (Milwaukee, 1964), 230 ff.; William Kirsch, "Cooperative Marketing in Wisconsin," *Blue Book* (1931); and Harold R. Groves, "Consumer Cooperation in Wisconsin," *Blue Book* (1937). M. E. McIntosh, "Cooperative Communities in Wisconsin," *Proceedings of the Historical Society of Wisconsin* (1903) pp. 99–117, deals with early experiments in the state. The Wisconsin Association of Cooperatives, founded in 1944, in 1962 listed in Wisconsin 2095 organizations classified as cooperative in principle.

[8]For good general accounts, see Gara, *op. cit.*, pp. 151–3; and William F. Raney, *Wisconsin: A Story of Progress* (New York, 1940) pp. 228–31.

These two examples seem to me representative Wisconsin responses to the socio-economic challenges confronting the establishment of "the good life" in times of change, and excellent evidence of the practicality and flexibility which have long characterized the state's approach to that "good life."

Whatever that good life, however, it must be lived within a political system, and the shape and quality of government determine what that life will be and how it is attained. Wisconsin's political past reflects its position within the Midwest, lying between the eastern bloc of industialized states (Ohio, Michigan, Indiana, and Illinois) and the more agriculturalized western bloc of Iowa, Minnesota, and the Dakotas. Wisconsin partakes historically of the characteristics of both, and has been subjected to those two great forces of modern America, industry and agriculture, in a mixture and manner unlike that of any other state in the region. One of the great questions of the late 19th century concerned the political balance between the private interests of industry and the public interests, and the proper role that government should play in establishing and maintaining that balance. Was government to be considered a positive force in arranging the new relationships among the elements of a rapidly-industrializing society? Or was government to be an interested bystander, participating in the clash of forces only when invited, or at the extremity of conflict? Or, the most crucial question of all, could a people with their government as the agency, regulate themselves in such a manner as to save that freedom, without endangering it in the process? These were the major political questions of the late nineteenth century decades, and ones which concerned Wisconsin quite directly.

The Constitution of 1848, a loose, permissive, typically Jacksonian document, granted the government of the new state few positive powers. Yet after the Civil War, as the issue of strong versus weak government was gradually joined, Wisconsin moved farther and farther away from this posture, toward stronger controls. The battles with the railroads during the midcentury years focussed on a slowly emerging principle—that government had both a right and a duty to intervene in private life for the public interest. The Potter Law of 1873 was a pioneer attempt to justify government regulation, and despite its early repeal it represented a type of decision on the issue that would reappear more than once in the future. The law was the first recognition, as Justice Ryan called it, of the necessity of public control of those "new aggregations of capital and power" with which that era, and all subsequent ones, would have to deal.[9]

The railroad problem was only one specific issue on which a decision was made. During the seventies and the eighties Wisconsin's government entered other areas of social control by assuming increasing responsibilities for public health, conservation, agricultural research and development, education, and industrial regulation. The State Board of Health and Vital Statistics, established in 1876, was followed by the appointment of boards of medical, dental, and pharmaceutical examiners, the Bureau of Labor Statistics, and

[9]For discussion of the importance of the principle implied in the Potter law, see Raney, *op. cit.*, pp. 248–250, and M .M. Quaife, *Wisconsin* (4 vols., Chicago, 1924) III: The Wisconsin Supreme Court's decision, upholding the constitutionality of the Potter law, preceded by two years the famous Federal Supreme Court's decision on *Munn v. Illinois*, the case generally assumed to has established the right of regulation.

the Insurance Commission. All of these, which were essentially experiments in the extension of state authority over sensitive areas of public interest, were accepted in Wisconsin before 1890. At a time when there was real doubt whether or not the states could competently handle the crises created by industrialization, urbanization, clashing class interests, and an exploding population, Wisconsin had already begun to define the nature, extent, and control of state regulation, and to explore the ramifications of the use of the government as a positive instrument for social and economic adjustment. Wisconsin's progressive movement of the post 1900 decades did not spring up from nowhere; it had deep roots in the regulatory and social legislation of the seventies and eighties and nineties, where Wisconsin had already established a tentative leadership. Wisconsin, long before 1900, had assumed that the state, working through the political process, had a primary function in humanitarian reform and a real responsibility for the encouragement of conditions for "the good life."

The fruition of all these trends, of course, came in the era of Wisconsin politics labelled as the "progressive" years, gathered together in the loose body of principles referred to by Charles McCarthy as "the Wisconsin Idea." This was, and still is in a number of ways, Wisconsin's chief political contribution to the "good life,"—an attitude, a state of mind perhaps, rather than a set of precise principles. Two books which appeared in 1912, McCarthy's *Wisconsin Idea* and Frederic C. Howe's *Wisconsin: Experiment in Democracy,* summarized and explained it better than any have since. There is no need here to repeat the story of Wisconsin's "progressive years" after the turn of the century, since it is well known and I have given my version of it elsewhere.[10] But suffice it to say that The Wisconsin Idea was a program *and* a theory. The program, effectuated between 1900 and 1914, was built about a three-pronged pattern of legislation. To insure and enlarge the functions of representative government, the state had a direct primary, an initiative and referendum law, a corrupt practices act, a law controlling campaign expenditures, a civil service law, and an anti-lobbying law. To protect the citizen against organized economic power it set up transportation, industrial, and public utility commissions; it had a tax commission, an income tax, an inheritance tax, regulatory laws for insurance and banking, and a fair-trade act. To insure public safety and welfare it had child and female labor laws, industrial safety laws, public health and pure food laws. The Wisconsin Idea was also a *theory*—that state government should be representative, responsible, and responsive to public need, and that most of all, government should serve as an active and efficient implement of social progress.

The key principle which lay behind the theory and the program, as The Wisconsin Idea took shape, was *regulation,* whether the issue was an equitable distribution of the tax burden, or the protection of health, or the maintenance of economic competition, or a guarantee of honest government. In essence the Wisconsin Idea assumed that government had an obligation to control and conduct public affairs in such a manner as to promote the wellbeing of

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[10]In *Midwestern Progressive Politics, op. cit.,* pp. 215–22. Two useful articles concerning specific reforms in Wisconsin are George M. Keith, "Development of the Wisconsin Pension Program," *Blue Book* (1940) pp. 129–43; and William Haines, "Fifty Years of Civil Service," *Wisconsin Magazine of History* 39 (Autumn, 1955), pp. 30–38.

its citizens—that "good life" of which we speak—or, in the words of Richard T. Ely, it assumed that the state is "an agency whose positive assistance is one of the indispensable conditions of human progress." The best contemporary estimate that I have found of The Wisconsin Idea is that of a travelling British journalist, C. P. Ibert, who in 1913 visited Madison, took careful notes about what he saw, and later lectured on his experiences to the London School of Economics. The Wisconsin Idea, he said,[11]

> is not afraid of government. It does not regard the Government as an enemy . . . It believes that the Government has important duties to perform, and should have extensive powers for the performance of those duties. Nor is it afraid of experts. It uses them freely and believes in their utility. But it is intensely democratic. It believes that the Government should be controlled by the people, and should be used by the people, not only for defence of their rights, but also for the supply of their needs.

This remains, I believe, Wisconsin's great *political* contribution to the "good life." Wisconsin was first to declare, test, and approve the expanded, positive, role of government which has since become the significant single operative principle of twentieth century political life. Theodore Roosevelt spoke prophetically in 1911 when, after visiting Wisconsin, he wrote:[12]

> We must look to Wisconsin when we desire to try to solve the great social and industrial problems of the present and future, for Wisconsin shows the way along which we Americans must make our civic and industrial advances during the next few decades.

By 1914 Wisconsin then had already drawn the shape of twentieth-century social politics to come; in it one may find the seeds of Theodore Roosevelt's Square Deal, Wilson's New Freedom, Franklin Roosevelt's New Deal, and the essentials of the Great Society.[13] What the Wisconsin Idea did, at bottom, was to assume the positive responsibilities of government, and to translate that acknowledgment into legislation.

I have spoken thus far of contributions to "the good life" in two areas —socio-economic and political life—in which it seems to me a claim may be made for Wisconsin's priority. I should like now to turn to a third, the field of education, for it seems to me that this institution at which we meet tonight—the University of Wisconsin—has had particular importance in Wisconsin's development.

American higher education, in the years after the Civil War, was being redefined. The changed country that emerged from that war, needed changed

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[11]"The Wisconsin Idea," *Living Age* 281 (May 2, 1914), p. 289.

[12]*Outlook* 98 (May 27, 1911), p. 144. Roosevelt, it should be noted, later wrote an introduction for Charles McCarthy's book, calling Wisconsin "a laboratory for wise experimental legislation aiming to secure the social and political betterment of the people as a whole."

[13]For a discussion of this relationship, see Nye, *op. cit.*, pp. 247–51, 262–93, and 360–82; an interesting article by a participant is Arthur J. Altmeyer, "The Wisconsin Idea and Social Security," *Wisconsin Magazine of History* 42 (Autumn, 1948) pp. 19–25. It was not mere happenstance that Edwin E. Witte, McCarthy's successor as director of the Wisconsin Legislative Reference Library and member of the University of Wisconsin faculty, was executive director of the Committee on Economic Security under Roosevelt, whose report became the basis for the Social Security Act of 1935.

educational aims and institutions. The American society, economy, and personality were never the same again after 1865, and the old pre-war colleges and universities were not, to be frank about it, equipped to deal with the new America and its needs. Garfield's remark about the ideal college being Mark Hopkins on one end of a log and a student on the other was a good example of why they were not; Garfield's ideal of education did not fit the new nation, and was not at all what it needed, no matter how admiringly it has been quoted since. Change was in the air in education—in the movement for scientific and technological education, in the movement for graduate work and advanced scholarship, in the movement away from the rigidities of the old classical curriculum toward the pragmatics of the elective system (which even conservative Harvard pioneered); in the movement toward democratizing education, toward recognizing individual differences and needs, and opening higher education to the middle and even the lower classes.[14] The kind of educational institution Garfield described had very little role to play in accomplishing any of these things.

The point was, and it was apparent by the 1850's, that the new industrial-agrarian society that was taking shape, needed new training and new education. The key to the future lay in the Land Grant College Act of 1862, the famed Morrill Act, first introduced in 1857,[15] which furnished a vague but understandable educational philosophy for a new kind of institution. It was this act which first gave some kind of meaning and purpose to the state universities recently created in the Midwestern States, and which soon became the new agencies of instruction that society required. By 1880 it was clear that the old colleges and the private universities could not longer speak for American higher education, set its standards, enunciate its goals, or monopolize the resources available to education. The Morrill Act was a long step toward making higher education a state and federal responsibility.

The American state university, a unique institution among all institutions of higher learning in the world, was defined and formed in the Midwest. There were a number of reasons for this. First, the state university had to cope with numbers. These states grew with tremendous rapidity, and the state universities were the only educational institutions whose responsibility it was to provide higher education for a rocketing population. Second, the state university had to meet the practical demands of late 19th century society, to make technical, vocational, and scientific education legitimate. Third, it had to provide economic, judicial, political, scientific, and intellectual leadership for a *new* American society—the society of Twain and Rockefeller and Bryan and Theodore Roosevelt—leadership that did not come from either end of Mark Hopkins' log or Harvard Yard. When President Andrew White of Cornell in 1870 wanted a botanist for his faculty, neither Harvard nor Yale could supply one who could qualify as a scientist. White remarked, "These colleges make lawyers and dilettanti," of which neither he nor society

[14]See Frederick Rudolph, *The American College and University*, (New York, 1963), Chapter 13, for an extended discussion of this period in higher education.

[15]For a complete analysis of the effect of the Morrill Act, see E. D. Eddy, Jr., *Colleges for Our Land and Time: The Land Grant Idea in American Education*, (New York, 1957),

needed an additional supply.[16] Fourth, the state university had to serve also the traditional university function of transmitting knowledge, culture, and enrichment to the next generation, as the old colleges had, and as universities had done since the middle ages.[17]

To summarize, the state university, as it developed in the later 19th century, brought higher education into the mainstream of American experience, and made the university an agency of public service. The university was assumed to bear a close relationship to society, and to have a major function in the operation of that society. A committee of the Wisconsin legislature, speaking as early as 1858 of the University of Wisconsin, stated it very clearly. It declared that the university "shall primarily be adapted to popular needs . . , shall aid them *(the people)* in securing to themselves and their posterity, such educational advantages as shall fit them for their pursuits in life, and which by an infusion of intelligence of power, shall elevate these pursuits to a dignity commensurate with their value."[18]

The Midwestern state universities which developed in this period out of this underlying philosophy soon assumed central roles in the lives of their states. They had to find out, from experiment and discussion, exactly what their role was and how they were to play it in a changing, complex society. In varying degrees these universities shaped and assumed certain identities and functions, but none with greater success than the University of Wisconsin. The concept of the American *state* university, developed here on this campus, seems to me one of Wisconsin's great contributions to "the good life." As the "Wisconsin Idea" in government made the state a laboratory for progressive legislation, so the "Wisconsin Idea" in education made this university the prototype of the new higher education. Richard T. Ely, who was political reformer as well as teacher, defined the university in 1894 as "the fourth department of the state, along with the judicial, executive, and legislative branches," a statement which while perhaps exaggerated, was not inaccurate.[19]

The idea of the Midwestern State university, of which Wisconsin became the primary example, derived from two beliefs: that the application of informed intelligence, drawn from the university and from an informed electorate, could be profitably applied to problems of modern society, and that higher education should be a mass, rather than a class, experience. Curiously enough, there were two conflicting principles implied within these beliefs, which the state universities have somehow managed to reconcile—the idea that the expert, the educated elite, have a special function and responsibility in affairs of state; and the idea that the university has a special obligation to popular education beyond any elite. The one reflects the Jeffersonian emphasis on learning and excellence; the other the Jacksonian emphasis on practical, mass education. The university is expected to serve both class and mass, and somehow does, not always without strain. But these two contrasting concepts

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[16]Rudolph, *op. cit.*, p. 246.

[17]For an extended discussion of the state universities as they developed in these years, see Rudolph, *op. cit.*, chapter 12.

[18]Vernon Carstensen, "The Origin and Early Development of the Wisconsin Idea," *Wisconsin Magazine of History* 39 (Spring, 1956), p. 182.

[19]Austin, *op. cit.*, p. 282.

of education have combined within a state university, such as Wisconsin's, to become the greatest single force of economic and social mobility in American society.

The University of Wisconsin, under four strong presidents, provided the model for the state university idea as it developed into the unique educational institution it now is. John Bascom (1874–1887), a powerful scholar and teacher, was a liberal (some thought radical) political and social thinker who believed that the university must become engaged with and involved in the issues of the day. He favored income taxes and monopoly laws, prohibition, woman suffrage and coeducation, among other things, and in his day the fledgling institution in Madison was no ivory tower. Thomas Chamberlain (1887–1892), a scientist of note, was among the first of the major state university presidents to recognize the urgent need for scientific and technological education, imparting to Wisconsin the strong scientific tradition it still holds. It was "a function of the university," Chamberlain said in 1889, "to seek a universal educational influence in the community tributary to it," and he urged his faculty to "offer all the aid . . . consistent with their duties . . . to educate the people in any industry or calling or in general culture or in any useful line . . ." Chamberlain, of course, created the School of Economics, Political Science, and History, which probably had more direct influence on the society of its era than any other academic grouping before or since. Charles Kendall Adams (1897–1902) maintained and amplified the tradition of service firmly established by his predecessors. Adams' administration saw the famous Ely case involving academic freedom, which established an educational precedent of great importance.[20] It saw too the establishment of the so-called "Wisconsin school" of institutional economics which transformed it from the legendary "dismal science" into what Charles McCarthy later called "a science by means of which order, morality, and statesmanship could live."

The University of Wisconsin, well before 1900, had established itself as a model for university participation in the life of the state. The College of Agriculture, founded in 1889, under William A. Henry, with the work of Henry, Babcock, Hart, Steenbock, and others, added millions of actual cash value to the state's economy. The School of Economics trained administrators and specialists as well as economists, we must remember, and men from its staff of the caliber of Sparling, Reinsch, Raymond, Scott, Jones, and Commons were in a sense consulting engineers to the state. The addition of the Short Course in 1885, and of Extension Courses in 1891 (fifty courses, from landscape gardening to Scandinavian literature, Chamberlain noted in his first report) offered additional evidence of how the university applied its ideal of public service to social needs.

The University of Wisconsin evolved its permanent and present pattern during the era of Theodore Roosevelt and Woodrow Wilson, when, between 1900 and 1914, it was most directly concerned with the large body of pioneering legislation passed by the Legislature during those years. The progressive political thinkers of that period saw in the university that combination of

[20]For studies of this case and its ramifications, see Theodore Herfuth, *Shifting and Winnowing: A Chapter in the History of Academic Freedom at the University of Wisconsin,* (Madison, 1949); and Walter Metzger, *Academic Freedom in the Age of the University,* (New York, 1961).

education and public service that they held as their ideal, and President Charles Van Hise (1903–1918) was exactly the kind of university president who could promote it. Van Hise's inaugural address of 1903 remains, I believe, the classic statement of the Progressive Era's concept of public university education; it could be repeated today by any state university president without changing more than a phrase or two, without losing a trifle of relevance.[21] Its theme throughout is service to the state, equality of educational opportunity, the duty of a university to serve and to lead. The university, wrote Van Hise, is to be creative and practical, vocational and visionary. "I shall never be content," he said later, "until the beneficent influence of the university reaches every family in the state." What Van Hise said coincided exactly with the prevailing Progressive idea of education. Robert LaFollette had long believed it imperative, he wrote in his *Autobiography*, "to bring all the reserve of knowledge and inspiration of a university more fully to the service of the people," and as if in reply to Van Hise's address, he wrote that "the State welcomes the ever-increasing tendency to make the university minister in a direct and practical way to the material interests of the state."[22]

It was this intimate, energized union between university and state, between academic and practical studies, which attracted nationwide attention to Wisconsin, and which made the University a nationally-known pattern for institutions of its kind. Journalists came to report on it—men such as Lincoln Steffens and William Hard—and visitors came in a constant stream to observe its policies in action.[23] Professor C. P. Ibert of London School of Economics, who discussed the educational philosophy of the University at some length with both McCarthy and Commons, gave it one of the best summaries I have found. He wrote:[24]

> The university, as a creature of the State and a partner of the State, should, so far as is consistent with her purpose, scope and functions, endeavor to meet and supply the proper needs of the State. But she must have liberty to interpret those needs herself, and should endeavor to interpret them in a comprehensive and lofty sense.

The story of how it worked, of the influence of the University of Wisconsin on governmental policy and of the coordination of research with the economic and social needs of the state has been well told elsewhere.[25] The important thing is that it *did* work, and that this concept of public higher education, developed in the Midwest and particularly exemplified by Wisconsin, provided the basic pattern for the twentieth-century American state

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[21]Lawrence Cremin, *The Transformation of the School*, (New York, 1961), p. 161 ff. has a good analysis of Van Hise's importance as educator.

[22]LaFollette, *Autobiography*, (Madison, 1912), pp. 26–7; Merle Curi and Vernon Carstensen, *The University of Wisconsin: A History*, (Madison, 1949), II:90.

[23]William Hard, "A University in Public Life," *Outlook* 86 (July 27, 1907) pp. 659–67; Lincoln Steffens, "Sending a State to College," *American Magazine* 67 (February, 1909) pp. 346–64. D. Y. Thomas, who reported on the University in *The Dial* 53 (September, 1912), p. 135, found seven faculty members serving officially with both university and state government; twenty-three serving the state unofficially; thirteen serving as consultants to state bureaus; and four state officers serving on the university staff.

[24]*Living Age*, (May 2, 1914), p. 291.

[25]Especially by Curti and Carstensen, *op cit.*, volume II, for the relevant years.

university. President Harrington not long ago remarked, as others have before him, of the fact that although "there are at least twenty universities with more money, with bigger physical plants, with more substantial states in terms of economic wealth behind them, and yet, somehow or other, this university has become one of the great universities of the nation and the world."[26] The educational philosophy worked out over the past three quarters of a century by the University, and to which it adheres still today, helps to explain that "somehow or other." I should maintain that this concept of higher education which Wisconsin exemplifies remains not only a major contribution to the "good life" of which we speak, but one of American society's chief tools for forging a better future.

I have spoken here for a long time, and I have left much undone. To find, in an hour, the temperament of a state's society, to attempt to define the configurations of its culture and the quality of its style, to sketch something of its pursuit of the "good life"—this is a task too large for any speaker, or for that matter for any conference, to fulfill. But I hope that I have provided a broad backdrop for the papers which follow, and which concern themselves with more specific aspects of Wisconsin's social, economic, political, and cultural development. I hope that as well I may have caught something of that elusive quality, that vague but real essence of what we sense, without quite being able to name it, that is Wisconsin. This is, I think, the heart of the matter—that Wisconsin's contribution to humanitarianism and the good life perhaps has been more than anything else an attitude, a state of mind, a projection of a personality and a style.

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[26]Austin, *op. cit.*, p. 457.

LANDMARK DECISIONS OF THE WISCONSIN SUPREME COURT

George R. Currie

We are all acutely aware of the tremendous impact made upon the law of this nation and the lives of its people by decisions of the United States Supreme Court. By comparison they tend to dwarf the importance of decisions of the highest courts of the various states. Neverthless, decisions of the latter courts do play a significant part in the development of the law and the lives of our people. It is the objective of this paper to discuss some of the decisions of the Wisconsin Supreme Court that fall in that category.

ATTORNEY GENERAL EX REL. BASHFORD V. BARSTOW

No case coming before the Wisconsin Supreme Court drew more public attention than that of the *Attorney General ex rel. Bashford v. Barstow*[1] which grew out of a bitterly contested election for governor in 1855. In those years state officers were elected in the odd numbered years in contrast to our present method of conducting such elections in the even numbered years.

William A. Barstow, Democrat, had been elected in the 1853 election. The following year the new Republican party had been born and in 1855 it put up a slate of candidates for state officers headed by Coles Bashford of Oshkosh for governor. Barstow sought re-election on the Democratic ticket. Barstow's term as governor had been a stormy one and one faction of his own party had accused him of dishonesty and corruption. After the election on November 6th both Barstow and Bashford claimed to have been elected. On December 17th, the state board of canvassers met to canvass the vote. This board was composed of the secretary of state, attorney general, and state treasurer, all Democrats. The board declared Barstow elected by a vote of 36,355 to 36,198 or a plurality of 157. The Republicans at once cried "fraud."

Barstow was inaugurated governor on January 7, 1856, but Bashford also took the oath of office as governor on the same day. In the meantime Bashford had employed four of the leading lawyers of the state including Edward G. Ryan, Timothy O. Howe, and Alexander W. Randall. Ryan was destined to be Chief Justice of the state Supreme Court, Howe United States senator, and Randall governor. They investigated the facts and found not only had there been falsification of the votes in favor of Barstow in Chippewa and Waupaca counties but votes had been reported and included in the canvass for three non-existent precincts; one each in Chippewa, Dunn and Polk counties.

An action in quo warranto was instituted in the Supreme Court by the attorney general which charged that Bashford had been elected governor, that Barstow had usurped the office, and asking for the ouster of Barstow. Bashford's lawyers also appeared in the action as did those of Barstow. Two of Barstow's lawyers were future United States Senator Matt. H. Carpenter

[1] (1856), 4 Wis. 567.

and future Chief Justice Harlow S. Orton. Barstow's lawyers moved to dismiss on the theory that to permit the Supreme Court to determine who was governor would destroy the independence of one of the three co-ordinate branches of government and subordinate the governorship to the control and domination of the Court.

When this position was rejected by the Court, Barstow's lawyers handed the Court a communication from Barstow and withdrew from the case. In his communication Barstow challenged the constitutional right of the Court to proceed and concluded with this statement, "I shall deem it my imperative duty to repel with all the force vested in this department any infringement upon the rights and powers which I exercise under the constitution." Barstow backed up his threat by storing a quantity of arms in the Capitol.

The Court was not to be daunted by this threat of force and proceeded to eventually take testimony and decide that Bashford had been elected and Barstow was to be ousted. Particularly noteworthy is this statement appearing in the concurring opinion of Justice COLE:

> This is not only a popular government. but it is a representative government—one where the officers are but the *agents,* and not the *rulers,* of the people; one where no man is so high as to be above the constitution, and no one so low as to be beneath its protection.

Three days before the Court's final decision was announced on March 24, 1856, Barstow resigned and was succeeded temporarily by Lieutenant Governor McArthur, grandfather of General Douglas McArthur. McArthur in time yielded the office to Bashford. Thus passed a crisis in our state's history that well could have erupted into bloodshed.

The case of *Attorney General ex rel. Bashford v. Barstow* established once and for all that not even the governor was above the law and that the Wisconsin Supreme Court had the jurisdiction and power to enforce the laws and state constitution against even the highest officer in the state.

Attorney General v. Railroad Companies

By 1873, the day of the little railroad of a hundred miles or more in length was gone. Two large railroad corporations were then operating in Wisconsin, the Chicago, Milwaukee and St. Paul, and the Chicago and Northwestern. They had been granted generous charters which clothed them with full power to regulate freight rates and passenger fares as they chose. Charges of discrimination and exorbitant rates were frequently leveled against the railroad companies. One vociferous group making such attacks was the Patrons of Husbandry, a national organization of farmers called the "Grangers" which achieved considerable political power in the West.

In 1873, the Democrats elected William R. Taylor, governor of Wisconsin, thus breaking many years of Republican rule. The legislature then enacted an act known as the "Potter Law" fixing maximum freight rates and passenger fares, and providing penalties for disobedience. It also created a railroad commission composed of three members and gave the commission power to investigate into the actual cost of the railroads, their gross and net receipts and indebtedness, and to reduce freight rates when it could be done without injury to the railroads. The law went into effect in April, 1874, but was disregarded by the railroad companies. They took the position that their charters, which gave them power to fix rates as they chose, constituted inviolable contracts, and that the Potter Law was unconstitutional. Attorney General Sloan then commenced original proceedings in the Wisconsin Supreme Court for writs of injunction to restrain both the Chicago, Milwaukee and St. Paul and the Northwestern from charging greater rates and fares than fixed by the Act.

Some of the leading lawyers of the state, together with two from Chicago participated in the arguing of these cases, the arguments consuming nearly a week. Part of these arguments and the opinion of the Court which followed had to do with the original jurisdiction of the Court as well as the constitutional issue. The opinion was written by Chief Justice EDWARD G. RYAN, who had only recently come onto the Court by appointment of Governor Taylor. It is probably Ryan's greatest opinion.

The opinion held that the Potter Law did not impair the obligation of any contract because of the power reserved to the state in the Wisconsin constitution to alter corporate charters and franchises. Neither did the Act confiscate the property of the railroad companies. On this latter point Ryan stated:

> It was repeated, with a singular confusion of ideas and a singular perversion of terms, that the provisions of the chapter amount to an act of confiscation; a well defined term in the law, signifying the appropriation, by the state, to itself, for its own use, as upon forfeiture, of the whole thing confiscated. It was denounced as an *act of communism*. We thank God that communism is a foreign abomination, without recognition or sympathy here. The people of Wisconsin are too intelligent, too staid, too just, too busy, too prosperous, for any such horror of doctrine; for any leaning towards confiscation or communism . . . . Such objections do not rise to the dignity of argument . . . . They were not worthy of the able and learned counsel who repeated them, and are hardly worthy even of this notice in a judicial opinion.

This decision by the Wisconsin Supreme Court preceded by two years the landmark decision of the United States Supreme Court in *Munn v. Illinois*,[2] wherein an Illinois law regulating the rates which public grain elevators might charge was held constitutional. While over the years rate regulation of railroads has for many years been taken over by the federal government under its power to regulate interstate commerce, many utility rates are subject to state regulation. Although *Attorney General v. Railroads* did not spell out the guide lines which determine whether a particular rate violates the state and federal constitutions, it established the board precedent that rate regulation in itself is a constitutional exercise of state power.

State ex rel. Wisconsin Inspection Bureau v. Whitman, Insurance Commissioner

One of the most significant developments in recent times has been the tremendous part which administrative agencies have come to play in the

[2] (1876), 94 U. S. 113.

daily lives of our citizens. We now take it for granted that, in a complex modern society such as ours, effective government at the state and national level could not function without administrative agencies. However, in years past courts often took a hostile attitude to this development in our law. They were troubled by the concept upon which our national and state governments were founded of the three separate, independent branches of government, viz., the legislative, executive, and judicial departments. The courts found it difficult to conceive how it was lawful to create administrative agencies and clothe them with legislative and decision-making power. Statutes conferring powers upon administrative agencies were struck down as unconstitutional on the ground that the legislature had attempted to delegate legislative power to an administrative agency appointed by the executive branch of government.

When the courts of this past era did sustain a grant of legislative power to an administrative agency they would resort to the fiction that the power granted was that of making rules and regulations which fell short of the power to legislate. One of the forward-looking decisions of the nation in the field of administrative law was that of the Wisconsin Supreme Court in *State ex rel. Wisconsin Inspection Bureau v. Whitman, Insurance Commissioner,*[3] decided in 1928. The opinion was written by Justice (later Chief Justice) ROSENBERRY. The case was concerned with the issue of whether a statute was constitutional which conferred upon the commissioner of insurance the power to disapprove rules and regulations of inspection bureaus operated by fire insurance companies.

The opinion pointed out that the question of constitutionality arose because of the concept of the separation of the three branches of government. This paragraph of the opinion succinctly states the problem:

> Beginning with the creation of the Interstate Commerce Commission, which in the beginning was little more than an extra-legislative committee, there has been a development in our law brought about chiefly by the creation of boards, bureaus, and commissions, which has worked and is working a fundamental change. Not only are legislative and judicial powers delegated, but they are exercised in combination, and we not infrequently find powers belonging to the three coordinate branches of government combined in a single administrative agency. The change is fundamental because the law, at least in some of its aspects, no longer emanates from the legislature, is no longer wholly declared and enforced by the courts; and to the extent that this is true, we have departed from the fundamental principles upon which our political institutions rest. This has been the cause of much concern and is a source of much diversity of opinion.

The court stressed that students of the law as well as those in government agreed that there existed an overpowering necessity for a modification of the doctrine of separation and non-delegation of powers of government. Therefore, the delegation of legislative power to the commissioner of insurance was not unconstitutional on the ground of separation or non-delegation

[3] 196 Wis. 472.

of powers. The test to be applied in determining the validity of a delegation of legislative power to an administrative agency was stated in this language:

> The power to declare whether or not there shall be a law; to determine the general purpose or policy to be achieved by the law; to fix the limits within which the law shall operate,—is a power which is vested by our constitutions in the legislature and may not be delegated. When, however, the legislature has laid down these fundamentals of a law, it may delegate to administrative agencies the authority to exercise such legislative power as is necessary to carry into effect the general legislative purpose . . .

As some reassurance to those who might be fearful that the freedoms and liberty of our citizens would be jeopardized by clothing administrative agencies with legislative power, the court pointed out that there existed effective checks upon abuse of power by such agencies. First, the agency must conform precisely to the statute creating the power. Second, the courts will prevent the exercise of the power oppressively and unreasonably. Lastly, the legislature may modify or withdraw the power granted.

Since this decision, the Wisconsin Supreme Court in passing on the validity of a statute conferring power on an administrative agency has not been troubled with the fact that legislative power has been so delegated. Instead the Court examines the statute to see if the legislature has set a sufficient guide line by stating the general purpose or policy to be achieved. The application of this policy has permitted our state and local administrative agencies to effectively operate.

Cases Upholding Right of State to Finance Public Buildings Through Dummy Corporations

Secs. 4 and 6, art. VIII, Wis. Const., limit the amount of state debt to $100,000. Sec. 3 of this same article provides:

> The credit of the state shall never be given, or loaned, in aid of any individual, association or corporation.

In spite of these prohibitions the state in recent years has been able to finance vast building projects running into millions of dollars such as state buildings and buildings for the University's two campuses and those of the state universities (formerly state colleges). The device used is that of the private building corporation commonly referred to as a "dummy" corporation. The present capacity and stature of our public institutions of higher learning would have been impossible from a practical standpoint if the cost of all buildings had to be paid for out of current revenues. Likewise, our mental and correctional institutions would be severely handicapped for lack of needed facilities.

Therefore, it is doubtful if any opinions of the Wisconsin Supreme Court have had more of an impact than those which have held constitutional the private building corporation method of financing public buildings.

The steps in this method of financing are these: State-owned land is leased to one of these building corporations. The building corporation then finances the construction of the building by issuing its own bonds. The building when completed is leased to the state or some state agency for sufficient rental to amortize and retire the bonds. After the bonds are paid, the lease to the building corporation terminates.

At the present time there are four of these building corporations, viz., the Wisconsin State Building Corporation, the Wisconsin State Public Building Corporation, the Wisconsin University Building Corporation, and the Wisconsin State College Building Corporation. The latter two corporations only finance self-liquidating buildings such as dormitories and no tax moneys are involved. The first two receive their rentals out of state appropriations derived from tax moneys. The personnel composing the boards of directors of these building corporations are public officers, employees and legislators, but the corporations are non-profit and are incorporated under the general corporation statutes. As of the end of 1963 the total indebtedness of all four was $164,859,000, and it is considerably more than that now.

The first case which upheld the constitutionality of this method of financing state buildings was *Loomis v. Callahan,*[4] decided in 1928. The two projects there involved were the furnishing of the Memorial Union and the construction of the Field House on the University campus. The Court held that, although the building corporation was a private corporation, its undertakings under the lease to it were public, so that the lease was not invalid on the ground that public property was being transferred for a private purpose. It was further held that no state indebtedness was incurred because the debt was that of the building corporation. A later case, which involved a somewhat similar method of financing, explained that an obligation on the part of the state to pay future rent is not a debt within the meaning of the debt prohibition of the constitution. There exists a sound historical basis for this holding.

This significant statement was made by Mr. Justice OWEN, in the opinion in *Loomis v. Callahan, supra* (at p. 524):

> It is of no legal consequence to say that the plan is a subterfuge and devised for the mere purpose of circumvening the constitution. That may be admitted without answering the question thus presented one way or the other. In order to condemn the transaction it must be found that it creates a state debt within the meaning of the constitution. Even though any plan which places needed buildings at the disposal of the state may be said to circumvene the constitution, it does not offend against the constitution unless the plan does give rise to a state debt within the meaning of the constitution.

State ex rel. Wisconsin Development Authority v. Dammann,[5] decided by the Court in 1938, also played an important part in buttressing the constitutionality of the "dummy" corporation method of financing construction costs of state buildings. The Wisconsin Development Authority ("W. D. A.") had been incorporated by private individuals under the general corporation statutes. The legislature passed an act which outlined the duties of the corporation and made an appropriation to it.

[4]196 Wis. 518.
[5]228 Wis. 147.

One of the grounds on which the act was attacked was that it made the W. D. A. a public agency. The Court held that W. D. A. already possessed under its articles of incorporation the powers the act sought to confer upon it. Therefore, it remained a private corporation although the funds appropriated were for a public purpose. In this respect the appropriation feature of the act was no different than other appropriations made for a public purpose to such private corporations as the State Historical Society, The State Horticultural Society, various county agricultural societies, Wisconsin Department of the G. A. R., etc. It was pointed out that all these also perform public functions.

In subsequent cases, which have attacked the constitutionality of financing state building projects through state building corporation statutes, it has been held that they remain private corporations even though they perform public functions. In so holding the Court has repeatedly cited and relied upon the *W. D. A. Case*. This holding provides the keystone for upholding the constitutionality of the building corporation method of financing state building construction because, were it to be held that the building corporations were state agencies, then their debts would constitute state indebtedness under sec. 3, art. VIII, Wis. Const.

Cases Abolishing Immunities

For many years the most fruitful source of litigation in our trial courts has been personal injuries. Over the years our Supreme Court, as well as the highest appellate courts of most states, formulated rules of immunity which prohibited for reasons of public policy recovery for negligence in these four situations: (1) where the fault was that of the state or its subdivisions; (2) where the action was brought against a charitable organization such as a non-profit hospital association or Y. M. C. A.; (3) where the negligence was that of a religious organization or corporation; and (4) where an unemancipated minor sued the parent.

The immunity rule with respect to the state and its political subdivisions, when traced back to its source, was found to rest on an old English case which held that the king could do no wrong. This is scarcely a legitimate reason in present day America for continuing the rule in effect. A better reason for not abolishing the rule was that a big damage judgment against a school district, town, village, small city, or rural county might divert tax revenues and either cause curtailment of public service or inflict great hardship on taxpayers.

The policy reasons for exempting charitable and religious organizations from liability for negligence was that to permit liability would divert the funds which had been donated to the support of these organizations to a purpose not intended by the donors.

The immunity granted parents against suits by their children rested on the premise that to permit such actions would be to disrupt family harmony.

There was one area in which the legislature for many years has departed from the immunity rule and that is by permitting recovery against towns, villages, and cities for injuries caused be defects in streets and sidewalks. However, it imposed a rather small dollar limit on the amount of damages which has only in recent years been raised. In time the legislature also enacted the safe-place statute which had the effect of abolishing the immunity with respect to accidents caused by defects in public buildings including those owned by municipal, charitable, and religious corporations. This gave rise to the incongruous situation, for example, that if a patient in a hospital operated by a non-profit corporation were hurt by reason of a piece of ceiling plaster falling on him he might recover damages, but, if injured by the negligent administration of a wrong drug he could not. Finally the legislature provided for recovery of damages for accidents resulting from the negligent operation of state and municipally owned motor vehicles.

Many areas of non-liability still existed in spite of these statutes. A few examples are these: A person injured by a pile of folding chairs falling upon him in a church basement; a boy losing several fingers on a power saw in school manual training class; and a child burned while playing on a city dump ground. The legislature turned a deaf ear to any proposal to permit a child to recover for any injuries caused by the parents' negligence.

Commencing in 1961 and ending in 1963, the Wisconsin Supreme Court, in a series of four decisions, abolished all four of these immunities. *Kojis v. Doctors Hospital*[6] did away with charitable immunity; *Holytz v. Milwaukee*[7] did the same with respect to governmental immunity; and *Widell v. Holy Trinity Catholic Church*[8] abolished the immunity of religious institutions. Then *Goller v. White*[9] held that an unemancipated minor child might recover for injuries sustained in an automobile accident caused by the negligence of the parent. These four decisions constituted an "about face" on the part of the Court from its prior position that changes such as these lay within the province of the legislature rather than the Court. The Court did not attempt to gloss over that this was so, but asserted that, because these rules of immunity were court-made rules, it was the responsibility of the Court to correct its own mistakes.

Insofar as there originally may have been legitimate policy reasons justifying these rules of immunity, the availability and wide use of liability insurance had largely destroyed their validity. In any event, modern day justice requires that a person sustaining injury through the negligence of another be permitted to recover damages for his injuries.

The legislature has taken no steps to reverse or modify the effect of the decisions in the *Kojis, Widell,* and *Goller Cases.* The one decision of the four which drew legislative action was the *Holytz Case* which abolished governmental immunity. This legislative action consists of a new statute applicable to negligence actions against policital subdivisions of the state and officers thereof which requires the giving of notice within 120 days after the accident and limits the maximum damages recoverable to $25,000 except in case of an accident caused by the negligent operation of a municipal or state-owned and operated motor vehicle.

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[6] (1961), 12 Wis. (2d) 367.

[7] (1962), 17 Wis. (2d) 26.

[8] (1963), 19 Wis. (2d) 648.

[9] (1963), 20 Wis. (2d) 402.

Cases Protecting Equality of Voting Rights

The last two cases to be mentioned may well prove in the long run the most important of all. These are the recent cases of *State ex rel. Reynolds v. Zimmerman*[10] and *State ex rel. Sonneborn v. Sylvester*,[11] hereafter referred to as the "County Board Case." The former dealt with reapportionment of the legislative districts of the state and the latter with the method of election of county boards. Central to both was compliance with the equal-protection-of-the-laws clause of the Fourteenth Amendment of the United States Constitution as interpreted by the United States Supreme Court in *Baker v. Carr*[12] and ensuing cases as embracing the "one man-one vote principle."

Prior to *Baker v. Carr* the United States Supreme Court had held that the matter of reapportioning election districts for voting purposes where a legislature failed to act was a political question with which the Court should not concern itself. While the Wisconsin Supreme Court had in years past held unconstitutional legislative apportionment acts which denied equality of representation because of gerrymandered districts, it held as late as 1962 that it had no power to interfere where an apportionment act was valid when enacted but later resulted in great disparity of representation due to subsequent population shifts.

The Wisconsin legislative apportionment act enacted after the 1950 census was known as the Rosenberry Act. While it had accomplished an equitable apportionment on the basis of the 1950 census, the 1960 census disclosed gross disparities. For example, the largest state senatorial district as of 1960 had a population of 208,343, and the smallest 74,293. Although the Wisconsin constitution requires the legislature to reapportion legislative districts at the first session following each federal decenial census, the legislature and governor were unable to agree on an apportionment bill at the 1961 and 1963 legislative sessions.

When *State ex rel. Reynolds v. Zimmerman* was argued before the Court in January, 1964, an election of all assemblymen and about half the state senators was to be held later that year. Nomination papers for the September primary were eligible to be circulated commencing May 15th. The Court's opinion, which held the Rosenberry Act unconstitutional, was handed down February 28th. Because chaos might result if the legislature and governor still were unable to agree on a new apportionment act, the Court retained jurisdiction and declared that, if no valid apportionment act were enacted by May first, the Court would promulgate an apportionment plan of its own by May 15th for holding the 1964 legislative elections.

The legislature thereafter passed an apportionment bill, the governor vetoed it, and the veto was not overridden. The Court then on May 28th promulgated its own apportionment plan but expressly made it only effective for the 1964 legislative elections and until the legislature and governor should supplant it with an act of their own. It was with great reluctance that the Court took this step, but it was felt to be the best of the alternatives open to it.

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[10](1964), 22 Wis. (2d) 544.
[11](1964), 25 Wis. (2d) 177.
[12](1962), 369 U. S. 186.

The County Board Case decided only this January held invalid the then statute for electing county boards in all counties except Milwaukee and Menominee Counties at any election subsequent to the April, 1965, election. The law held invalid provided that county boards should be composed of the town chairman of each town, a supervisor elected from each village, and a supervisor elected from each ward of a city. The opinion pointed out far greater disparities in representation on county boards than existed with respect to legislative districts at the time of the court's decision in *State ex rel. Reynolds v. Sylvester*. It was the first decision in the country by the highest court of a state to apply the "one man-one vote principle" to an elective law-making body of a state political subdivision. Again the Court retained jurisdiction in case the legislature and governor failed to enact by November first a valid law with respect to the composition of county boards. The legislature did promptly enact a new law which the governor has signed. Under this law county board members are to be elected by districts apportioned according to population. The actual apportioning is to be done by the existing county boards. The law provides the maximum number of board members a county falling within a particular population class may have.

Some people predict that, as the result of the *County Board Case* decision and the enactment of this statute, county government in areas of dense population will become more effective, and town governments will be relegated to a place of little importance. There is presently a great need for strong county government in such areas to grapple effectively with urban problems which transcend city and village boundaries. On the other hand, in counties in rural areas with no metropolitan population centers, town government may continue to flourish for a long time to come. These of course are aspects of the problem with which the Court was not, and should not, be concerned, as the issue which faced the court was solely a constitutional one.

Conclusion

Not all students of the law will agree with the selection of cases included in this paper as qualifying as "landmark" decisions. On the other hand, there well may be other cases which the author has overlooked which are deserving of inclusion. All of those included, however, afford potent illustration of the important part which the highest appellate court of one state has played in the lives and times of its people.

DOES WISCONSIN HAVE AN IDENTITY?
(Some Suggestions on an Historical Problem)

Leslie H. Fishel, Jr.

I want to talk first about a man named Edwin Bottomley. If you know your Wisconsin historical publications, you will remember that the letters of Edwin Bottomley were published by the State Historical Society more than forty-five years ago and that the editor was one of my distinguished predecessors.[1] Bottomley was one of the thousands of settlers who populated the Midwest before the Civil War and contributed to its regional identity. As a Wisconsin resident he exemplifies both the section and the state which claimed him: he was at once a Midwesterner and a Wisconsin man.

The traits which particularize a son of the Midwest and a son of Wisconsin overlap at certain points, yet at others they are distinct and isolable. In essence the question is what makes a state both a separable and an inseparable part of the section to which it belongs? What makes Wisconsin Midwestern and what makes it Wisconsin? I do not propose to answer these questions in specifics, since an historically-oriented profile of the state deserves detailed attention. This, I am happy to report, Wisconsin is about to receive. I propose, rather, an approach to these questions in the form of five general forces: change, the church, chicanery, choice and chance.

I will try to use events from Edwin Bottomley's life, coupled with random observations about Wisconsin's history, as illustrations of these forces at work.

The Bottomley story has no special consequence in the sense that Bottomley and his family played a significant role in history, but its tone has a Midwestern ring, its resonance is of Wisconsin. Edwin Bottomleys settled the Wisconsin territory as they did the whole Midwest, giving a certain commonness to the Midwestern experience and a singular distinctiveness to each of the Midwestern states. In Bottomley's case, it was his and his neighbors' reaction to their change of place and pace that has contributed to Wisconsin's special character. His ambition or apathy, his diligence or dilatoriness have become part of the Wisconsin tradition. His close ties to his church, his artful balancing of funds, his decisions to purchase land, and to remain aloof from alien neighbors, the buffeting he received from chance events—these, multiplied a thousandfold, have made Wisconsin.

In the last analysis, we must go to people to discover the universal and the unique. No matter the rocks and rills, the waters and the woodlands, their impact is read in individuals and families and communities. To distinguish the Midwest as a region in these United States and to distinguish Wisconsin as a state within the Midwest, we can look to the Edward Bottomleys.

Bottomley was born in 1809 in England to a respectable middle class family. His father managed a mill and the family was well-respected in their small English community. Bottomley himself was trained as a pattern-maker for the mill, a job that had considerably more security than most industrial

[1] Milo M. Quaife, ed., *An English Settler in Pioneer Wisconsin* (Madison, Wisconsin 1918).

jobs in England at the time. He was interested in music and, as an active church member, directed the church choir. In 1829, he married a woman of equal place, and this changed a lot of things for Mr. Bottomley as it does for most of us. In little more than a decade, there were six babies, five of whom survived. As his family grew, Bottomley worried about his children's future. He saw at first hand the consequences of child labor: families forced to send their youngsters into the mill, into the factory, or into the fields at a very early age, depriving them of opportunities for physical and mental growth. He did not want his children to face this and sought a way out.

After great deliberation, he decided to emigrate to the United States with his wife and children. They arrived in 1842 proceeding directly to a little community in western Racine County known as the English Settlement. There Bottomley bought some land and became a farmer. His experiences as a pioneer in Wisconsin were not much different from those of other pioneers. He wrote consistently and informatively to his parents in England and his letters add color and meaning to our understanding of frontier life. The first winter his house was not quite weather-proof and the Bottomleys frequently woke up in the morning to find snow on the bed and, under it, their hobnail boots frozen to the floor. He was unable to clear and till all of his land immediately nor could he afford a full herd of cattle, but as he worked and worried he began slowly to stabilize his life. Several years after his family settled in, his oldest daughter married a young neighbor in the church which Bottomley and his friends had built.

In 1850, tragedy struck the family in the form of typhoid fever and Edwin Bottomley succumbed after eight years in Wisconsin. His story, so full of promise, comes to an end, but his letters, so rich in detail, remain for perennial harvest.

This is the narrative which is of no particular consequence, except as it can help us move from the particular to the general. The five factors which I suggest as an approach to Wisconsin history are common to all historical experience. It is their interplay among people which casts the unusual mold of a state.

The first factor is change. Professor Nye alluded to this in his keynote address. In Bottomley's case, change was a basic force in his life. He not only changed location, from England to Racine County, but he changed his occupation, his way of living, and his outlook on life. Reading his letters to his parents, you can detect the care with which he explained to them the unfamiliar and the strange. The changes had made of him, in Crevecoeur's phrase, a new man, and he tried to convey this in his letters without upsetting the folks back home. For Bottomley, the changes in his personal experience were the predominant forces which shaped his life in America.

During the midwest's formative years, change provided a fundamental thrust in the progression from territory to state. One of Wisconsin's greatest sons, historian Frederick Jackson Turner, noted this phenomenon in his famous 1893 address on the significance of the frontier, read before the American Historical Association in July and the State Historical Society of Wisconsin in December:

> Now, the peculiarity of American institutions is the fact that they have been compelled to adapt themselves to the changes of an expending

> people—to the changes involved in crossing a continent, in winning a wilderness, and in developing at each area of this progress out of the primitive economic and political conditions of the frontier into the complexity of city life.[2]

Surely this has been a shared Midwestern pattern, for more than a century, whether you remark the transformation from frontier to farmland, or from city to suburb.

For Wisconsin, it was the specific changes which shaped the face of the state. The use of capital, for example, motivated by a multiplicity of factors, moved sequentially from one investment form to another, each move adding a new dimension to the state. Landed capital focused first on lumber, then wheat, then dairying. Commercial capital was expended on river and canal transportation, then railroads. Industrial capital favored saw mills, then flour mills and eventually paper mills. Much of this capital came from outside of the state and the section, yet its application in Wiscinsin progressing in particular ways, formed communities, economic classes, labor markets, and legislation—in short those manifestations which make Wisconsin unique.

Other needs of Wisconsin's settlers led to changes which brought distinctiveness. The mixture of new world isolation and old world entertainment patterns helped to make Wisconsin the mother of almost one hundred different circuses during the nineteenth century. The amalgam which was Wisconsin helped to found a new political party before the Civil War. At the start of the war, Wisconsin men who had left the old country to escape military service flocked to volunteer in the Union army. A changing technology assisted an artist with the camera, H. H. Bennett of Wisconsin Dells, to record Wisconsin scenes for posterity and lay the groundwork for the twentieth century tourist industry. And through it all, the people were changing, moving in from Europe and the East, moving out to the plains and the far west, making and leaving their mark on the state.[3]

Will Herbert once remarked that when immigrants come to the United States, they change everything—their language, their job, their national loyalty—except their religion. This perceptive observation suggests the close relationship between change and the second factor, the church. Organized religion played a major role in shaping Wisconsin as it did in the life of Edwin Bottomley.

In Bottomley's case, this is revealed in a negative way. In 1847, some Dutch families moved into western Racine county. While they spoke a foreign tongue and exhibited some alien traits, Bottomley reported that they were fine people. He had no prejudice in his heart. However, the Dutch were Roman Catholic and when one Dutch family wanted to buy land adjacent to Bottomley's, he became frantic. Although he was land poor and already in debt, he scraped together enough money to travel to Milwaukee to make a down payment on this land. He justified this purchase to his father by explaining

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[2]Frederick Jackson Turner, "The Significance of the Frontier in American History," Proceedings of the State Historical Society of Wisconsin . . . December 14, 1893 (Madison, Wis., 1894), 80.

[3]Peter J. Coleman, "Restless Grant County," *Wisconsin Magazine of History,* XLVI (Autumn, 1962), 16–20.

that he feared a possible restriction on his use of a watering hole. Here, intermixed with economic and social factors, is the force of church differences at work.

Because a wide variety of ethnic groups settled Wisconsin bringing with them religious affiliations, religious diversity was fact. The commonplace division between Roman Catholics and Protestants was complicated by ethnic divisions within the Wisconsin Catholic community on the one hand and the primary Protestant group, the Lutherans, on the other. These ethnic concentrations and their counterparts of other denominations gripped their religious practices and centered their social activities around their church with a tenacity which isolated one from another culturally, even as they grew together physically and geographically.

Church-centered ethnic groups in Wisconsin in the nineteenth century retained their group idenity long after immigrant clusters elsewhere had married into the American mainstream. Here emerged a tossed salad of nationalities in which each ingredient kept its own taste, while adding to the overall flavor. This tendency to stay apart, while communication accelerated and distances shortened within the state, in itself became characteristic of Wisconsin.

This contradictory drawing together and drawing apart had, I believe, singular and salutary effects. It fostered a high degree of community participation, often church-led, in which all families entered actively into the life of the community. The Swiss of New Glarus are one example and the Finns in northern Wisconsin another. It spearheaded a healthy but competitive respect for cultural differences, too. Bottomley's posture in the face of new Dutch neighbors is a specific instance, while the Milwaukee Germans, predominant but not preemptory, are another.

The political ramifications of long-lived church-dominated ethnic groups are perhaps more susceptible to analysis, although there has been no recent serious study of this in Wisconsin. While modern pollsters and politicians scrutinize wards and precincts for bloc voting, the historical experience has been largely ignored. We know generally that Wisconsin Germans voted for Douglass rather than Lincoln in 1860 and that Wisconsin's Scandinavians supported Robert M. LaFollette, Sr. and the Progressives at the turn of the century, but we are uncertain about the ethnic amalgam, the joining together of ethnic groups for political purposes.[4] Whatever future research will uncover about the impact of the ethnic amalgam on Wisconsin politics, it is certain that in this as in other areas of activity, the church was a substantial ingredient in the mortar which supported the bricks of ethnic life in Wisconsin.

A third factor is the force of chicanery. Now I really cannot say, in Edwin Bottomley's case, that he actually practiced this art, but I can offer two fairly close examples. (After all, a son does not usually write home about his falls from grace, and Bottomley's letters provided the substance of our knowledge of the man.)

The first example is a recurrent one: the artistic and skillful way in which he let his father know that he needed money. The second example is more specific. When the time came for a payment on the land which he had

[4]See Frank L. Kelment, *Wisconsin and the Civil War* (Madison, 1963), pp. 6–10 and Robert S. Maxwell, *LaFollette and the Rise of Progressives in Wisconsin* (Madison, 1956), pp. 59–62.

purchased, Bottomley was completely without money and the resources to borrow. He went to his son-in-law and convinced him to advance $150 which the younger man was saving for spring expenses. It takes an artist to borrow from his father and then turn around and borrow from his son-in-law.

Whether or not these acts border on the chicane, the point is clear. Chicanery is a worldwide skill, practiced even in Wisconsin and the Midwest. In his remarks today, Chief Justice Currie reported on a court case involving three precincts which were recorded as voting, though the precincts did not even exist.

Other examples are legion and led to constructive reactions. Wisconsin's state treasurers were habituated to pocketing for themselves or their political party the interest earned by invested state funds, a practice not uncommon in other states. The Progressive momentum eliminated this bit of chicanery in Wisconsin. In Milwaukee in the 1890's, the head of the public library, a distinguished and nationally-known librarian, absconded with over $10,000 of library funds, was caught and convicted by a jury but released without penalty by the judge because of his upstanding character. The blatancy of this juridical act led directly to a concerted movement for municipal reform on the part of businessmen, lawyers, labor leaders and urban reformers.[5]

Chicanery, then, is not a force that molds the unique, but it creates one. In Wisconsin, the chicane has generally been greeted by righteous indignation, by reform movements, by reactions which vacuum clean the dirt and change the legislative furniture. The great Progressive thrust in Wisconsin began as a reaction to acts of chicanery. Modern conservation methods, in which this state is a leader, began because of past acts of chicanery. Wisconsin's labor movement, the dairy cooperatives, industry's civic activities, all began in part as a reaction to chicanery—and these have helped to create an identifiable Wisconsin.

A fourth factor is choice, at the practical not the philosophic level. Like the rest of us, Edwin Bottomley went through life faced with limited alternatives and making choices among them. His decisions changed the course of his life and that of his family. In similar fashion, men and women of the Midwest and Wisconsin played out their lives choosing among alternatives and thereby shaping the present and the future for themselves and their posterity.

The choices which individuals and institutions make alter the form and substance of a state. The political leaders in Madison determined in 1846 to form an historical society and the seed took root. The University of Wisconsin Board of Regents in 1894 chose to support Professor Richard T. Ely and not only did the seed take root, but the statement which flowered from the choice still holds its bloom.[6] Individual choices occasionally make a difference to a state also. William Dempster Hoard, as Professor Nye has explained, dedicated his talents, by choice, to convincing Wisconsin farmers to become dairymen. John A. Kimberly chose paper-making at a time when most of his business friends were worrying over grist mills and lumbering.

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[5] I am indebted to David Thelen for this Milwaukee example of chicanery and its consequences, and for other helpful suggestions.

[6] Vernon Carstensen, "Wisconsin Regents: Academic Freedom and Innovation, 1900–1925," *Wisconsin Magazine of History* XLVIII (Winter, 1964–5), 101–110.

To protect the interests of government workers at state and local lavels, Arnold Zander began a small union in Wisconsin which grew into an influential national organization. His choice helped to make Wisconsin a leader in this field.

Choice is a force which makes life and history intriguing. Historians have not ignored it, but few have grappled with it as a shaping force in the history of a region or state. This is a problem of some magnitude; Wisconsin can be differentiated from other midwestern states because of the results of choices which its citizens, from the Bottomleys to top executives have made.

The final factor is chance. We all push aside expectations of the unexpected living in hope that we can cope with whatever happens. Edwin Bottomley lived that way until he was struck down, at the age of forty-one, by typhoid fever. He was gone before he realized fully the good life he had hoped for and behind him he left young children, untilled land, and debts. Chance is amoral; it works at all levels of human activity. Its consequences carve out the distinguishing marks of a nation, a region, or a state.

In Wisconsin, to cite some specific examples, the risk of random forest fires brought about the first aerial fire-spotting crew, the discovery of lead brought the distinctive Cornish lead miners to Mineral Point, and the sinking of the *Lady Elgin* in 1860 with 400 of Milwaukee's Irish–Americans aboard checked the Irish influence in that city's affairs for years to come.

The timing of a particular event or movement is also part chance. That Turner should reach maturity as the frontier influence waned was sheer coincidence, yet his reputation as a historian and his substantial contribution to the University of Wisconsin's reputation as a seat of learning depended upon it.[7] That LaFollette could sense that the fertile ground would nourish the seed of progressivism was in good part chance, and LaFollette changed the face of the state. It was chance which led Joe McCarthy to charge the State Department with harboring Communists, yet this speech catapulted him to fame, as the junior Senator from Wisconsin, and his subsequent career innovated far-reaching nuances in Wisconsin and national politics.[8] In each instance, the force of the man's personality was critical to the success of his mission and this, too, is part chance.

Because chance is beyond logic, it is seldom counted as an evaluative force. So much depends upon it and so little do we take it into account. But in analyzing what makes a state stand out, chance is a force to be reckoned with.

Five factors, then, have played a predominant role in Wisconsin and Midwestern history, as they would in the history of any area. The five—change, the church, chicanery, choice and chance—have created a Wisconsin which is both a part of and apart from the Midwest. Because of these forces, the Midwest's Wisconsin is unique and identifiable.

If this analysis has meaning, it is a challenge to historians to dig into Wisconsin's history. For too long, the resident historians of national reputation have tended other pastures, leaving their home state to too small a

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[7]See Ray Allen Billington's perceptive article, "Young Fred Turner," *Wisconsin Magazine of History,* XILVI (Autumn, 1962), 38–48.

[8]David A. Shannon, "Was McCarthy a Political Heir of LaFollette?" *Wisconsin Magazine of History,* XLV (Autumn, 1961), 3–9.

group of able scholars among whom Alice E. Smith stands pre-eminent. The opportunity to do this is at hand once more with the organization of a small research staff at the Society under the direction of William Fletcher Thompson. Their charge is to produce a multi-volumed history of Wisconsin.

This project, to be financed with privately-raised funds, will proceed in concert with the University of Wisconsin. We hope that distinguished historians in Wisconsin will lend their talents. We expect these investigations in depth to provide still further opportunities for younger scholars to explore in the years ahead. We anticipate that this will not only be intensive and interpretive history, but that it will break new ground in examining cultural history, community history, and the life cycles of ordinary people like Edwin Bottomley. We will try to utilize ignored resources like artifacts and photographs along with newspapers, manuscripts and archival records. And, speaking personally, I would hope that the volumes will come to grips with these five factors and demonstrate evidentially the contradictory concept of the uniqueness and the oneness with the Midwest of this attractive and stimulating state we call Wisconsin.

THE BASIC SCIENCES IN WISCONSIN*

Aaron J. Ihde

The basic sciences, as they have developed in Wisconsin, have been characterized by: 1) opportunism, and 2) pragmatism, but with 3) an intense drive toward the discovery of fundamental relationships, and 4) a reputation for educating Wisconsin youth and the youth of others for pursuit and application of scientific knowledge throughout the world. I trust that the examples which follow will illustrate these four characteristics.

The earliest scientific work of fundamental significance to be done in Wisconsin was carried out at Fort Crawford, on the site of modern Prairie du Chien, in 1829. The state did not yet exist. Fort Crawford lay on the western edge of Michigan Territory.[1]

The circumstances of the experiments were accidental. The investigator was William Beaumont of Connecticut, a military surgeon who had learned medicine by reading in the offices of two Eastern physicians and accompanying them on their rounds. During the War of 1812 he had ample opportunity to gain surgical experience. Thus, he was no novice at Fort Mackinac when he was called, on the morning of June 6, 1822, to treat an Indian youth, Alexis St. Martin, who had been the unwitting recipient of a gunshot blast which removed part of his left side, exposing a lung and the interior of his stomach.

Beaumont cleaned the wound, made the patient as comfortable as conditions permitted, and left to attend other duties, anticipating St. Martin's death in a matter of hours. The nineteen year old Indian did not die, but went through a long and painful convalescence to regain his vigor and facilities, but with a stomach wound which healed without fully closing, thus exposing the interior of the stomach to the prying eyes of Dr. Beaumont.

It was not until May, 1825 that the doctor, still at Fort Mackinac, took advantage of his patient's peculiar abnormality to undertake experiments on digestion of pieces of food attached to strings and placed into the stomach through the fistula. These studies were continued at Fort Niagara where Beaumont was soon transferred, but were terminated in August when St. Martin disappeared.

Four years later, when Beaumont was at Fort Crawford, he learned the whereabouts of his former patient and, through the aid of the American Fur Company, persuaded him to return as a hired hand and experimental subject. St. Martin appeared with a wife and two children. A total of 56 experiments were carried out between then and March, 1831 when his wife's homesickness, coupled with St. Martin's discontent with his role as experimental animal, brought a new separation. The Indian family left for Canada by canoe, moving down the Mississippi to the Ohio River, paddling upstream until transfer might be made across Ohio to Lake Erie, then on through Lake Ontario and the St. Lawrence River, evidence of the generally robust good health of St. Martin.

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The Fort Crawford experiments laid the foundation for understanding gastric digestion. Beaumont, though far from the centers of investigation, had a deep understanding of the physiological knowledge of his day and proceeded from these foundations to utilize his unique patient so as to determine the fate of food in its passage through the stomach. In his early studies at Fort Crawford, Beaumont checked the temperature of the stomach during digestion. He collected gastric juices through the fistula and established that the juice is not secreted continuously by the stomach glands, but is secreted only when food appears in the stomach or when irritation of instruments initiates secretion, contrary to the widely held belief that secretion was continuous.

With gastric juice isolated from the stomach, Beaumont studied the external digestion of beef and made comparisons with internal digestion. Other foods were similarly studied. He found that digestion of meat takes place particularly well in the stomach, though vegetables tend to remain undigested. In studies of milk he ascertained that the milk is first coagulated, then the curds undergo digestion.

Temperature studies revealed that gastric juice becomes inactive when the temperature drops. Beaumont further showed that anger supresses the effectiveness of gastric digestion. In studies with beef gall and pancreatic juice isolated from freshly slaughtered animals Beaumont established the inhibitory effect of these juices on gastric digestion.

Late in 1832 Beaumont was able to persuade St. Martin to submit to another series of experiments which were carried out in Washington, D.C. and Plattsburg, New York. These experiments terminated in 1833, the same year that Beaumont's *Experiments and Observations on the Gastric Juice in the Physiology of Digestion* was published.[2] This recounted the experiments and discussed the conclusions to be drawn therefrom. The book attracted world wide attention and was reprinted in England and Germany before another year had passed. It represented a milestone in the history of science.

The opportunistic studies of Beaumont, while carried out in what is geographically Wisconsin, cannot be looked upon as a uniquely Wisconsin work since the circumstances might very easily have led Beaumont to carry out his observations in another army post. Accident or not, the event marked an auspicious beginning for developments in the basic sciences which were to follow.

The second scientist in our account was also an Easterner. He was born of Quaker parents in upper New York in 1811, his father being a construction engineer on the Erie Canal. Increase Allen Lapham entered Wisconsin territory in 1836 when friendship with Bryon Kilbourn brought him to Milwaukee. He had already had experience as a canal builder in New York, Pennsylvania and Ohio, and in the latter state began the herbarum collection which contained 8,000 specimens at the time of his death in 1875. Lapham settled in Wisconsin, making the territory and the state his home during the remainder of his days.

Lapham is representative of the gifted amateur who played such an important role in the development of science from the 16th century to the present. His interests and enthusiasms caused him to make important contributions to virtually every field he touched. As a naturalist he was in contact with Asa Gray, Louis Agassiz, and other Eastern scientists, reporting on plants and animals of the Milwaukee area. His *Catalogue of Plants and Shells Found in The Vicinity of Milwaukee* was the first scientific imprint published in Wisconsin (1836). He discovered Indian mounds at Fort Atkinson, Butte des Mortes, Aztalan, and in Sauk County and described them in his *Antiques of Wisconsin (1855).* As a gazetteer he published the book, *Geographical and Topographical Description of Wisconsin,* in 1844. He advocated crop rotation and fertilization of the soil in a day when wheat farmers felt that the fertile Wisconsin soil might be mined indefinitely. He advocated conservation in a day when the timber stands of Wisconsin seemed endless. His *Report of the Disastrous Effects of the Destruction of Forest Trees* (1867) was a pioneering work in the field.

For many years Lapham recorded weather information and advocated a weather recording and forecasting service at the federal level. His 15 year campaign finally bore fruit in 1870 when a Weather Bureau was created within the U.S. Army Signal Corps.

In addition to these activities he recognized, despite being largely self-educated, the importance of educational institutions and intellectual organizations. He was a founder of the Milwaukee Female College which was later incorporated into Milwaukee–Downer; a founder of the Milwaukee Public Library; a founder of the State Historical Society whose presidency he held for twenty-two years; and a founder of the Wisconsin Academy of Sciences, Arts and Letters.[3]

While gifted amateurs have always made important contributions to the growth of science, they alone are inadequate to make a profound impact. The center of scientific growth must be an educational system with its principal objective the broad education of youth, but without neglecting the practical needs of its contemporary society, and the obligation to open up new understanding. The citizens of early Wisconsin recognized the importance of education in a day when they might easily have postponed action to a later time.

Carroll College was founded in 1846, Beloit College began instruction in 1847, both before Wisconsin achieved statehood. Lawrence and the University of Wisconsin received their first students in 1849. By 1875 there were four more private liberal arts colleges (Milton, Ripon, Wisconsin Female and Milwaukee Female) and four state normal schools (Platteville, Whitewater, Oshkosh, River Falls).[4] All of these schools had serious struggles for survival in their early days and science instruction was seldom at a distinguished level. At the private schools science instruction was frequently carried on by ordained ministers, a pattern which was only broken late in the century. A major exception to this was Beloit College where a physician, S. P. Lathrop became the first professor of chemistry and natural history in 1849.[5] After he took a similar chair at the University in 1854 the Beloit position was filled between 1858 and 1921 by a succession of four men who had taken Ph.D. degrees in chemistry at the University of Gottingen in the famous laboratory of Friedrich Wöhler. In the other schools scientists of this stature only began to be attracted in the last years of the century.[6]

At the state normal schools there was an almost steady turnover of science teachers in the early years, although in two instances (T. C. Chamberlin at Whitewater and Franklin H. King at River Falls) the chairs were once held by men who became distinguished scientists.[7]

At the University of Wisconsin there was no science instruction until Lathrop arrived in 1854. Death terminated his career before the year ended. Although his chair was filled by another physician, Ezra S. Carr, there was no science instruction of distinction during the next decade of the University's precarious existence. A new era began in 1868 when the post-war reorganization, partly a consequence of passage of the Morrill Act, led to the appointment of John W. Davies, with a B.A. from Lawrence and a medical degree from Chicago Medical College, as professor of chemistry and natural philosophy; and W. W. Daniels, a graduate of Michigan Agricultural College with some graduate work at Lawrence Scientific School at Harvard, as professor of agriculture and analytical chemistry.[8] In 1870 Roland D. Irving, a graduate of the Columbia School of Mines, became professor of geology, mining, and metallurgy.[9]

These three men became a nucleus for the growth of science in the University. Daniells introduced the first laboratory instruction when he took over a carpenter shop in the basement of what is now Bascom Hall. Irving quickly introduced laboratory work in metallurgy after his arrival. The scientific cabinet, steadily and systematically enlarged through the years, was vastly improved by the acquisition of Increase Lapham's private cabinet following his death. A brand new Science Hall was opened in 1877. An observatory with the third largest telescope in the nation was acquired through the gift of former Governor C. C. Washburn in 1877.[10]

By 1881 a significant degree of specialization was evident in the science faculty. Daniells was givng his full time to chemistry, Davies to physics. James C. Watson had come from the University of Michigan to direct the observatory and initiate its research program. Edward A. Birge, who had offered some of the work in natural history since 1875, now returned with a Harvard Ph.D. and a year in Europe to a professorship of zoology.[11] William A. Henry came to Wisconsin in 1880 as professor of botany and agriculture.[12] In 1883 the founding of the College of Pharmacy led to the appointment of Frederick B. Power who came with a Ph.D. in chemistry from Strassburg.[13]

Irving, who suffered an untimely death in 1888, had become a scientist of national reputation in connection with his work on the geological survey. The state authorized such a survey in 1873 with Lapham as chief geologist. Irving was assigned work on the copper-iron region surrounding Lake Superior. Not only did he investigate the mineral-producing prospects of the region but sought for answers to the more fundamental questions dealing with the geological origin of the rocks of the region.[14]

Thomas C. Chamberlin, then professor of geology at Beloit, was also associated with the geological survey and became chief geologist in 1877, thereby becoming responsible for editing the four-volume *Geology of Wisconsin* which was published between 1877 and 1883. He became an authority on glacial geology and between 1882 and 1907 was U. S. Geologist in charge of glacial studies. After he became president of the University of Wisconsin in 1885 he did much to encourage fundamental research by establishing a fellowship plan, encouraging the seminar method of instruction, and authorizing study for the Ph.D.[15] The first such degree was granted in 1892 to

Charles R. Van Hise who also became a distinguished geologist and, in 1903, president of the University.[16] Although Chamberlin gave up the presidency in 1892 to become head of the geology department at the new University of Chicago where he developed the planetisimal hypothesis of the earth's origin with F. R. Mouton, his program for basic research at the University of Wisconsin was expanded by succeeding presidents. In 1906 a graduate school was formally established with astronomer George C. Comstock as the first dean. By then fundamental research was a recognized activity in many departments and a number of Ph.D.'s. had been granted.

It is in many ways remarkable that basic research was pursued this early for the people of the state had a strong attitude for the practical. This is reflected in the demands for instruction in pedagogy, agriculture, mechanic arts, medicine, and law. In 1855 the Regents established a medical department and made appointments to seven chairs but the department failed to materialize.[17] In 1859 a department or school of "physiology and hygeine" was established with a Scottish immigrant, David Boswell Reid, as professor. Because of the precarious condition of the University, Reid's position survived for only one year.[18] Similar efforts were made to provide instruction in agriculture and Professor Carr probably did give some instruction in agricultural chemistry.

The reorganization in 1868 provided for instruction in agriculture by Professor Daniells, who was also given responsibility for operation of an experimental farm. Instruction of agriculture proved a disappointment, since farmers' sons showed little interest in the acquisition of book learning, and the obligations of the Director of the Experimental Farm appeared to be primarily the operation of the farm at a profit, an impossibility under the circumstances. When Daniells relinquished his farm obligations with the formation of the chemistry department in 1880, direction of the farm was assigned to Wiliam Henry, the botanist. Henry recognized the importance of agricultural experimentation and was successful in having the farm designated an agricultural experiment station in 1883. A chemist with a Yale Ph.D., Henry Armsby, was appointed professor of agricultural chemistry and chemist of the experiment station.

William Henry proved an enthusiast for scientific agriculture and, up to the time of his retirement in 1907, he developed a College of Agriculture catering directly to the needs of Wisconsin farmers and an experiment station carrying out both applied and fundamental research. His own interests developed along the lines of animal feeding and his book, *Feeds and Feeding*, was widely accepted for many years as the authorative work in the field.[19]

The most spectacular accomplishment of Henry's period was the development of a successful milk test by Stephen Molten Babcock in 1890. Babcock came to the University three years earlier as successor to Professor Armsby who had moved to Pennsylvania State College. The development of Wisconsin as a dairy state was handicapped by the frequent adulteration of milk by watering or skimming. One of Babcock's first assignments was to seek a test for butterfat in milk which would make such adulteration unprofitable. Babcock was successful at designing a test which was simple, rapid and inexpensive. Development of this test had a profound impact on dairying, not only in Wisconsin, but in the United States as a whole. Watering and skimming of milk became unprofitable after farmers began to be paid on the basis of pounds of butterfat delivered to the cheese factory or creamery.[20]

Meanwhile, agricultural research was developing along a variety of lines, many of them being empirical applications of scientific knowledge. This was largely the case with Babcock's test, Franklin King's work on barn ventilation and silo construction, Harry Russell's improvements in the pasteurization of milk, and his eradication of tuberculosis from the university cattle herd. However, studies of a fundamental nature was also being made at the station. King's studies of soil water and soil fertility represented an approach involving the best scientific methodology available at the time. His work on soils was practical only in the sense that through fundamental knowledge a better practice ultimately results. When King joined the U.S. Department of Soils in 1902 his work was fruitfully continued in Wisconsin by his disciple Andrew R. Whitson who soon saw the need for a soil survey on a statewide basis.[21]

Particularly illustrative of the tendency to combine the practical with the theoretical are the consequences of Babcock's searching questions about comparative value of animal feeds. Henry's feeding tables were based largely on values for proteins, carbohydrates, fats, and minerals as determined in the chemical laboratory. Babcock questioned the equivalence of such components in different feeds and finally succeeded, in 1907, in initiating a set of single grain experiments.

The feeding tests were conducted on 16 heifers by four of Babcock's younger colleagues, E. B. Hart, E. V. McCollum, George Humphrey, and Harry Steenbock. During the four-year experiment it quickly became evident that cows dependent on wheat as the sole source of nutriment, even when fed a scientifically balanced ration, failed to develop satisfactorily. To a lesser degree, this was also true of animals fed a ration derived solely from the oat plant, or from a mixture of wheat, oats, and corn. Only corn-fed animals developed normally. These experiments represent a milestone in the history of nutrition by revealing that feeds are not qualitatively equivalent, even when chemical analysis would indicate equivalency.[22]

Even before the single grain experiment was concluded in 1911, McCollum despaired of making progress in understanding the basic cause of the problem through experimentation with large farm animals. Despite opposition from Dean Harry Russell and department chairman Hart, but with the backing of Babcock, McCollum began using albino rats in his feeding experiments. Russell, when approached with the proposal had exploded, "The rat is a barnyard pest and should be exterminated. The legislature will never stand for the College feeding them. The answer is no!"[23]

McCollum's feeding experiments, mostly with the assistance of Marguerite Davis, quickly revealed different "biological values" in different foodstoffs. It became evident that butterfat provided a peculiar stimulus to growth of rats on a highly purified diet. After F. G. Hopkins of Cambridge introduced the concept of "accessory food factors", and Casimir Funk at the Lister Institute suggested the term *vitamine* for a substance in rice polishings which presumably prevented beri-beri, McCollum showed experimentally the need for two factors for which he suggested the terms "fat soluble A" and "water soluble B". He showed the fat soluble A to be present in butterfat, egg yolk fat, and the lipid extract of leaves. In later work, done at Johns Hopkins where he moved in 1917 to become director of the new School of Hygeine and Public Health, McCollum showed the association of vitamin A with the unsaponifiable fraction of fats and did fundamental work in showing the role of the associated fat soluble vitamin D to the prevention of rickets. He also became an ardent campaigner for better nutrition.

At Wisconsin Harry Steenbock observed the frequent association of vitamin A activity with yellow color in foods and demonstrated an association with the yellow pigment, carotene.[24] He also followed up the association between rickets and lack of sunshine and showed in 1924 that rickets-preventing activity could be induced in foods by irradiation with ultra violet light.[25] Patents on the irradiation process were turned over to the newly formed Wisconsin Alumni Research Foundation for management. The proceeds from royalties were invested and the income used to sponsor scientific research at the University and, in more recent years, to also construct university housing and research facilities.[26]

During the first five decades of the twentieth century the Department of Agricultural Chemistry (later Biochemistry) was in the forefront of nutrition research. Other developments of significance were the work of Hart and Conrad A. Elvehjem on the role of copper in anemia, Elvehjem's demonstration of nicotinic acid as the anti-pellagra factor, and somewhat peripherally to nutrition, Karl Paul Link's demonstration of dicoumarol as a hemmorhagic agent and its subsequent application to surgery and rat killing. Although one sees in all of these researches an application to practical affairs, the approaches have always been such as to provide fundamental understanding of the materials and processes involved.

Available time makes it impossible to explore other areas of fundamental contributions to pure and applied science in Wisconsin. One can only refer in passing to Louis Kahlenberg's criticisms of ionization theory,[27] to the work of Birge, Chauncey Juday, Arthur Hasler, and their associates on limnology,[28] to the work of Norman Fassett, Aldo Leopold, John Curtis, A. W. Schorger and associates on ecology and conservation, to the fermentation studies of E. B. Fred and W. E. Peterson, the reaction rate studies of Farrington Daniels, the hydrogenation work of Homer Adkins, the development of the pressurized linear accelerator by Raymond G. Herb. Even in making such a listing one becomes guilty of overlooking other equally significant researches in the University. Furthermore, there has been no reference to work in the other colleges and universities, of the state, or to work done at the Yerkes Observatory, the Forest Products Laboratory, or coming out of industrial laboratories.

Not only have Wisconsin scientists made important contributions to fundamental and applied science, but the state has served as a training ground and a maturing ground for scientists who have made or are making fundamental contributions to teaching and research in all other states of the Union and many foreign countries as well. John Muir comes to mind as perhaps the first such expatriate. But there are many others. One University department, Chemistry, has granted degrees to over 3000 students. One thousand of these degrees were at the doctoral level. Most of these chemists are not in Wisconsin today. If we include further, the chemists educated in our other universities and colleges, the impact of Wisconsin in this one science alone is profound.

If we turn to what is looked upon in many quarters as the supreme mark of international recognition, the Nobel Prize, we find a Wisconsin connection in the lives of five of the science laureates. Joseph Erlanger, who shared the medicine prize in 1944 for his research on the nervous system was the first professor and head of the newly founded physiology department from 1906 to 1910. Herbert S. Gasser, who shared the prize with Erlanger, was born in Platteville and received his B.A. and M.A. at the University. He served on the medical faculty of the University for short periods before and after taking his M.D. at Johns Hopkins. His research was on electrophysiology of nerves.

John Bardeen, who shared the 1956 prize in physics for his research on semiconductors, was born in Madison and educated through the M.S. at the University.

Edward L. Tatum, who shared the prize in medicine in 1958 was raised in Madison, taking his B.A. in chemistry at the University, and his Ph.D. in fermentation biochemistry. Joshua Lederberg, who shared the prize with Tatum, was a member of the genetics faculty at the University from 1947 to 1959 where he did his work on genetics and evolution of microorganisms.

I trust that this survey with its limited number of examples demonstrates the four characteristics referred to in my introductory remarks. *Opportunism* is evident in Beaumont's experiments, in the lake studies of Birge and Juday, and the geological and soil surveys. Concern for the *practical* is seen in Henry's *Feeds and Feeding,* Babcock's test, in the application of nutritional knowledge, in the development of improved varieties of grain, in the eradication of tuberculosis and brucellosis from dairy herds, in Daniels work on solar energy. The *fundamental* outlook appears in the single grain experiments, in the geological studies of Irving, Chamberlin, and their successors, in King's soil studies, in the probing for nutritional understanding by McCollum, Hart, Steenbock, and Elvehjem. Finally, the place of the state as an *educational center* is seen in the number of working scientists around the world who claim a Wisconsin connection, frequently short in duration but profound in results. Perhaps it might be said that education is Wisconsin's most important product.

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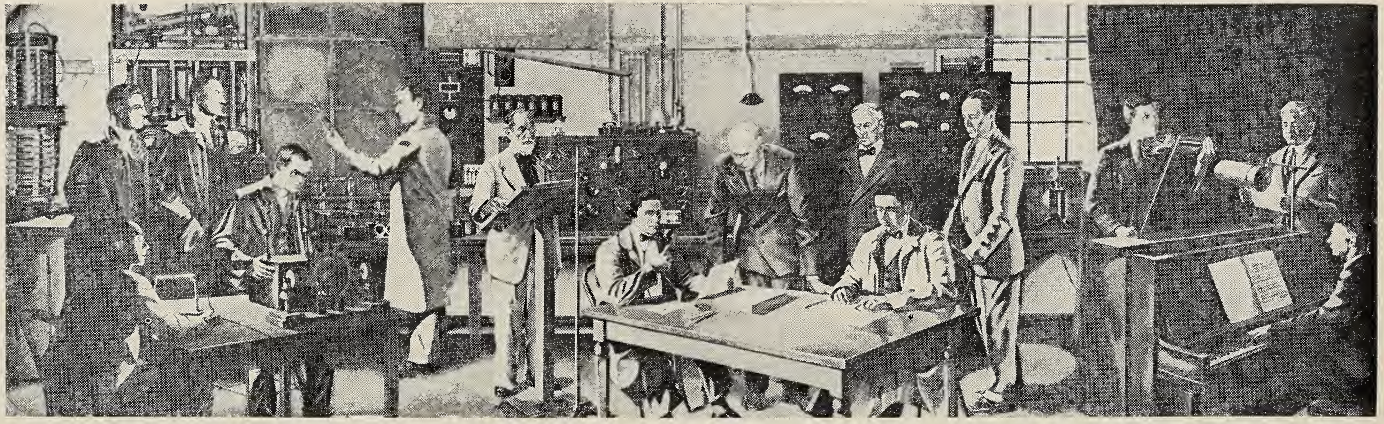

Mural in Radio Hall lobby pictures broadcast pioneers (l. to r.): James B. Davis, Roswell Herrick, Burton Miller, C. M. Jansky, Jr., J. P. Foerst, William H. Lighty, Malcolm Hanson, Andrew W. Hopkins, Edward Bennett, Earle M. Terry, Henry L. Ewbank, Waldemar Geltch, Edgar B. Gordon, and Paul Sanders.

HIGHLIGHTS IN THE HISTORY OF WHA: A SALUTE TO SEVERAL RADIO PIONEERS

Harold B. McCarty

Permit me, first to congratulate your Academy President or your conference Program Chairman or both on the choice of this topic for this particular conference. The timing is excellent.

Yesterday was Engineer's Day on our campus, and last night the College of Engineering, at a banquet in Great Hall of the Memorial Union, honored four of its graduates for their distinguished contributions to science and industry. One of the four was C. M. Jansky, Jr., a name we honor greatly in recalling the history of WHA.

"C. M.," also known as Moreau, is one of the sons of C. M. Jansky, Sr., long-time professor of electrical engineering in the University. Another son, Carl, is credited with the initial experiments and discoveries which launched the science of radio astronomy. C. M., Jr. now heads a large firm of communications consulting engineers with extensive laboratory facilities in Washington, D. C., and with assignments that are national and international in scope. While a student here, he was stimulated, as others were, by Earle M. Terry, Professor of Phyics. Professor Terry was dedicated to the conversion of wireless telegraphy into wireless telephony, or radio broadcasting as we know it now. His leadership and inspiration attracted another student whose name we honor among the pioneers responsible for the founding of WHA: Malcolm Hanson.

You may know part of the story of Malcolm Hanson, for he was chief radio engineer on Admiral Richard E. Byrd's first expedition to Antarctica. Remember the thrill and excitement of those first broadcasts from the "South Pole"? Later Hanson served as a consultant to the U. S. Navy, as a specialist in the development of radar. He was killed in a plane crash while serving on a communications mission in the Aleutian Islands during World War II.

There were other physicists and engineers active in producing wireless telephone transmissions from the University station known as 9XM, but we must be sure to pay tribute to these three: Prof. Earle M. Terry and his devoted students, Malcolm Hanson and C. M. Jansky, Jr. Together they designed the circuits, made the vacuum tubes, and built the equipment which made possible the start of broadcasting on a scheduled basis in 1919. It was their pioneering which enables WHA (known as 9XM until 1921) to identify itself as "The Oldest Station in the Nation." So, a salute to Terry, Hanson, and Jansky!

Naturally, the physical capability of reaching many listeners at one time led to a recognition of service opportunities. Slowly at first, we're told. But Terry was a socially-minded scientist. He insisted that his colleagues on the faculty come in and "say something worthwhile into the microphone." Among the first to see the possibilities and use the new instrument were three additional pioneers whose names we revere: Professors Wm. H. Lighty, Andrew W. Hopkins, and Edgar B. Gordon.

Professor Lighty was Director of Extension Teaching. It was his responsibility, in effect, to take the University to the people. And he did, in various ways—by correspondence study, by traveling teachers, by chatauqua-type events combining entertainment and serious subjects, by resident classes, and other means. He believed deeply that the University belongs to all the people of the state and should serve them in every way possible. Frequently he recalled for himself and others the words of President Charles R. Van Hise: "I shall not rest content until the beneficent influences of the University are available in every home of the state."

Imbued with that idea, it was natural that Professor Lighty should embrace radio. Here was a means of instant access to the minds of people far and wide. He planned and scheduled talks by faculty members. If a professor shied away from the microphone or felt, as it is reported some did, that radio was a passing fancy and a little beneath their dignity, Professor Lighty would read the manuscript himself. He was a delightful character, and a colorful one—with his neatly trimmed goatee, a flowing Windsor tie, and his twinkling eyes and merry laugh. For years he rode horseback to the campus from his home in The Highlands west of town. After that, for many years, you could see him driving about town perched high in an old-fashioned Franklin air-cooled automobile long after other cars of that make had disappeared from the streets. But Professor Lighty's old-fashioned mode of transportation had nothing to do with his vision and ideas about communication. In this area he was truly far-sighted.

Equally far-seeing and quick to use the new medium was another leader we honor, Andrew W. Hopkins, Professor of Agricultural Journalism and head of the department responsible for publicizing the findings of agricultural research and experimentation. When I first met and fell in love with WHA in 1929, the station was carrying two important daily features—the Farm Program and the Homemakers Program—which had been established years earlier by Professor Hopkins. Except for a quarter-hour of music and a single talk of a general nature, those two programs comprised the entire schedule when I began, and they are still maintained at a high level of excellence by the Department of Agricultural Journalism.

We have in our files a picture which provides documentation of some of Professor Hopkins' early efforts. It shows a scene in Agriculture Hall during Wisconsin Jubilee and Dairy Month in June, 1922. Prominent among the exhibits was a demonstration of how the University received and transmitted market reports for the benefit of farmers. Near the radio receiver in the picture is a sign which reads, "Wisconsin was the first state to use the wireless telephone for market reports and still leads all the others." One more first, followed by many others in farm and home radio service, thanks to the pioneering work of Andrew W. Hopkins.

Perhaps the name best known and most widely honored among WHA broadcasters throughout the years is that of Prof. Edgar B. ("Pop") Gordon, conductor for 24 years of the popular Journeys in Music Land on the Wisconsin School of the Air. He responded immediately when Harold Engel and I organized the School of the Air in 1931 and issued a call for teachers who could help to enrich the classroom activities of school children within range of WHA. Beginning with a few hundred listeners in the schools of Dane County, his radio class grew with the state radio network until it reached an estimated total of 100,000 participating children each week. But Professor Gordon's pioneering began long before the start of the School of the Air, ten years before. Records indicate that he broadcast a course in music appreciation for adults in 1921, and the historical mural which hangs in Radio Hall pictures one of those early programs. So, let us salute "Pop" Gordon when we acknowledge our debt to early leaders in radio.

The staff of WHA has always been grateful for another kind of leadership—the supervision, policy-making, and administrative support provided by the University Radio (now Radio and Television) Committee of the faculty. For more than thirty years, beginning in 1927, the Committee was headed by Prof. H. L. Ewbank of the Speech Department, a pioneer in the development of course instruction in broadcasting and the guidance of graduate students, as well as in determining the educational role of a university radio station. We proudly acknowledge also the technical guidance and general counsel provided for many years by Edward Bennett, Professor of Electrical Engineering.

When we organized the Wisconsin School of the Air in 1931, the gods were certainly smiling. Broadcasts began on October 5, though it was barely three weeks earlier that the idea emerged and the project was officially launched. Yet, consider this lineup of programs for the first week:

Monday,	9:35 a.m.	You and Your Government—Gov. Philip F. La Follette (Direct from the State Capitol)
	2:10 p.m.	Counseling and Guidance: Three Questions of Importance to Students—Frank O. Holt, Registrar, University of Wisconsin.
Tuesday,	9:35 a.m.	Dramatization and Stories for Young Children—Miss Carrie Rasmussen, Auditorium Teacher, Longfellow School, Madison.
	2:10 p.m.	Wisconsin History: Coming of the White Man—Edgar G. Doudna, State Board of Normal School Regents.
Wednesday,	9:35 a.m.	Let's Sing—Prof. Edgar B. Gordon, U.W.
	2:10 p.m.	Art Appreciation: How Can the Study of Art Increase the Joy of Living?—Walter R. Agard, U.W. Professor of Classics and Vice President, Madison Art Association.
Thursday,	9:35 a.m.	Birds in Autumn and Winter—Prof. R. H. Denniston, U.W.
	2:10 p.m.	What Makes a House a Home?—Miss Kathryn Counsell, Home Economics Instructor, Lowell School, Madison
Friday,	9:35 a.m.	Health and Safety—Mrs. Fannie M. Steve, Director of Health Education, Madison Schools.
	2:10 p.m.	The Poetry Club—Miss Charlotte Wood, Department of English, U.W

Isn't that a remarkable array of prominent leaders and effective teachers? How lucky can a program planner be! Who could have foreseen the kind of development that was so innocently launched then? Who could have guessed that Professor Gordon was beginning a series of 24 years of weekly music lessons for Wisconsin school children? Or that Fannie Steve would go far beyond that into 1965–66, her 35th year of regular broadcasts of rhythmic activities and games for kindergarten and primary grades? (And still with a lilt in her voice and an infectious chuckle.) Who could have foretold that the beginners would soon be joined by others who would establish similar longevity records—Wakelin ("Ranger Mac") McNeel with his inspiring Monday morning nature hikes and James Schwalbach with a distinctive, award-winning series in creative art?

Chance plays an important part in such developments, as Leslie Fishel of the State Historical Society pointed out in his remarks earlier in this conference. Surely, however, one of the major highlights in the history of WHA has been a constant and dependable factor. It is the attraction the station offers and the gratification it provides for unselfish broadcasters willing to share with others their knowledge and skills.

The same spirit which has sustained the School of the Air since 1931 has been apparent also throughout the development of the College of the Air and other program features. Somehow the noncommercial, public service character of WHA seems to establish a kinship between broadcaster and listener, and bring out the best in both.

The University News and Publications Service recently issued a brochure which portrays beautifully the WHA goal of service to the state. It is entitled "The University With The State as Its Community," and it is based on a radio talk by President Harrington recorded at WHA for broadcast overseas by the Voice of America. The text explains the nature of a big, state-supported university, and the pictures illustrate some of its distinctive services. I am prejudiced, I admit, but I find it appropriate that the brochure begins and ends with pictures of broadcast activities by WHA. The front cover shows students in a fifth grade class in Black Earth listening to a School of the Air science program from WHA, and the concluding page pictures Professor Gordon directing thousands of children in the University Stock Pavilion in his final music festival when he announced his retirement from the School of the Air.

This handsome booklet, as indicated earlier, illustrates the state-wide campus responsibility of the University of Wisconsin. Perhaps a more appropriate title would be the name of a program series currently broadcast by WHA and the State Radio Network: Our Campus—the World. Surely the influence of the University is world-wide and, similarly, WHA's service area has grown far beyond the state boundaries.

Last month, for example, seemed like United Nations month at Radio Hall, as visitors singly and in groups came pouring in from seven different countries—from Tanzania, Korea, Venezuela, Egypt, and elsewhere. At the end of his five-day stay, the gentleman from Egypt said, "I wish the committee had planned my trip so I could spend the entire three months at WHA and WHA–TV. I have learned more and found more to learn here than any place in America. I am so grateful to you. Remember, when you come to Cairo, you have a brother there."

Here, it seems, is an indication of the ultimate goal of WHA and of all instruments and agencies of communication. It goes beyond the speedy dissemination of information to the cultivation of the wisdom, goodwill, and brotherhood essential to the preservation and enjoyment of life.

For the steps taken in this direction through WHA, let us salute again the planners and workers whose pioneering efforts we have recounted here.

TWO CHANGES AND A CHALLENGE IN GRADUATE EDUCATION

Karl Kroeber

My purpose today is to highlight two developments in the recent history of graduate education and to suggest the nature and significance of one special challenge which these developments pose to the humanities. I shall speak of the University of Wisconsin, but what has happened here is representative of national phenomena—and what might be done at Wisconsin could have extended significance.

Everyone knows that university enrollments are increasing, but surprisingly few have recognized how much of the increase is in the area of graduate studies. Between 1954 and 1964 undergraduate enrollment at the University of Wisconsin increased 77%. In the same period graduate enrollment increased 155%. These figures become more interesting when seen in historical perspective. Although the university is well over one hundred years old, the Graduate School has existed for only sixty years. In 1920 the total enrollment at Madison was 7500, including 570 graduate students. In 1930 total enrollment exceeded 10,000, including 1200 graduate students. In 1958 total enrollment was 16,600, including 3,400 graduate students. This year we have about 18,700 undergraduates and about 6500 graduates.

In brief, the recent increase in graduate enrollment is not an explosion, a unique event, but the becoming-apparent of a process which has been operating continuously throughout this century. For sixty years a steadily increasing proportion of our students have been college graduates. In 1920 seven-and-one-half per cent of the student population were graduates; this year more than 25% are graduates.

A more striking, and probably more significant, illustration of this pattern is the fact that our present *under*graduate enrollment is only a little more than twice what it was 35 years ago—whereas present graduate enrollment is about 5 and a half times what it was in 1930.

These figures tell only part of the story. In the first official report to the president by the Dean of the Graduate School in 1938 it was suggested that, due to expansion of knowledge and the need for increased specialization, particularly in the natural sciences, *post*-doctoral appointments ought to be encouraged. This year Dean Alberty conducted a survey, the first of its kind, to discover how many post-doctoral appointees actually are on the Madison campus—and came up with a listing of nearly 500. That's more than twice the size of the total faculty of some distinguished colleges, and it suggests that in twenty-five years there may be more post-doctoral appointees on the campus than there were graduate students twenty-five years ago.

One final set of figures and I'll have done with population. Thirty-five years ago about 15% of our graduate students worked for doctoral degrees in the humanities; today about 20% are enrolled in the humanities division. Because of this shift, enrollment pressure is stronger in the humanities than in the sciences, although there is far less money for research, and hence less for support of graduate students in the humanities.

This brings me to the second of the changes I wish to mention: the federalization of university research—a factor of significance because the education of graduate students cannot be separated from the research functions of a university.

Twenty-five years ago federal funds for research at Wisconsin amounted to 150,000 dollars. Today they amount to nineteen million dollars and support 62% of the expenditures for research on this campus. Ten years ago, to suggest the rate of acceleration involved, 31% of Wisconsin research funds, about two million dollars, came from federal sources.

It is difficult to determine precisely how these funds are distributed among the disciplines. A couple of years ago it was said that, nationally, 97% of federal funds for research supported the natural sciences, 3% the social sciences, and so small a fraction, the humanities that it could not be measured. Today I'd hazard the guess that 5% of federal funds for research go to the social sciences and possibly ½% to the humanities. But these percentages will rise rapidly—if for no other reason because of moral and political pressures exerted by the growing number of graduate students who choose non-scientific disciplines. The Office of Education has recently begun to support research in the arts and humanities and the Congress is expected to pass legislation establishing a National Humanities Foundation this spring.

The virtues and benefits of the federalization of research no longer need emphasis. And I do not intend to discuss familiar general problems associated with federalization. These of course are troubling—the problem of localized loyalty, for example. The modern scientist, it is sometimes said, owes his primary allegiance to agencies of the federal government rather than to his university, which may serve only as his base—for almost continuous travel throughout this country and abroad. In my view, it is not intrinsically better to be loyal to the University of Wisconsin than to the National Institutes of Health, but more impersonal and abstract loyalties, such as those to federal agencies, are unreliable unless built out of more personally-experienced and particularized loyalties. The moral incertitude and bewildered self-questioning of some scientists seems to originate in their lack of localized, as it were, tangible, bases for their affectional commitments. Perhaps "the best introduction to astronomy is to think of the nightly heavens as a little lot of stars belonging to one's own homestead."

Today, however, I want to tackle a less familiar subject: the challenge posed to humanists by the *fact* of increased graduate enrollments in their disciplines and the *prospect* of increased federal support for their research. Should the humanities, as they are now tending to do, model themselves on patterns established by the natural sciences, or should the humanities seize this opportunity to differentiate themselves, to set forth on a new and adventuresome course?

I believe the humanities should strike out in a new direction, that they should differentiate themselves by becoming, more creative.

So as to make my meaning as clear as possible I shall speak of the "aesthetic" humanities, the fine arts, music, literature and language studies, and exclude the less aesthetically oriented disciplines such as history and philosophy. The expression of creativity in these disciplines is more complicated since it lies above all in humanizing the social sciences, which are—or should be—the studies in which humanism and science meet, fuse, and fructify. I challenge anyone to name an outstanding work of economics, psychology, anthropology, or political science, for example, which is not in fact a synthesis of the humanistic and the scientific.

But if one confines his attention to the aesthetically-oriented disciplines of the humanities one can see quite clearly how humanistic research and teaching necessarily differ from scientific research and teaching. Research I take to be a systematic endeavor to discover knowledge and new ways of utilizing knowledge. Teaching I take to be not the mere dissemination of knowledge, though it may include that function, but a systematic endeavor to discipline and improve sensory, mental, and emotional powers. Socrates was an effective teacher, even though (like our own Dean of Education) he got into trouble by refusing accreditation; but Socrates did not disseminate information—he left that to Xantippe.

Now—while the scientific scholar's research typically is into the unexplored and the unknown, the humanistic scholar's research typically is into the forgotten. The humanist labors not on the bright edge of a new frontier but among the tangled ruins of the past. The first men to whom the designation "humanist" was applied were Renaissance students of classical antiquity, revivalists of pagan culture, scholars who unearthed what medieval societies had buried.

Humanistic research tends to grow out of teaching, whereas scientific teaching tends to follow behind research. The laboratory of an introductory chemistry course is not normally where a fine chemist develops the ideas which inspire his research—but it *is* in his introductory courses that a literary scholar is likely to find inspiration for his specialized scholarship. As for the training of mental and emotional powers, the scientist tends to discipline emotions through segregation—he teaches his students consciously to exclude sentiment from their work. The humanist teaches his students not to exclude sentiments but consciously to analyze and to evaluate them. These distinctions suffer from the fault of all generalizations, but they are valid enough to establish the point that teaching and research *and their relationship* in the sciences and the humanities differ radically.

For this reason the humanist ought to respond differently to the pressure of increased enrollments and the temptations of increased research support. An obvious problem: the scientist who receives financing for his research is taken from the classroom into the laboratory, where at the least he works *with* graduate students. The humanist whose research is financed is likely to be removed from the classroom to the library—where his chief contacts will be with desk clerks and janitors. And, more importantly, on the research side we must admit the finiteness of the past. Now that we have more books about the Civil War than there were generals in that war, now that we have more books about Shakespeare than there are characters in his plays, we must question the purpose and value of enormously expanding the number and scholarly potential of historians and literary critics.

There *is* value in intensive study of the past—but the value will decrease unless the study becomes more creative. Humanists, who are in danger of swamping themselves in endlessly refined minutiae and in cutting themselves off from classrooms where the most vigorous source of their inspiration lies, should not flinch from introducing the aesthetic, the consciously imaginative, into their own procedures of teaching and research. How this might be done I may suggest by a simplified example. If a graduate student of English literature wishes to write a doctoral dissertation *about* Goeffry Chaucer—fine. But also fine if he wishes to write a doctoral dissertation which consists principally of his creation in middle English of another Canterbury Tale—Chaucer's plan for the series being 120 tales of which he completed only a fraction. To write another Canterbury Tale judged by professional scholars to be a competent imitation would be at least as difficult as writing an essay about Chaucer and would provide as good *humanistic* training. Even more significant, the professor directing such a creative dissertation will be forced to apply his historical, philological, and aesthetic knowledge, the product of his research, to a newly challenging and vital presentation of his familiar preoccupations.

My example is simple, perhaps trivial, and, though it certainly has outraged any conservative academicians present, it probably strikes most of you as unexciting. But the principle it illustrates—that humanistic teaching and research can be effective when their *forms* are radically differentiated from the forms of scientific teaching and research—this principle is important, at least in my biassed view, because humanism is important.

Of all creatures only man inherits, through his civilization, an accumulative past which makes possible dramatic and lasting improvements in the very nature, as well as the conditions, of his existence. This unique heritage, like all surpassing gifts, carries with it special dangers—among which is the threat of becoming enamoured and then imprisoned by one's traditions. Because civilization at its best is creative, we are perpetually challenged to preserve what is good in itself and also as a guide into the future, and, simultaneously, to slough off that which may impede our development and growth. The humanist should be the professional diagnostician of our success at meeting this demand, and, therefore, he should be, implicitly or explicitly an indispensable critic of the immediate choices which constitute the evolving value-systems of contemporary life. We must live in the present, but we cannot live well, fully humanly, unless our present embodies the best of the past—without making of it an excuse for inaction, a refuge, or an obstacle to advancement.

The proper task of the humanities is to enhance our lives by fabricating out of our specially human, our civilizational, past an analog of the living continuity described by a great writer as essential to precious personal experience:

> We could never have loved the earth so well if we had had no childhood in it,—if it were not the earth where the same flowers come up again every spring that we used to gather with our tiny fingers as we sat lisping to ourselves in the grass . . . These familiar flowers, these

well-remembered bird-notes, this sky with its fitful brightness, these furrowed and grassy fields, each with a sort of personality . . . such things as these are the mother tongue of our imagination, the language that is laden with all the subtle, inextricable associations the fleeting hours of our childhood left behind them. Our delight in the sunshine on the deep-bladed grass today, might be no more than the faint perception of wearied souls, if it were not for the sunshine and the grass in the far-off years, which still live in us, and transform our perception into love.

WISCONSIN'S ENCOURAGEMENT OF THE ARTS: A SURVEY

Fannie Taylor

This paper is a survey only, by its nature leaving out much more than it includes. My hope is that the material may suggest patterns of support which the fine arts have received in the state of Wisconsin through citizens, communities, and state government, working together.

As I see it, these patterns are three. One comes through education. The University of Wisconsin, established in 1849, has long been deeply influential in all branches of creative activity.

A second pattern is the interest of the individual citizen, who is willing to commit himself with time, money and sympathy.

A third pattern is essentially a "policy" of encouragement by the state government which, often unintentionally, has created agencies whose function includes the fine arts.

Wisconsin has never had major funds for the arts and few physical facilities. We have not always spent our modest monies wisely. But over and over in our history, we find consistent interest in, and support for, music, theater, dance, plastic arts, architecture and writing, and an equally consistent reference to the University for standards, for innovations, and for organizational support. Seldom is the Wisconsin Idea so clearly developed as in this interchange between the campus and the state community, particularly in the past quarter century.

When early residents set about civilizing the wilderness it is probable that they were not consciously concerned with the fine arts, even though a piano was brought up the Mississippi river to grace the Dousman House in Prairie du Chien.

Such concern usually comes with advancing civilization and the shelter of education, and this education expanded quickly. There was a state college at Platteville in 1866, one at Whitewater in 1868, and Oshkosh, River Falls and Milwaukee all began before 1885.

But the teaching of fine arts moved slowly.

Although as early as 1867, in the old Female College in Madison, vocal and instrumental music had been taught, a chair of music at the University of Wisconsin was not created until 1880. The School of Music was established by Charles Kendall Adams in 1894, with no budget, by the way. Its staff did not go on a regular salary basis until 1907.

The bachelor of music degree program was set up during the year 1915–16. The school had always emphasized training for public school music teaching, and under Peter W. Dykema (1913–1924) this was expanded, reflecting the Wisconsin concept of practical service to the state.

President Charles R. Van Hise, in the early 20th century, often emphasized that the humanities were deficient at the University and should be supported by instruction in the history and appreciation of the fine arts, yet the department of art history was not established until 1925.

Graduate study in the theater and allied areas was approved for the Department of Speech in 1916, and the first doctorate was awarded to C. Lowell Lees in 1934.

At Beloit College, the Music Department was organized in 1891, and its art collections and curricular interest in art history date from the same period. Lawrence University has maintained a Conservatory since 1884 and opened a Music–Drama Center in 1959. At St. Norbert College in Green Bay the Music Department was started in 1937 by Rev. R. A. Sromovsky, O. Praem., who had received the first doctorate in music from the University of Wisconsin.[1]

In the last thirty-five years secondary school music has produced hundreds of school bands, orchestras and vocal groups, and the best of them compete for ratings annually which may lead to academic scholarships. The summer high school Music Clinic at the University of Wisconsin, directed by Prof. Emmett Sarig, has trained thousands of youngsters. For many years Prof. E. B. Gordon's beloved radio series, "Journeys in Musicland" originated over the state station WHA.

At the University of Wisconsin, Milwaukee campus, a School of Fine Arts embracing art, theater, music and dance was established in December, 1962, with Adolph Suppan appointed as its Dean.

In early days, other state agencies which would, by their nature, support the arts, were created. The State Historical Society was chartered in 1853 to receive its first grant of state funds and to accept private funds for endowment as well. The Society, incidentally, is the oldest in the nation to benefit from continuing grants of state moneys. Aside from its library, its collections extend to many visual displays—the Museum at Madison, and historic sites operated throughout the state. These include Villa Louis, a nineteenth century fur trader's mansion at Prairie du Chien where some of the first uses of the fine arts in daily frontier living can be observed; and museums and restorations at Greenbush, Cassville, and the Baraboo Circus World Museum. The latter certainly should be included in any discussion of the arts in Wisconsin, whether fine or popular, because the development of the circus by the Ringling Brothers of Baraboo is assuredly a splendiferous creative effort of the nineteenth century.

In March, 1870 a special act of the legislature chartered the Wisconsin Academy of Sciences, Arts and Letters, with whose objectives we are all conversant.

A state fine arts commission was created in 1951 to approve the designs, structure, composition, location and arrangement of all monuments, memorials and works of art which are to become the property of the State.[2] Works of art belonging to the University and the State Historical Society are excluded from this approval, by the way.

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[1]By 1952 the Blue Book was reporting that state colleges at Milwaukee and Superior offered special majors in art, and those at Eau Claire, Milwaukee, River Falls, and Superior had special majors in music.

[2]*Laws of Wisconsin* 1951, Chapter 450. The Commission consists of the State Architect, the Director of the Milwaukee Art Institute, a member of the art faculty of the University of Wisconsin, a member of the Board of Curators of the State Historical Society, and a citizen of the state of recognized standing in the field of fine arts, architecture or landscape architecture, appointed by the Governor.

For the Wisconsin Centennial in 1948–49 a sub-committee on Music, Drama and Art was appointed, with Mrs. Ronald A. Dougan of Beloit as general chairman.[3]

In October 1963, Governor John Reynolds established the first Governor's Council on the Arts. The Council made the first state awards for contributions in the arts on October 9, 1964 at a dinner in the Governor's Mansion.[4]

Subsequently Governor Warren P. Knowles reorganized his office's support of the arts by appointing "public members" to the Wisconsin Arts Foundation and Council. The latter organization, which grew out of the University Agriculture and Extension Department in 1937, has as its intention the coordination of arts organizations in the state.

As we search the records, we find a repeated pattern in Wisconsin of self-perpetuating growth, a citizen's responsibility, in which individuals according to their means, have contributed to a sympathetic climate in which the fine arts have been able to grow.

A prime example, of course, is the individual membership program in the Wisconsin Union. This system helps support many academically related extra-curricular fine arts events held in the Memorial Union building. Union membership is the prerogative of all students on the Madison campus and extends to about 37,000 alumni and friends of the University. The State Historical Society also operates as a public membership organization. In the 1964 annual report its Director Leslie Fishel, Jr., commented that while state funds had gone up 35% in six years, private funds, gained through admissions, sales and services, had gone up 65%, proof of individual citizen interest.[5]

Special non-state funds, administered by state officials but not from the state treasury, have occasionally come to the rescue of the arts at the University. Notable examples have been the assistance given the Old Masters' Show displayed in the Wisconsin Union Gallery in 1948, presentation of "Twelfth Night" and "Hamlet" by the Old Vic Theatre in 1958, and the funds which will be forthcoming next fall for the presentation of three performances by the Metropolitan Opera Touring Company at the Union Theater.

The citizen's responsibility in encouraging the fine arts is reflected in the activities of the Johnson family of Racine. In 1937, H. F. Johnson established a trust, which in 1958 was broadened by the family decision to convert its home, Wingspread, into an educational conference center. Wingspread is one of the last of the "prairie houses" designed by Frank Lloyd Wright and

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[3]*Wisconsin Blue Book*, 1950, pp. 146–153.

[4]*The Wisconsin State Journal*, Oct. 10, 1964, lists the following: Recipients were: Robert von Neumann, Milwaukee painter who has taught for more than 50 years at the University, Milwaukee, and its predecessor, Milwaukee State College; Margaret H'Doubler, Sister Bay, who developed revolutionary ideas in the science and theory of dance while teaching at the University of Wis.; Father John Walsh, Marquette University, who has incorporated original and creative adaptations and style to the classic as well as contemporary drama; Mrs. Harry Lynde Bradley, River Falls, for her contributions to the Milwaukee Art Center, Milwaukee Symphony Orchestra and the Milwaukee Repertory Theatre; The University of Wisconsin's Union Theater, which, at its 25th anniversary, had gained a national reputation for consistent excellence and diversity in programming in the arts; the University of Wisconsin–Milwaukee, for its summer arts festival; the Wisconsin Painters and Sculptors, for its 50th anniversary and its impressive contribution to the development of the arts and the cultural life of the state; the Peninsula Music Festival, for giving Door County a music festival worthy of national recognition for 12 years; the late Frank Lloyd Wright, father of organic architecture, posthumous award; Edward Steichen, photographer; illustrator-satirist Robert Osborn; writers Thornton Wilder and Edna Ferber; and actors Alferd Lunt and Lynn Fontanne.

[5]Director's Report, 1963–64, *Wisconsin Magazine of History*, Vol. 48, No. 1 (1964) p. 78.

is uniquely suited to the kind of program dreamed of by the Johnson Foundation trustees, with its "concern for the individual's creative abilities, for his constant growth in mind and spirit."[6]

A Wingspread conference having far-reaching impact was the May 1964 Conference on the Arts. A special issue of the University of Wisconsin journal "Arts in Society" was devoted to the proceedings.[7]

Another family willing to support the arts have been the Brittinghams, whose gifts of major private funds have had important results. Through monies from the Brittingham Foundation the concept of the artist-in-residence was pioneered at the University's Madison campus. Brittingham funds established John Steuart Curry, the painter, in 1936, and the State Emergency Board, in the heart of the depression of the 30's, found funds to build him a one-room studio on the Ag Campus.[8]

Both Gunnar Johansen, pianist, who came in the late 30's to the campus and the Pro Arte Quartet, in 1940, were originally financed by the Brittingham Estate.[9]

There are many other examples of contribution to the community by individual citizens. In the late nineteenth century civic benevolences and free enterprise, frequently in tandem, built many theaters. In 1893 Capt. Frederick Pabst put up the Pabst Theatre in Milwaukee to replace the fire-destroyed Stadt Theater, inheritor of a 45-year tradition of excellent German productions. In Madison, M. E. Fuller and his brother, aided by one hundred and forty subscribers who underwrote a building fund, erected the Fuller Opera House in 1890, right next to the old City Hall on the capitol square.

The period home in Oshkosh of Mr. and Mrs. Nathan Paine, built in the 1920's, became the Paine Art Center and Arboretum in 1947, privately endowed for public use.

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[6]*The Johnson Foundation,* A Program Report, p. 5.

[7]*Arts in Society,* Vol. 2, No. 2, Edward L. Kamarck, Editor, University of Wisconsin Extention Division.

[8]*Handwritten memorandum* in University of Wisconsin News Service Files for J. S. Curry: Madison, August 15, 1936—The appointment of John Steuart Curry as "artist-in-resident" at the University of Wisconsin, announced by President Glenn Frank today, sets going at the University a new movement which civic, educational, and art leaders believe will exert a far-reaching influence in the cultural life of the state. The terms of this appointment are unique, in that, while Mr. Curry's appointment is a general university appointment, and he is to have contact with all phases of the University's life, he will sustain a special relation to the work of the College of Agriculture with the rural youth of Wisconsin. Curry, along with Grant Wood and Thomas Hart Benton, is distinctive in the degree to which his art draws its strength from the very soil of America.

In launching this new educational venture, we are undertaking to give added impetus to regional art as a force for rural, as well as urban, culture in this Middle West area.

The funds to finance this development have been provided by a grant from the U. of W. Trust of the Brittingham Estate. The Emergency Board made available funds for the building of a simple one-room studio on the campus.

[9]Professor Gunnar Johansen first performed at the University of Wisconsin under a grant from the Elizabeth Sprague Coolidge funds. He was established as a lecturer in the School of Music in 1938 with Brittingham funds.

The Pro Arte Quartet, with a grant from the Elizabeth Sprague Coolidge Foundation in the Library of Congress, played all the Beethoven Quartets at the 1940 Spring Festival in the Wisconsin Union Theater. They were stranded in this country by the Nazi invasion of Belgium. Four leading alumni raised funds to retain the group on the campus. They were Thomas E. Brittingham, Jr., investment counselor; Joseph E. Davies, lawyer and ambassador to the Soviet Union; George I. Haight, Chicago attorney; Frank Sensenbrenner, president of the U. W. Regents.

In Menomonie, lumberman Capt. Andrew Tainter, erected an imposing Romanesque structure out of the Dunville sandstone of the area, and in 1890 made the town a gift of a $125,000 "community center" as a memorial to his daughter, Mabel. The building included space for the library, city hall, recreation facilities, and a 500-seat theater which present-day residents are trying to restore as a charming memento of the gay nineties.[10]

The theater has always interested Wisconsin residents, and the Wisconsin Dramatic Society, founded by Prof. Thomas H. Dickinson in 1910 in Madison, is thought to have been the first "little theater group" in America.[11] Its Milwaukee branch, directed by Mrs. Laura Sherry, functioned into the 30's. The oldest summer theater in the state is the Belfry Players at Williams Bay, which started in 1932 as a dramatic club and utilizes an old Mormon church for its auditorium. Dozens of other summer groups, some privately sponsored, others municipally conducted, flourish or have flourished. Among them are the Port Washington Players, the Peninsula Players in Door County, the Court Theatre at Beloit College, the Green Ram at Baraboo. One of the most popular summer undertakings is the annual William Tell Festival, produced at New Glarus by descendants of the Swiss settlers there.

At the University the most vigorous, long-term student theater ventures reflect generational impulses twenty-three or four years apart. In 1899 the Haresfoot Club was established. It presented original musicals, written and acted by students, and using an all-male cast so that it could go "on the road" without the attendant difficulties of chaperoning young ladies. Haresfoot lasted into recent times, surviving wars and depressions, and finally dying in 1963 of old age and insolvency. The Wisconsin Players, stage production arm of the Department of Speech, was created in 1922, largely through the influence of one of the university's most able faculty members, the late Gertrude E. Johnson, professor of speech. She brought three struggling student organizations together into one viable organization, the Wisconsin Players, today one of the distinguished campus drama activities of the United States. Mention of several faculty members of the Speech Department who have had a long influence on state drama should be made: Prof. Fredrick A. Buerki, whose technical knowledge of the theater has been carried by his students from one end of the country to the other; Prof. Ronald E. Mitchell, playwright and director; Prof. Jonathan W. Curvin, director; and Prof. John E. Dietrich, generally credited with setting up the financial structure under which the Wisconsin Players has operated so successfully that nearly 50,000 people annually attend their productions.

Still another college generation produced a student variety show, "Humorology", started in 1946 and vigorously supported by its campus adherents. Since about 1935 student actors also have performed at WHA in a variety of radio and television productions for the state station.

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[10]Earl Chapin, "A Gay 90's Gem Comes Back to Life," *St. Paul Pioneer Press*, March 15, 1964.

[11]The William F. Vilas will (1905) provides for scholarships, fellowships, professorships in music, prizes, contributions to periodic music festivals, construction of a theater and other aids to the campus at Madison.

Henry C. Youngerman, in his history of Madison's Theaters states that "The course of Madison's theatrical activities so closely parallels the growth of the city as to mark clearly its place in the city's culture."[12]

But the problems of production in the City of Madison have always been troublesome. Early activities took place under conditions that were a severe test of the community's enthusiasm. Not until Hooley's Opera House was built in 1871, with a cellar furnace and three gas chandeliers, did theater activities find an adequate home. Here, Madison's first theater group, the Madison Dramatic Society, presented Tennyson's drama "Dora" to an audience of 700 patrons who paid $400 for the privilege. Some years later, in 1877, we find an amateur benefit performance being given to cover the cost of new seats, which were to be designed as single chairs, with turn-up seats and arms, copied after those used in that model of new architecture, Science Hall on the campus.

The University itself was long in getting adequate stage facilities. A small, makeshift stage in Ladies' Chapel was used in 1877 to present the first campus show, with Robert M. LaFollette, Sr. in the cast.[13] In 1879 Library Hall (now Music Hall) opened and solved temporarily, at least, the problem of a place to congregate. In later years, a room in Bascom was remodeled to house the "Bascom Theatre" where the Wisconsin Players were launched. Not until 1939, with the opening of the Wisconsin Union Theater, did the Wisconsin Players productions and other campus activities come into appropriate facilities and essentially their "modern" history. Alfred Lunt and Lynn Fontanne, Wisconsin's famous acting couple, performed "The Taming of the Shrew" for this gala opening which brought celebrities from all over the world.

In 1945 the Wisconsin Idea Theatre was founded by Prof. Robert A. Gard under the sheltering umbrella of the University's Extension Division.[14] Its purpose was, and is, to stimulate cultural work throughout the state, particularly in theater arts and in writing. A corollary operation has been the Wisconsin Idea Theatre Conference, which reaches its 21st birthday this spring.

Antecedent to the Wisconsin Idea Theatre were the Bureau of Instruction by Lecture, established in 1909 and the Bureau of Community Music founded in 1913. In 1916 these were combined into the Bureau of Community Music and Drama and Prof. Edgar B. Gordon, as their director, began a career that spanned five decades of selfless devotion to the arts.

Many community theaters have functioned successfully for years. Green Bay's group, for example, is in its 29th season. For a period of the 1950's the Fred Miller in Milwaukee was gaining national attention for its theater-in-the-round productions.

Another important educational theater element in the state is represented by activities at the Roman Catholic institutions. Father John Walsh at Marquette University is known as a distinguished director. Sister Marie Aileen at

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[12]Red Domino, founded in 1899; Edwin Booth, founded in 1902; Twelfth Night, founded in 1912 Henry C. Youngerman, "Theater Buildings in Madison, Wisconsin 1836–1900," *Wisconsin Magazine of History*, Vol. 30, No. 3, March, 1947.

[13]"Ici On Parle Francais."

[14]Robert E. Gard, *Grassroots Theatre, Madison*, 1955.

Edgewood College of the Sacred Heart at Madison was Helen Hayes' teacher. St. Norbert's College in Green Bay and both Cardinal Stritch and Alverno Colleges in Milwaukee maintain vigorous programs in all the arts.

Dance, as an art form, was late blooming in the state, and received its greatest impetus through the work of Prof. Margaret N. H'Doubler, who taught a new theory of movement in the department of physical education for women. She also organized the first Orchesis group, of which there are today hundreds of chapters in colleges and high schools all over the country, and with the aid of Prof. Blanche M. Trilling, director of the department, succeeded in establishing a major in dance for her students, the first in the country.

Recently, in 1961, the Wisconsin Ballet Company, with headquarters in Madison, and strong support in Sheboygan, has been organized with Tibor Zana as its artistic director.

Differing aspects of the story of the plastic arts in Wisconsin have been well and fully told in two volumes. One is "Art in Wisconsin" by Porter Butts, published in 1936; the other "Rural Artists of Wisconsin" by John Rector Barton, published in 1948.

Prof. Butts' book was described in the preface written by Prof. Oskar F. L. Hagen, first chairman of the department of art history at the University, as "the first scholarly study of the origin and development of art in our State and being the first publication by a graduate of the Department of Art History . . ., it is in itself a fruit of that development."[15]

In connection with the State Historical Society, in 1854, Lyman C. Draper established a museum and with it a modest art gallery. In 1888 the Layton Art Gallery, gift of Frederick Layton, was opened in Milwaukee with an endowment of $100,000. In 1920 the Layton School of Art was organized as a professional training school. There are other museums serving the state such as the Theodore Lyman Wright Art Hall at Beloit College, and institutions at Fond du Lac, Green Bay, Oshkosh and elsewhere.

By the early 20th century the art impulse in Milwaukee was sturdily growing. In 1901 the Society of Milwaukee Artists was organized, followed by the Milwaukee Art Institute in 1910. The Wisconsin Painters and Sculptors, of which the painter Gustave Moeller was the secretary and dominant force for years, annually holds an April exhibition at the Milwaukee Art Institute. During the depression years of the thirties, the Milwaukee Works Project Administration put out a vigorously creative product. Many of the distinguished artists of today, such as the late Prof. Alfred Sessler, Prof. Santos Zingale, Schomer Lichtner, and others, worked in this program.

In 1929, the building of the Memorial Union at the University opened another art gallery, and with it a vigorous art program which sponsors the annual Wisconsin Salon of Art, now in its 30th season. It also presents an annual Student Art Show in the spring, as well as a diverse gallery program, some of it in cooperation with the Madison Art Association—one of the state's most effective civic art groups.

The rural arts program, described by Prof. Barton in his "Rural Artists of Wisconsin" can be counted as one of the glories of the state's encouragement of the arts. Barton's book was a University Centennial publication and

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[15]Porter Butts, *Art in Wisconsin,* preface, v.

was dedicated to the memory of John Steuart Curry ". . . a fragmentary but convincing record of the vital influence of a great artist, a shy and unassuming man who inspired in everyday people the desire to create something true and beautiful."[16]

Curry, painter-in-residence at the time of his death in 1946, was followed by Aaron Bohrod, who is still in the post. This painter-in-residence program has been a function of the College of Agriculture Extension Department which annually encourages more than a thousand Wisconsin residents to participate in rural art activity, and sponsors a state show and numerous regional shows.[17] Implicit in the rural art growth, too, has been the work of Prof. James A. Schwalbach, who in 1945 started the program "Let's Draw" for school children over the WHA School of the Air, and began the annual Junior Exhibit.

The restoration begun in the mid-thirties at Mineral Point of Cornish miners' old houses was early evidence of growing art interests in the southwestern part of the state.[18]

Culmination of much of the impulse toward the encouragement and display of the visual arts is presently before us in the great undertaking to build the Elvehjem Art Center, a $3,300,000 tribute to the late University president Conrad E. Elvehjem.[19] The University of Wisconsin Foundation has undertaken the drive to obtain support from other than state funds for the construction, and one of the key figures in this work has been James S. Watrous, painter and professor of art history at the university, whose murals and mosaics adorn many public and private buildings in the state. The first seed money incidentally toward the construction of the Art Center came as a one-million dollar gift from Brittingham Trust Funds in May 1962.

At Taliesin, near Spring Green, one can still see a little wooden windmill designed by Frank Lloyd Wright in 1896 for his aunts who operated the Hillside School for Boys and Girls. And on the hillside, like outcroppings of warm brown limestone and sandstone are the buildings Wright created in subsequent years for his own home and school. Wisconsin is known around the world for its one "authentic giant".[20] His reputation as philosopher-innovator brought him international honors of all kinds, but his own country gave him little recognition until very late in the career which carried him 90 years, from Richland Center in 1869 to Phoenix, Arizona in 1959. He was finally awarded the highest honor—the Gold Medal—of the American Institute of Architects in 1949, and the University of Wisconsin granted him the honor-

[16]John Rector Barton, *Rural Artists of Wisconsin*, dedication, Madison, 1948.

[17]The idea of such a state-wide exhibition originated with Curry and Dean Chris L. Christensen of the College of Agriculture when they were attending an American Country Life Conference at Pennsylvania State College in 1939. The first show was held in the Memorial Union at Madison, with the Rural Art Committee and the students of the Wisconsin Union Gallery Committee as the sponsors. Thirty people from 17 counties entered. By 1947, 105 people were seeking entry with works in all media.

[18]"*Mineral Point, The Cornish Pendarvis*" by Charlotte Knechtges, Vol. 5, No. 1 (1964).

[19]Elvehjem Art Center Plans Approved, *Wisconsin Alumnus*, November, 1964, p. 4.

[20]James Marston Fitch "A Tribute—Frank Lloyd Wright 1869–1959," *Architectural Forum*, May, 1959, p. 109.

ary degree of Doctor of Fine Arts in 1955. The state contains about forty examples of his work: schools, churches, the Johnson Wax administration building at Racine, and a number of homes.[21]

In his Wisconsin history William F. Raney comments that most of the incoming American and European pioneers were literate, thinking people "who needed newspapers and books," and this need took immediate expression in the establishment of the Green Bay Intelligencer in 1833. About one hundred newspapers were started in the state before 1850 but the mortality was high. In spite of this tradition Wisconsin has not had a large proportion of writers, although many excellent works have been published, and a number of Pulitzer prizes won. They went to Zona Gale in 1921 for "Miss Lulu Bett,"; to Hamlin Garlin in 1922 for "A Daughter of the Middle Border"; to Edna Ferber in 1925 for "So Big"; to Thornton Wilder in 1928, 1938 and 1943; to Marjorie Kinnan Rawlings for "The Yearling" 1939.[22]

Other influential Wisconsin writers who should be mentioned are the naturalist John Muir, Sterling North, Glenway Wescott, Helen C. White, and August Derleth.

In 1948 the Wisconsin Regional Writers Association was established and now has 33 groups. It sponsors, in cooperation with the extension service of the College of Agriculture, a two-week workshop for professional writers at Rhinelander.

A new Council for Wisconsin Writers was founded in the spring of 1963 as a working group of citizens whose purpose it is to obtain financial aid for the state's resident writers. Its first award of $1000 went to Chad Walsh, Beloit College poet.

Perhaps the most widespread involvement in the arts by the state and its people is found in music. Milwaukee's history abounds with community choruses and famous groups like the Arion Club, and the city's first such organization was the Milwaukee Musical Society.[23]

The Milwaukee County Park Commission began its popular "Music Under the Stars" program in 1938. Today the city is involved in two all-out campaigns: the first to build up the Milwaukee Symphony Orchestra, which was organized in 1959 and currently presents series at the Pabst Theatre and the Milwaukee Auditorium; the second to erect a Music Hall–Theater Center for the Performing Arts. The neighboring community, Waukesha, has had a community orchestra for 17 years, led by Milton Weber.[24]

Green Bay and La Crosse also maintain civic orchestras.

In Madison, while the community has sponsored many musical activities, and groups like the Madison Sinfonia conducted by Marie Endres have long held a top place in the local affection, much of the musical life has necessarily centered around the University. It will probably continue to do so at least until the community is able to resolve its long debate over the site and archi-

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[21]Richard W. E. Perrin, "Frank Lloyd Wright in Wisconsin: Prophet in His Own Country," *Wisconsin Magazine of History,* Vol. 48, No. 1, 1964.

[22]Jerry Bock, part of the team that wrote "Fiorello," shared the prize for the musical show in 1960.

[23]Musikverein (1850).

[24]"Waukesha's Amazing Austrian," Jo Curtis Dugan, *Wisconsin Tales and Trails,* Vol. 5, No. 4 (1964), p. 12.

tect for its Arts Center, although the Madison Civic Music Association, with the musical guidance of the Symphony conductor Roland Johnson and his wife, is creating a vigorous orchestra and opera program for the city, to which members of the University Music faculty have contributed their talent and interest. Earlier conductors were Sigfried Prager and Walter Heermann.

At the Madison campus, and with occasional state tours, the University of Wisconsin Band, directed by Prof. Raymond F. Dvorak, and the University Symphony Orchestra, directed by Prof. Richard C. Church, have performed important service in music education. The Band was first organized as a military band of 11 men in 1885. Recently Prof. Karlos Moser established the University Opera Workshop and began a new kind of integrated program.

For decades the music, theater and dance programs of the Wisconsin Union have strongly supported these departments at the University with both student and professional presentations, although the program has taken on its present breadth since the 1939 opening of the Union Theater with the steady encouragement of the Union director, Professor Porter Butts.[25]

Keystone to the music program is the Wisconsin Union Concert Series, which has just concluded its 45th season. Numerous other artists and attractions have been offered by the Union over the years as well, including orchestras, ballet and contemporary dance, operas, and theater attractions, often brought to Madison for their only Wisconsin engagement. The University student has had a prime opportunity, while in school, to view the musical giants of his time.[26]

One of the state's most consistent musical visitors has been the Minneapolis Symphony Orchestra, first heard in La Crosse in 1910.[27] Its circuit in the following years through an array of Wisconsin towns indicates the hunger existing for professional music more than 50 years ago.

Such hunger manifested itself in Door County when the Peninsula Arts Association was chartered in 1939 and began to build its large related arts program. By 1953 the Association was able to sponsor the first Peninsula Music Festival, with Mrs. Carl T. Wilson starting her long leadership.[28] Dr. Thor Johnson became musical director of the chamber orchestra which performs each summer at the Gibraltar High School Auditorium at Fish Creek, introduces young artists, and presents awards from the National Federation of Music Clubs.

There are other festivals, differently organized, but all encouraging the fine arts. Madison's Edgewood College holds a spring arts festival with dance, films, discussion, plastic arts and music. Beloit College recently focused on baroque music. The University at Milwaukee presented a wide-ranging Beethoven Festival, and conducts its summer arts program with the Fine Arts

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[25] "The Story of the Wisconsin Union Theater," Madison 1949. A U. of W. Centennial publication.

[26] Complete listings of all productions at the Theater and Play Circle are available in the Wisconsin Union Theater files.

[27] John K. Sherman, *Music and Maestros*, Minneapolis, 1952, p. 315

[28] "The program booklets which are issued for each season contain a set of program notes which have been written by an eminent musicologist. For the past 3 years they have been written by Heuwell Tircuit, music critic of Tokyo, Japan. These booklets for their own value, have come to be in great demand from other musical organizations as well as public and musical libraries." Letter from Mrs. Carl T. Wilson to author, April 1, 1965.

Quartet in residence as a festival. The Wisconsin Union festivals of recent seasons, on the Madison campus, have tended to concentrate themselves on a particular area or theme. The Far Eastern Festival of 1963 made use of the advice of the University's Asian Theatre expert, Professor A. C. Scott. In many ways the fine arts festival has become a very useful tool in our society, a peculiarly twentieth century device for segmenting and organizing a corner of the vast riches available to us.

Another such method of arts organization is the fine arts and recreational calendar, of which Wisconsin has several.[29]

These, then, are some of the patterns into which encouragement of the arts falls in our state: leadership by the University of Wisconsin, the State Universities, and other public and private educational institutions; personal commitment by our citizens; government approval implicit in state and municipal agencies.

As might be expected, the most forceful encouragement of the arts seems to be found at the Madison campus of the University, in part because it has had long established administration. But the arts never florish without an audience. There must be some person or group to receive the message, and there is an ever-growing receptivity of this kind throughout the state. The newspapers report increased attendance, need for larger auditoriums, sales of original art work, striking awards for writing, painting, and other creative activity. Through its public agencies, Wisconsin has indeed fostered the arts, and also made possible the development of an audience. Now, today, we are beginning to reap results.

I would like to suggest that in a state where we encourage vacationing visitors, and the resort business is one of our chief commodities, that the continuing development of the arts, for both their esthetic and recreational potential, may have an important influence on our economy.

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[29]The Wisconsin Union Quarterly calendar has been issued for decades, cataloguing activities. The Conservation Department began a Calendar of Events in 1959 which has become a definitive record of leisure time activity in the state. The Wisconsin Arts Foundation and Council publishes a quarterly arts guide. *Wisconsin Tales and Trails* puts out a three-month survey. There are many others at the various educational centers and in communities.

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ALLIS–CHALMERS: A REPRESENTATIVE WISCONSIN INDUSTRY

Walter F. Peterson

Nearly half the early American settlers in Wisconsin were from New York state. Among these were the Kimberly brothers, John and Harvey, who, along with Charles B. Clark found the Fox River valley congenial. Jerome Increase Case had settled on Racine as his home by 1844. Even German immigrants such as Guido Pfister and Frederick Vogel moved to Milwaukee after working in Buffalo, New York. Edward Phelps Allis was obviously in the main stream of migration when he arrived in Milwaukee during the spring of 1846 from Cazenovia, New York.[1]

For all these men, and many more, Wisconsin was another name for opportunity, a word defined in *Webster's Collegiate Dictionary* as "a favorable juncture of circumstances." Wisconsin was just that. Raw materials existed in profusion and in happy combination. On the eve of the Civil War Wisconsin's soil was offering not only an ever greater amount of wheat for milling but food in abundance for the working man which would provide a basis for the highest standard of living in history. The state's ample forests provided lumber of all types for all purposes. The mines of northern Wisconsin and upper Michigan yielded the metals so necessary for an emerging industrial society. Numerous excellent streams then meant abundant power. While the state had no coal, the growing network of railroads brought ample supplies from nearby Illinois and lake boats involved in the grain trade with the East brought back even greater supplies of coal more cheaply from Pennsylvania and Ohio.[2]

Milwaukee was a growing city of about 10,000 souls when Allis, along with a Union College classmate, William Allen, established a leather shop. His expanding business gave him valuable experience in the management of materials, men and capital. His abilities rapidly gained for him the recognition of the business community and soon he was serving in executive capacities on the boards of insurance companies, banks and railroads.[3]

Through contacts and observation Allis could see the opportunities for manufacturing in the booming Midwest. He also noted that Milwaukee of all cities in Wisconsin was destined to be the state's manufacturing capitol. Her commanding position on Lake Michigan was complemented by her excellent communications with the interior. Not only Milwaukee but the state and the region were growing in population to provide an ever expanding market. By 1870 the population of Wisconsin was more than 1,000,000 and the in-

[1]William Francis Raney, *Wisconsin: A Story of Progress* (Appleton, 1963), p. 217. Bayrd Still, *Milwaukee: The History of a City* (Madison, 1948), pp. 71–72. *Four Men and a Machine* (Appleton, 1947), pp. 4–5. *Dictionary of Wisconsin Biography* (Madison, 1960), p. 206, 77, 70, 286, 362, 9.

[2]*Webster's Collegiate Dictionary* (Springfield, 1941), p. 695. Frederick Merk, *Economic History of Wisconsin During the Civil War Decade* (Madison, 1916), pp. 123–124.

[3]*Milwaukee Sentinel*, December 2, 1845; April 2, 1889. John G. Gregory, *History of Milwaukee Wisconsin* (Chicago, 1931) I, 550–551.

creasing numbers in Iowa, Minnesota and the Dakotas supported the rapidly developing potential.[4]

Opportunity presented itself in a variety of forms. Pfister and Vogel have always been connected with leather just as the names of Kimberly and Clark have been associated with paper. But Captain Frederick Pabst left the lakes for brewing and the Falk family sold their brewing business to become iron founders. Edward Allis felt that opportunity in his case rested in manufacturing rather than leather. When the Reliance Works, established by Decker and Seville in 1847, came on the market in 1861, Allis bought it and launched himself and Milwaukee into a new era in history. Moving to a larger site in 1867 so that he could greatly expand his operation, he started building a plant that, at the time of his death in 1889, covered 20 acres and employed 1,500 men. In fact, the annual business of E. P. Allis and Company at that time amounted to three million dollars—half of the product of all the machinery plants in Milwaukee.[5]

What was the key to the success of E. P. Allis? The American Society of Civil Engineering which invited Allis to become a Fellow in 1883, made this appraisal of his successful business technique. "Mr. Allis was not an engineer, not an inventor, not a mechanic, but he had in full measure that rare talent for bringing together the work of the engineer, the inventor, the mechanic, that it might come to full fruition, and the world at large be the gainer thereby." Allis brought together the engineering talent and provided the financial support to secure the constant expansion of his works. It was up to his engineers to provide the excellence in product and efficiency in production that would result in profits.[6]

Allis began to use this business technique successfully in 1873 when W. D. Hinkley, an outstanding man in the field of saw milling, came to the Allis Company to head the Saw Mill Department. Hinkley revolutionized saw milling by perfecting the band mill. The thin band not only reduced waste but also cut more logs. The fact that Hinkley, colorful and eloquently profane, increased sales of his department from a few thousand dollars in 1873 to over $400,000 by 1889 clearly indicates the value of a superior product. This success was in response to the opportunity presented by Wisconsin as the center of the lumber industry during the period 1865–1890. During those years Michigan and Wisconsin accounted for nearly 30 per cent of the national production.[7]

From the days of Decker and Seville the Reliance Works had been known for the excellence of its flour mills and that department had been the

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[4]Merk, pp. 126–127.

[5]Thomas C. Cochran, *The Pabst Brewing Company* (New York, 1948), pp. 53–69 *passim*. *Dictionary of Wisconsin Biography*, p. 126. *Sentinel*, May 21, 1861. James Seville, "Milwaukee's First Railway," *Early Milwaukee: Papers from the Archives of the Old Settlers' Club of Milwaukee County (Milwaukee*, 1916), p. 92. *Sentinel*, February 1, 1866; August 17, 1866; December 7, 1866. Letter from Henry Riemenschneider to Louis Allis, October 9, 1903, Louis Allis Scrapbook, II. *Sentinel*, April 2, 1889.

[6]*Proceedings of American Society of Civil Engineers*, 1889, Louis Allis Scrapbook, I. This technique was also recognized in Milwaukee at the time of the death of E. P. Allis for an observer stated in the *Sentinel*, January 2, 1889, "It has been Mr. Allis' policy to secure the assistance of the best specialists in the different lines of machinery manufacture, and thus turn out the best machinery made, to which is due in a large measure his great success."

[7]Allis–Chalmers Company, *Sales Bulletin*, December, 1905, p. 1. *American Lumberman*, December 23, 1905, p. 1.

primary one in the company. Allis again applied his basic principle for success. He found the best possible man in William D. Gray. Given a free hand, Gray perfected the modern roller mill, thus relegating mill stones to historical museums. The introduction of the roller mill wreested the milling crown from Budapest in Europe and St. Louis in the United States and gave it to Minneapolis which drew on the great wheat fields of the American Northwest. The Allis Company was thus responsible for an agricultural as well as a technological revolution. For nearly a century the Allis Company and later Allis-Chalmers were the primary manufacturers of flour milling equipment in the United States.[8]

In 1877, Allis rounded out his staff of brilliant engineers by securing the greatest genius of them all, Edwin Reynolds. Around the top of the engineering building at the University of Wisconsin in Madison are carved the names of the great engineers in history, but only one was so honored during his lifetime and that was Edwin Reynolds. The strength of the United States in large part has been based on power, and power in the late 19th century meant the giant steam engine with its enormous flywheel Edwin Reynolds' contribution to the 19th century was the perfection of the steam engines that the company was prepared to take in payment the amount of money saved during the first year of operation When the Columbian Exposition opened in Chicago, the Allis Works had the distinction of supplying the machine most representative of American engineering progress. Known as "The Pride of Machinery Hall," this steam engine was not only the mechanical showpiece of the Exposition, but also became the source of electrical power for the entire fair when President Grover Cleveland pulled the switch on the 3,000 horsepower, 325 ton monster. The thousands of steam engines sold around the world by the turn of the century did as much as beer to spread the fame of Milwaukee, Wisconsin.[9]

In 1883 the largest employer in Milwaukee sponsored the formation of the Allis Mutual Aid Society, an example soon followed by other Milwaukee companies such as Filer and Stowell. Allis, who twice ran for the governorship on the Greenback ticket, thus cast himself in the forefront of benevolent employers. He matched annual membership fees and provided rooms for society meetings. By the time of his death the facilities of the society included a dining room, reading room, and a social hall besides being primarily concerned with the health and safety of the men. In the spring of 1900 the *Milwaukee Journal* claimed that the Edward P. Allis Company "probably keeps in closer relationship with the employees than any other establishment in the country."[10]

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[8]W. D. Gray, "A Quarter Century of Milling," *The Weekly Northwestern Miller*, Part VII, December 6, 1899, p. 1092. This is a portion of Gray's twenty-part account. Merk, pp. 136–137. John Storck and Walter Dorwin Teague, *Flour for Man's Bread: a History of Milling* (Minneapolis, 1952). pp. 161–199.

[9]Allis–Chalmers Company, *Sales Bulletin*, April, 1909, p. 42. *Industrial Progress*, April, 1909, p. 228. Robert H. Thurston, *A History of the Growth of the Steam–Engine* (Ithaca, 1939), pp. 501–503. *Transactions*, American Society of Mechanical Engineers, vol. 31, 1909, 1052. It says something about Reynolds and also about Allis that the engineer was willing to leave his position with the Corliss Works and a salary of $5,000 a year to come to Milwaukee for less money, the only consideration being that he could have a free hand and financial support to build anything he wished.

[10]*Sentinel*, July 21, 22, 23, 1883; April 2, 1887; March 13, April 10, 1888. *Milwaukee Journal*, March 31, 1900. Gregory, IV, 146–149.

At the turn of the century Milwaukee was a mirror for the national scene as the United States emerged as the greatest manufacturing nation in the world. The stock companies of the seventies had vastly increased their capitalization in the nineties and merged into ever larger units around 1900. Consolidations brought the old Bay View Works into the United States Steel Corporation in 1901; the Milwaukee Harvester Company joined with four other firms in 1902 to form the International Harvester Company, and others such as the Bucyrus Company followed suit. The banner year was 1901 when forty-seven industrial combinations were formed, each having a capital of $1,000,000 or more. The Allis–Chalmers Company was one of these and played its part in one of the major changes in history resulting from the rise of the large business corporation.[11]

The Allis–Chalmers Company was the result of the merger of four industrial firms, each nationally prominent for its own products. The Fraser and Chalmers Company of Chicago was known throughout the world for its mining machinery and had equipped many of the South African gold mines as well as the Homestake Mining Company and the Anaconda Copper Company in the United States. The Gates Iron Works, also of Chicago, was justly famous for its line of crushers and cement-making machinery. The Dickson Manufacturing Company of Scranton, Pennsylvania, brought several lines of heavy machinery into the merger. The fact that currently Allis–Chalmers is one of the prominent manufacturers of crushing and mining machinery and is the primary manufacturer of cement-making equipment can be traced back to the merger of 1901.[12]

The merger also made possible the fulfillment of a dream that had matured in the fertile mind of Edwin Reyonlds—a great, new, scientifically designed plant. At that time most manufacturing plants, the Reliance Works not excepted, had been built in a haphazard manner, with a new building here and an addition there as the pressure of increased business dictated. Reynolds' conception of the ideal, the truly modern and efficient plant was one where all raw materials came in one end, moved through the fabricating shops and came out the other as a finished product ready for shipment. This dream came to fruition in the West Allis Works—a plant that revolutionized the process of manufacturing heavy machinery. This plant, which for many years was used as a model for designing other plants throughout the nation, was built to utilize the services of 10,000 men and became the home office for an industrial complex which was ultimately to girdle the globe with its plants and products.[13]

Recognizing that the new century needed new sources of power to supply the demands of an age of electricity, Allis–Chalmers purchased the Bullock Manufacturing Company located at Norwood, Ohio. This company which had

[11]John Moody, *The Truth About the Trusts* (New York, 1904), p. 488. Thomas C. Cochran, *The American Business System; A Historical Perspective, 1900–1905* (Cambridge, 1957), p. 51. Bernard Korn, *A History of Bay View,* Unpublished M. A. thesis, Marquette University, 1938, pp. 124–125, 170–171, 327. Still, *Milwaukee,* 354. Harold F. Williams and Kenneth H. Myers, II, *Designed for Digging; The First 75 Years of Bucyrus–Erie Company* (Evanston, 1955), pp. 105–111.

[12]*Milwaukee Journal,* May 3, 1901. *Minutes, Meetings Board of Directors,* Allis–Chalmers Company, May 9, 16, 1901.

[13]"The Great West–Allis Plant of the Allis–Chalmers Company, Milwaukee, Wis." *Machinery,* February, 1903. *Industrial Progress,* September, 1909, p. 530.

for two decades enjoyed an excellent reputation for quality electrical products became the nucleus for the company's expanding electrical line. For over half a century Allis–Chalmers has ranked behind only General Electric and Westinghouse in the electrical industry.[14]

The steam turbine was to mean power in the 20th century as the steam engine had been the symbol of power in the 19th century. In 1902 company engineers combed Europe for the best turbine information available. Allis–Chalmers built its first steam turbine in 1903 and for the next half century remained one of the leading turbine builders in the United States. The company also purchased the rights to the best hydraulic turbines then manufactured in Europe. Due to the ingenuity of the company engineers, Allis–Chalmers was soon producing turbines more advinced in design and with higher efficiency ratings than those imported from Europe. During the next half century the company was to produce hydraulic turbines generating well over 10 million horsepower. Hoover Dam, the whole TVA complex, Bonneville, Grand Coulee and Niagara—the prestige hydro-electric developments—were equipped totally or in large part by Allis–Chalmers.[15]

The addition of enormous gas engines which operated on industrial gases from the country's great steel mills and ranged in size up to 10,000 horsepower completed the major additions to the company's product lines during the first decade of this century. It was then possible for the Milwaukee company to provide electric, hydro-electric, gas and steam power. In 1904 Allis–Chalmers boasted that "Ours are the Four Powers." No other manufacturer could make that claim.[16]

Although the merger of 1901 had brought together a wide variety of famous products and had produced a great new plant, the anticipated yearly profits of 10 per cent did not materialize. In fact, there were no profits. Where the Allis Company had been locally owned, control now rested largely with Eastern bankers and industrialists. It is true that the board of directors read like a "Who's Who" of American business and included Elbert A. Gary, head of United States Steel; James Stillman, of the National City Bank of New York; and Cornelius Vanderbilt, member of the famous family of New York capitalists. But the fact of the matter was that they were interested in the short term profits secured through the merger and Allis–Chalmers was relegated to the position of a forgotten stepchild. As a consequence the company fell into difficulties which forced a reorganization in the period 1911–1913.[17]

Reorganization did not spell disaster for the company largely because Milwaukee refused to allow this to take place. It was in the interest of the city and the state that Wisconsin's largest and best known company should

[14]*Electrical World and Engineer,* February 13, 1904, p. 304, *Milwaukee Journal,* March 7, 1904. For the development of the electric utility industry in Wisconsin from 1881 to 1955 see Forrest McDonald, *Let There Be Light* (Madison, 1957).

[15]*Sales Bulletin,* November, 1905, p. 5; November, 1906, p. 1. *Electrical World,* February 17, 1904, p. 410. Edward Dean Adams, "Early Hydraulic–Turbine History," *Mechanical Engineering,* April, 1930, p. 395.

[16]*Milwaukee Journal,* May 1, 1903. *Industrial Progress,* January 1909, pp. 13–14; May, 1910, p. 1048. Walter F. Peterson, "Built to Last—The Allis–Chalmers Gas Engine," *Wisconsin Academy Review,* Spring, 1961, pp. 63–66. *The Book of the Four Powers,* Allis–Chalmers Company, Chicago, 1904.

[17]*Minutes,* Meetings Board of Directors, Allis–Chalmers Company, May 9, 16, 1901. *Plan of Reorganization,* March 18, 1912.

survive and prosper. Having wrested control from the East, the Executive Committee of the Allis–Chalmers Manufacturing Company represented the best in Milwaukee in terms of business acumen. Fred Vogel, Jr., President of the First National Bank, was elected chairman. The others were Oliver C. Fuller, President, Wisconsin Trust Company; J. D. Mortimer, President, the Electric Company; Gustav Pabst, President, Pabst Brewing Company; and General Otto H. Falk, Vice President, the Falk Corporation, who had been elected President of Allis–Chalmers.[18]

What E. P. Allis had been to the company and Milwaukee in the 19th century, General Falk was to the city and Allis–Chalmers in the 20th century. This square-built, former general of the Wisconsin National Guard directed the affairs of the company for 27 crucial years of war and depression. Operating as a professional industrialist, General Falk once stated his philosophy of management in concise form:[19]

> I looked upon it as my function, the true executive function, to secure co-ordination of effort throughout the organization in accord with well-established principles of management: Such as thrift in the use of all physical properties—fair and square treatment of every individual—the winning of the kind of co-operation that accompanies loyalty and interest—financial good health—excellent quality in products—and the final test, *profits*.

Otto Falk succeeded in achieving all his objectives. He consolidated operations in the West Allis and Norwood Works and disposed of the other properties. Through modernization of the plants and the development of a spirit of cooperation and loyalty he increased efficiency. By devoting ever more funds to research and development the company was able to pioneer in new and exciting areas. Through astute management during World War I, Otto Falk placed the company on a sound financial footing. All of this produced a healthy financial atmosphere evidenced in the profits of the company which averaged more than 10 per cent yearly during the period 1919 to 1930.[20]

While the twenties were tremendously profitable, General Falk, in an almost Biblical sense, accumulated reserve funds during the years of prosperity. These financial resources allowed Allis–Chalmers to buy up more than a dozen companies during the late twenties and early thirties. This expansion of product lines, especially in the electrical and agricultural machinery fields,

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[18] Allis–Chalmers Manufacturing Company Board of Directors, March 15, 1913. *Milwaukee Journal,* March 18, 1913. The Executive Committee was a closely knit group. On December 10, 1901, General Falk had married Elizabeth A. Vogel, daughter of Fred Vogel, Jr. Their daughter Elizabeth Louise, married into the Pabst family. When Gustave Pabst resigned from the board in October, 1915, he was replaced early the next year by Charles F. Pfister who was a brother of Mrs. Fred Vogel. Otto Falk held directorships in the First National Bank (Fred Vogel, Jr., President), The Wisconsin Trust Company (Oliver C. Fuller, President), and the Hotel Pfister Company.

[19] Neil M. Clark, "How General Falk Converted Bankruptcy into Profits," *Forbes,* February 15, 1926, pp. 10–11.

[20] *Ibid.* Otto H. Falk, "How a Change in Policy Saved Our Business," *System,* February, 1922, p. 136.

provided further diversification. Moreover, these reserves provided a cushion which helped the company weather the depression.[21]

If any single branch of the company helped carry Allis–Chalmers through the depression it was the Tractor Division. When Falk took over the company in 1913 he noted that the average man on the street had never heard of Allis–Chalmers because it manufactured only heavy equipment. To remedy this situation he launched the company into the tractor business. Allis–Chalmers was just another tractor manufacturer during the first dozen years of tractor production. All tractors, including Allis–Chalmers', were drab, heavy and difficult to start, drive and maintain. But in 1925 the General found the kind of man that Allis had found in Hinkley, Gray and Reynolds—the kind of man who could revolutionize a product line. He found this man in Harry Merritt, a human dynamo who loved tractors and had an idea of what could be done with them. This was a period of tractor renaissance in Wisconsin at large for Leon Clausen came to Case in Racine in the summer of 1924 and provided an enormous stimulus to that old and then lethargic company.[22]

However, Merritt moved faster and went farther in his tractor development. He reduced the weight and price of the tractor while increasing its power and utility. Painting it a unique "Persian Orange" so that it could be easily seen, he streamlined its lines to give it what he called "tractor sex appeal." He revolutionized the industry by putting the tractor on rubber tires and by bringing out a small combine called the All-Crop Harvester. Through the energetic efforts of his able young lieutenant, W. A. Roberts, sales increased until in the late thirties Allis–Chalmers had captured nearly one-third of the national tractor market. The tractor line was also expanded to cover all types of farm implements and a complete line of earthmoving equipment as well.[23]

Another example of the impact of an inventive mind on American society and also a corporation is seen in the development of the multiple V–Belt Drive by Walter Geist. Starting as an errand boy in the milling department, Geist rose to be a draftsman and then a power transmission engineer. In the early twenties almost all shops were full of shafts and belts for the transmission of power. Unsightly and inefficient, they posed a special problem in textile production when grease and dirt fell on the thread or cloth. One old employee claimed that Walter Geist "damn near burned the place down" in

[21]From 1923 through 1938, Allis–Chalmers acquired the products or plants of the following companies: Midwest Engineering Co., Indianapolis, Ind., 1923 (Products.; Worthington Pump, Cudahy, Wis., 1924 (Products); Nordyke and Marmon, Indianapolis, Ind., 1926 (Products); Hoar Shovel, Duluth, Minn., 1926 (Products); Pittsburgh Transformer, Pittsburgh, Pa., 1927 (Entire Plant); Monarch Tractor, Springfield, Ill., 1928 (Entire Plant); La Crosse Plow Co., La Crosse, Wis., 1929 (Entire Plant); Stearns Motor Co., Muskegon, Mich., 1930 (Products); Advance Rumely, La Porte, Ind., 1931 (Entire Plant); Condit Electric, Boston, Mass., 1931 (Entire Plant); Brown–Boveri, Camden, New Jersey, 1931 (Products); Birdsell Huller, South Bend, Ind., 1931 (Products); Reyan Grader, Hegewisch, Ill., 1932 (Products); Avery South America, Buenos Aires and Rosario, Argentina, 1932 (Distributors of Agricultural Equipment); Brenneis, Oxnard, Calif., 1938 (Entire Plant).

[22]A–C Mfg. Co. Executive Committee, August 15, December 22, 31, 1913; April 23, November 5, 1914. Arthur Van Vlissingen, "50,000,000 New Dollars a Year," *Forbes*, June 1, 1938. *President's Circular Letter*, No. 173, December 29, 1925. Stewart H. Holbrook, *Machines of Plenty; Pioneering in American Agriculture* (New York, 1955), p. 188.

[23]Walter F. Peterson, "Allis–Chalmers, Technology and the Farm," *Transactions of the Wisconsin Academy of Sciences, Arts, and Letters*, LI, 1962, 245–252.

the process of his experimentation. But he solved the problem with a V-shaped cord and rubber transmission belt which was economical and extremely efficient. Through the use of multiple V-belts on one shaft, power could be provided to drive the heaviest machinery. Demand was so great for the V-belt that Allis–Chalmers issued licenses to other manufacturers for its production. This innovation became part of the power revolution that was taking place in American society. It also focused attention on Walter Geist who rose with his invention in Horatio Alger fashion to become President of Allis–Chalmers during World War II.[24]

Any company manufacturing 1,600 basic products is obviously of prime importance in time of war. As a consequence, Allis–Chalmers was destined to become a veritable "Arsenal of Democracy" during World War II. Its turbines and electric motors helped provide the power necessary to forge the weapons of victory. Bulldozers and tank-type attack vehicles poured from its factories for use abroad, while on the home front the agricultural division was helping to feed a hungry world at war. Men and supplies were carried to all corners of the globe by boats propelled by Allis–Chalmers marine propulsion turbines. In the air more than 16,000,000 horsepower of Milwaukee manufactured turbo-supercharges made possible higher and faster flights. In fact, Allis–Chalmers helped bring the war to a close and usher in the atomic age through its contribution to the Manhattan Project, the greatest on the basis of weight, in the production of the first atomic bomb.[25]

The close of the war and readjustment to a peace-time economy meant a decline in sales from the war-time high of $379,000,000 in 1944. Resistance by the company to an eleven month strike caused billings to plummet during 1946. The basic cause for a decade of continuous labor strife running from 1937 to 1947 became increasingly clear during the war. The root of the problem lay in Communist domination and control of Local 248 UAW–CIO representing the production and maintenance employees. While the company could bargain in good faith in the hope that a sound labor relations program might evolve, the union leadership employed tactics deliberately designed to prevent the achievement of genuine accord. While other Wisconsin companies faced serious labor problems during the post-war period, no other possessed ideological overtones to the same extent. From April 29, 1946 to March 23, 1947, the West Allis Works was struck. Walter Reuther stated the official position of the UAW–CIO in relation to the extended period of labor difficulties at West Allis in a speech in Milwaukee in December, 1947: "The Allis–Chalmers situation . . . was not something of which the labor movement could be proud. It was a black spot on the whole CIO and Milwaukee and Wisconsin labor in particular."[26]

With Communist control of the union broken and normal labor relations restored, billings increased so that from 1955 on annual sales have al-

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[24] *From the Shadoof to the Dominant Drive*, A–C Brochure, 1944, *passim*. *Texrope Circular Letters*, *passim*.

[25] See the *Annual Reports* and the *Annual Reviews* for the years 1940–1945. The phrase "arsenal of democracy" is taken from a Message to Congress delivered by President Franklin D. Roosevelt on January 6, 1941.

[26] Louis Budenz, former Communist official and Editor of the *Daily Worker*, disclosed the subservience of Local 248 officials to secret orders of the party Politburo in testimony before the Congressional Committee on Education and Labor, March 13, 1947. *Milwaukee Journal*, March 14, 1947. For the Reuther statement, see the *Milwaukee Journal*, December 9, 1947.

ways exceeded a half billion dollars. W. A. (Bill) Roberts, who followed Walter Geist, was charged with the responsibilities of directing the company from 1951 until his death in 1955. The mantle of corporate authority has since rested on the shoulders of Robert S. Stevenson. The basic managerial philosophy of the Allis and Falk eras is still reflected in the mid sixties. The best available talent is still being sought and the best possible product is being produced. These are the only constant factors in an age of rapid change when the role of research and development have assumed ever increasing importance. The decade following the war can be seen as the beginning of the atomic age and from the Manhattan Project to the present, Allis–Chalmers has responded to this challenge and has pioneered in the development of thermonuclear power.[27]

But a successful business in any age must do more than keep abreast of the times. There is a constant acceleration of technology in our society. Before the complexities and problems of the atomic age had been totally understood we entered the space age. What was only recently science fiction has suddenly become reality. The United States is now committed to a lunar project in which the National Aeronautic and Space Administration plans to establish a base on the moon. In getting there NASA proposes to use the Allis–Chalmers fuel cell as a source of self-generating power along with controls from a number of Wisconsin electronics manufacturers.[28]

Wisconsin was another name for opportunity, in terms of regional resources and markets, prior to the Civil War. By the beginning of the twentieth century, in products ranging from beer to steam engines, Wisconsin's manufacturers were serving the nation and much of the civilized world. In 1965 the frontiers of Wisconsin business enterprise have expanded to embrace the universe.

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[27]*Business Week*, September 13, 1952, pp. 102–110: April 9, 1960, pp. 75–87.

[28]*Forbes*, February 15, 1964, pp. 16–17. *Electrical World*, February 8, 1965, pp. 50–51, 156.

BUSINESS AND CULTURE IN NINETEENTH-CENTURY WISCONSIN

Alice E. Smith

Events moved swiftly in nineteenth-century Wisconsin to transform the wilderness into a region of farms and villages and cut-over timberland. The opening of the century had found the unnamed region the domain of the red man and the wild beast. Thirty-six years later, when separation from Michigan made possible the establishment of Wisconsin Territory, the site of the future capitol was still a lonely uninhabited rise of ground between two lakes.

Yet before the century had ended a historian in Madison had proclaimed the disappearance of the American frontier. The year 1900 found Frederick Jackson Turner's native state approaching a predominantly urban status, with four out of every ten inhabitants residing in villages and cities. Lines of communication connected the settlements and united them with the outside world. The railroad, non-existent in Wisconsin in 1850, had virtually reached its maximum mileage by the century's close; lake traffic had helped build up Milwaukee to be the state's biggest city, with Superior ranking second in size. Industries, while not widely diversified, were well established. They were largely home industries, many of them operated by the founders or the sons of founders, some of whom had become wealthy almost overnight.

The population of over two million in 1900 was a big stride from the some three hundred thousand of 1850, when Wisconsin's first census as a state had been recorded. Government had had a direct part in this remarkable growth. As early as 1852 through an energetic program of advertising, the state had opened a campaign to attract immigrants. To that end it had published newspaper items and pamphlets in German, Norwegian, Dutch, and other foreign languages, as well as in English. These were distributed at home and abroad. At times Wisconsin stationed agents in foreign ports and in the East, to encourage and guide migration to the Badger State. The State Board of Immigration which succeeded the plan of personal agents continued its activities well into the twentieth century.[1]

Industry had likewise received enthusiastic support from the state. A student of the business corporation in Wisconsin asserts that "The agencies of state government promoted, encouraged, subsidized, tax exempted, and exhorted the business corporation towards bigger and better things." Rising from a position of relative obscurity, the business corporation moved into a dominating position in the early years of statehood, taking on an importance formerly undreamed of. In fact, the dominant role of the legislature from about 1850 to 1870 was the promotion of the economic growth of the state. During those years the legislature devoted at least two-thirds of its energies and efforts to the promotion, growth, development and stimulation of in-

[1]Theodore C. Blegen, "The Competition of the Northwestern States for Immigrants," *Wisconsin Magazine of History,* 3(1919), 4–7, 11, 27.

dustry, commerce, and agriculture. Governors in their annual messages urged the encouragement of this or that industry. Alexander Randall, in 1861, trying to narrow the unfavorable gap tetween exports and imports, went so far as to propose a tax exemption for from five to ten years for all establishments which would develop or work up in some new form the raw materials so plentiful in Wisconsin.[2]

This favorable public attitude, coupled with the extension of transportation facilities and the opening of markets in the rapidly expanding nation, helped to loosen capital for the development of industry parallelling the pace of population expansion. Each decennial enumeration testified to the substantial increase. In 1900 there were, in round numbers, 16,000 manufacturing establishments in Wisconsin as compared with 10,000 in 1890 and 1,000 in 1850. The capital invested in manufacture in 1900 was 350 million dollars; in 1890 it had been 246 million; and in 1850, only 3 million. The value of manufactured products in 1900 was placed at 360 million dollars; in 1890, 248 million; in 1850, 9 million—a 4,000 per cent increase in half a century.[3]

The manufactures were extractive ones, transforming the products of Wisconsin woods and waters, its soil and animal and plant life, into the wherewith to clothe, nourish, house, and transport members of the human race. Timber products led all other industries. But the supply was declining, foreshadowing Wisconsin's drop from first place among the states at the century mark to eighth in rank in 1910. Flour and grist mill products, which ranked second, likewise had declined since 1890. Third and fourth on the list came foundry and machine-shop products and factory-produced butter, cheese, and condensed milk, both industries rising rapidly in production. The other leaders in rank of importance were leather, malt liquors, meat slaughter and packing, paper and wood pulp, iron and steel, and furniture.[4] Fortunes had piled up within a generation in these industries, with timber the chief source of sudden wealth. Of the thirty La Crosse men who in 1883 were worth over $100,000, seventeen were lumbermen. That year Eau Claire, another lumber center, had fourteen lumbering fortunes of $100,000 or more.[5]

The setting was scarcely one for the encouragement of instruments of culture. The wonder is that literature, the visual arts, music, the theater, or even education or religion received any attention whatever in the busy workaday world of the nineteenth-century businessman. He might, with the Chicagoan, have asserted that he hadn't gotten around to culture yet, but when he did, he would make it hum. The state offered no official encouragement to the development of cultural activities, as it had in the promotion of immigration and industry. No governor raised his voice to proclaim the advantages that would follow the growth of arts and literature. In the struggle to subdue the wilderness, things of the mind and the spirit were left to private initiative, to be subsidized, hopefully, by men of wealth.

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[2]George J. Kuehnl, *The Wisconsin Business Corporation* (Madison, 1959), pp. 98, 104, 173.

[3]U. S. Census, *Twelfth Census, Manufacturing. Part 2. States and Territories* (Washington, 1902), 951.

[4]*Ibid.*, 952–953; *Thirteenth Census, Abstract with Supplement for Wisconsin* (Washington, 1913), 667.

[5]Robert F. Fries, *Empire in Pine: The Story of Lumbering in Wisconsin, 1830–1900* (Madison, 1951), p. 228.

It is evident that in the formative years the emphasis must necessarily be on the economic, rather than the cultural, aspects of life. Until pressures of daily living had ceased to be the main problem, there was not adequate support for the music studio, the art gallery, the bookstore, the subscription library. Even when pressures lessened, residents of the state who regarded money not as an end in itself but as a means for the betterment of humanity had difficulty making themselves heard through the din of industry. Especially was this true in the "pineries," where settlements owed their existence and residents their subsistence to the saw mill, and all homage was paid to the gods of commerce. But everywhere in the state advocates of the good life had reason to bemoan, with Nathaniel Hawthorne in New England, the cleavage between the artist and a practical society and the obsession with utility as opposed to beauty.[6]

Engrossed in business affairs, many men entrusted domestic and charitable matters to the management of their wives, from whence developed women's extensive influence on humanitarianian and cultural movements. Regardless of who held the purse strings in a family, the pattern of rise to wealth and sophistication was so well marked that it could be documented in the annals of any Wisconsin village. This was the era of huge pretentious mansions, usually set in spacious grounds, with well-stocked carriage houses and stables in the rear and sometimes a conservatory on the side. The impression was one of bulk, space, and permanence.

A Wisconsin-born economist, Thorstein Veblen, advanced an explanation for the architectural extravagence of the era and coined a phrase for it. The busy businessman, he asserted, unable to demonstrate wealth by conspicuous leisure, resorted increasingly to visible forms of conspicuous consumption: big houses, wasteful food, drink and sport, and a classical education. Daughters of the rich were sent East to preparatory schools, and the really socially successful wife induced her husband to accompany her on a European trip.[7]

A Wisconsin family that made an extravagent display of quickly won wealth was that of Joseph G. Thorp, a founder of the Eau Claire Lumber Company. The Thorps had not one home, but two. The second was a "fabulously appointed house" in Madison, from which Mrs. Thorp directed the Wisconsin women's activities committee for the Philadelphia Centennial of 1876, and in which the marriage of the young Thorp daughter Sarah to the world-renowned violinist, Ole Bull, was celebrated with all the pomp and circumstance that money could buy.[8]

Admittedly performances of this nature were a dubious form of cultural advancement; certainly they were directed towards individual glorification, rather than the public interest. Nevertheless, the lives of the rich helped to raise the level of existence in frontier villages and, let us hope, encouraged some of their fellow citizens to explore the vast region beyond the surrounding tall timbers. The elegant houses, some of them of good architectural quality, improved the appearance of the communities and frequently inspired a pro-

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[6]For the comments by Hawthorne, see Harry H. Clark, *Transactions of the Wisconsin Academy of Sciences, Arts, and Letters,* 50(1961), 251, 255–256.

[7]Edward C. Kirkland, chapter on "The Big House," in *Dream and Thought in the Business Community, 1860–1900* (Ithaca, 1956), especially pp. 33–34.

[8]Fries, *Empire in Pine,* 228–229; Albert O. Barton, "Ole Bull and His Wisconsin Contacts," *Wisconsin Magazine of History,* 7(1924), 431–432.

gram of village beautification. One happy result was the donation of tracts for the public parks found in every Wisconsin village and city. Many of them were mere village squares, but others were reservations of fine scenic areas of woods and waters, such as Irvine Park in Chippewa Falls, presented to the city by the lumberman, William Irvine.[9]

The earliest as well as the most extensive public benefaction of the business man was in religion. Established through missionary efforts from outside the territory, Wisconsin Catholic and Protestant congregations solicited aid from non-resident and local sources for building and maintaining churches, schools, and colleges. Whether it was because of the "practical" value of churches and church schools in building a successful community, the feeling of stewardship in the wise use of the rewards of his labors, a genuine anxiety to improve the conditions of his fellow men, a desire to implant and perpetuate the traditions and practices of his homeland, or a hope of salvation through good works, many a business man subscribed generously to religious enterprises in the new state.

An example, which is undoubtedly an extreme in donations to every cause he regarded as good, is that of Elisha D. Smith, founder of the Menasha Wooden Ware Company. Smith kept a little ledger of 250 pages itemizing his gifts from 1858 to his death in 1899. While his benefactions were not great, ranging in size from five to one thousand dollars, they were numerous. He made between thirty and forty contributions towards construction of churches in his own and surrounding communities; forty-four to foreign missions, and sixty-four to home missions of his church. Christian colleges and academies in his own state got a total of $22,000 during his lifetime and bequests at his death. In addition, he assisted numerous other collegiate institutions far and wide, including Tuskegee Institute in the South, the schools established by the revivalist Moody, and Robert College in Constantinople.[10]

The denominational colleges and academies that sprang up in Wisconsin about the middle of the century testify to the union of business and education in raising money for buildings. Oftentimes the donations came a bit reluctantly, almost always they were contingent on "matching funds" from other sources, but surprisingly often they were earmarked for cultural, rather than vocational, beginnings. As early as 1848–49 Milwaukee's Bishop Henni received an initial contribution for what became Marquette University with the gift of some $16,000 from "a rich, self-made business man" of Antwerp, Belgium, towards "a proposed academy of learning." Thirty years later a wealthy biscuit manufacturer, Robert A. Johnston of Milwaukee, assured the construction of a liberal arts building for the heavily mortgaged institution with a gift of $110,000. John Lawler of Prairie du Chien, railroad and river boat company executive, was a founder and financier of St. Mary's and Campion colleges in his home town and a liberal contributor to the Georgetown and the Catholic universities in Washington, D. C.[11]

A final gift in the drive of little Wayland Academy of Beaver Dam for funds in 1899 came from Judson H. Roundy, a Milwaukee wholesale grocer,

[9]For brief sketch of Irvine see *Dictionary of Wisconsin Biography* (Madison, 1960), p. 186.

[10]H. A. Miner, *Memorial of Elisha Dickinson Smith, 1827–1899* (Madison, 1903). pp. 45–47.

[11]Raphael N. Hamilton, *The Story of Marquette University* (Milwaukee, 1953), pp. 4–5, 63–64; *Dictionary of Wisconsin Biography*, p. 224.

to be used "for the immediate construction of a Music and Arts Building." Beloit College, chartered in 1846 in a community with a strong New England element, benefited from the generosity of many Mid-Westerners who wished to preserve that early American heritage. Chief among them was Dr. D. K. Pearsons of Vermont and Chicago, a shrewd investor in western city lots, pine lands, and bank stocks, who in his closing years gave away his entire fortune to religious educational institutions.[12]

The biggest single pledge of the Eau Claire lumberman, Orrin H. Ingram, patron of Ripon College, was for $15,000 in 1900 for a Science Hall, but he also helped raise the "matching" $30,000 needed. The college founded at Appleton through an initial gift of $10,000 by the Boston merchant, Amos A. Lawrence, had notable success in obtaining a share in the growing wealth of the Fox River Valley and elsewhere. The Marinette lumberman, Isaac Stephenson, anxious that his "family name be permanently connected with the cause of education," contributed $15,000 towards a Hall of Science at Lawrence. Another millionaire lumberman (who, like Stephenson, became a United States Senator) Philetus Sawyer, patron of several institutions in Oshkosh and elsewhere, gave some $50,000 to Lawrence College. L. M. Alexander of the Nekoosa–Edwards Company subscribed $16,000 for a gymnasium in 1901 and later made other generous donations.[13]

These were all church-affiliated schools, and undoubtedly the religious connection was a strong talking point in soliciting subscriptions for their establishment and support. There were questions in people's minds as to the role of the state in underwriting an educational institution above the secondary level, and of the competence of such institutions. As sophisticated an observer as the British James Bryce, noting the varied provisions in American state constitutions, wrote, "Even universities are the object of popular zeal, although a zeal not always according to knowledge."[14]

President John Bascom of the University of Wisconsin vigorously countered such questioning in his baccalaureate sermons, declaring that the state must provide not merely on the level of primary and secondary instruction, but also for those seeking the highest values of mind and spirit. The need for state universities was even greater in the West than in the East, he declared, for the new country had a less disciplined and less stable cultural tradition such as was needed to temper the passion for money making.[15]

It took time for Bascom's pronouncements to gain acceptance, and it was not until early in the twentieth century that private citizens began to contribute to the support of their state university. An early contribution, one that is still an outstanding model in its generosity and balanced understanding of the needs of higher education, was the Vilas bequest of 1908, in

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[12]Alton E. Wichman, *The Wayland Story: Centennial History of Wayland Academy, 1855–1955* (Beaver Dam, 1954), pp. 71–72; Edward D. Eaton, *Historical Sketches of Beloit College* (New York, 1928), pp. 291–295.

[13]Marguerite E. Schumann, *Creation of a Campus: A Chronicle of Lawrence College Buildings and the Men Who Made Them* (Appleton, 1957), pp. 30, 34, 38; Richard N. Current, *Pine Logs and Politics: A Life of Philetus Sawyer* (Madison, 1950), pp. 294–296; James H. Smith, "The Stewardship of Orrin Henry Ingram," a manuscript article in the possession of Mr. Smith.

[14]James Bryce, *The American Commonwealth* (Philadelphia, 1906), p. 186.

[15]Merle E. Curti and Vernon Carstensen, *The University of Wisconsin: A History, 1848–1925* (2 vols., 1949), 1: 293–294.

which the lawyer and statesman, William F. Vilas, placed the proceeds of his business investments at the service of the University, with specific instructions on the application of their use.[16]

Paralleling the rise of the small college came the library movement. Often libraries started as subscription groups in which individuals collected books for the use of members with money they had raised through such means as winter lecture programs. Some libraries received substantial support from large benefactions and eventually became public institutions. Again Elisha D. Smith of Menasha and Isaac Stephenson of Marinette appear as representative donors in their respective communities. Smith put over $30,000 into the Menasha library and furnished fifteen outlying circulating libraries besides. In Green Bay Rufus B. Kellogg, an Amherst College graduate connected with several banks in the West, was chiefly responsible for creating (1888) the Kellogg Library, to which he donated large sums of money and numerous books. On the other side of the state C. C. Washburn, who made his money in lumber, lands, and flour milling, endowed the library bearing his name at La Crosse, one of a number of his benefactions.[17]

Some libraries, like the Mabel Taintor Library at Menomonie, the gift in 1890 of a lumberman, were memorial institutions. Another Menomonie lumberman, James H. Stout, who expended over half a million dollars on a manual training school and other educational agencies in his home community, introduced the bill in the 1895 legislature for establishing the Wisconsin Free Library Commission and gave vigorous support to the traveling library system thereby created.[18]

The public library movement received a powerful stimulus late in the century through the example and the preaching of Andrew Carnegie. In his "Gospel of Wealth," published in 1889 the Scottish-born steel magnate enunciated the doctrine that a millionaire's unquestioned right to accumulate a great fortune was balanced by his obligation to arrange for its disposition in socially useful ways. Carnegie's pronouncement on the duties of men of wealth was widely distributed and discussed. In fact, it is believed that "one may almost trace the history of modern philanthropy from this article." He went farther and named the "ladders upon which the aspiring can rise: free libraries, parks, and means of recreation . . . works of art, certain to give pleasure and improve the public taste; and public institutions of various kinds, which will improve the general condition of the people."[19]

Some Wisconsinites found more imaginative ladders to cultural heights than those suggested by the Pittsburgh steel magnate. Searching for subjects of interest and self-expression in the frontier environment, Wisconsin business leaders here and there immersed themselves in a self-directed study of their local regions, collecting artifacts, organizing associations, and writing and publishing. William R. Smith of Mineral Point, scion of an old and dis-

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[16]Horace S. Merrill, *William Freeman Vilas: Doctrinaire Democrat* (Madison, 1954), pp. 252, 254.

[17]Miner, *Elisha D. Smith*, pp. 30–32; *Dictionary of Wisconsin Biography,* pp. 201, 366.

[18]Ann M. Keppel and James I. Clark, "James H. Stout and the Menomonie Schools," *Wisconsin Magazine of History,* 42(1958–59), 200–210; *Dictionary of Wisconsin Biography,* pp. 340, 346.

[19]Richard N. Current and John A. Garraty, *Words That Made American History* (2 vols., Boston, 1962), 2: 101–102, 105–111.

tinguished Pennsylvania family, began the publication of a history of Wisconsin in 1854. Henry P. Hamilton, a businessman of Two Rivers, made an avocation of collecting archeological specimens from old Indian village sites, mounds, and graves, and presented what had become a very valuable collection to the Museum of the State Historical Society. Publius V. Lawson, a successful manufacturer of Menasha with a law degree from the University of Wisconsin, wrote extensively on the geology, history, and archeology of his home region.[20]

Men of learning and talent such as these were among the organizers of the Wisconsin Academy of Sciences, Arts and Letters, the State Historical Society, and the Wisconsin Archeological Society. The non-professional members of these associations have produced some valuable studies in state and local history, archeology, and science. In one respect at least they have been less successful. We are told that the Wisconsin Academy of Science, Arts and Letters had "no success with the fine arts" in its early period, and throughout its ninety-five years of existence, science has far outshadowed letters, while art remains virtually non-existent.[21]

In the largest of the state's urban centers civic leaders such as Rufus King, editor of the Milwaukee *Sentinel*, and Increase A. Lapham, a self-trained scientist with boundless interests, began early to build up institutions which would widen the intellectual horizons. A Germanic flood pouring into the city established its own cultural centers: music, drama, Turner societies, education, customs, and the press. Yet despite an advanced appreciation of music and letters in Milwaukee, for a long time the community at large seemed to be "more concerned with markets than musicals, more impressed with adequate fire houses than adequate school buildings."[22]

Eventually community efforts in creating associations for the enrichment of living began to bear fruit. Music was the mediator which bridged many differences between native Americans and foreign-born. The opening of the Academy of Music (1865), the Grand Opera House (1875), and the Davidson Theatre (1890) were important landmarks in Milwaukee's rise to prominence in the performing arts. By the middle of the 1890's the musical taste and abilities of the city were so high as to raise hopes for a permanent symphony orchestra. But with the small amount of industrial wealth that could be commandeered, the dream failed to reach reality.[23]

Art, which had been regarded as the realm of women in the formative days of Milwaukee, had become masculine and German by 1900. By that time the number of cultural professional specialists had grown substantially. In the city of 285,000 106 men reported themselves to the federal enumerator as actors and showmen, 350 as architects, and 97 as artists. The same census recorded 594 musicians and music teachers in the city, of whom 336, more than half, were males. Although no women were recorded among the artists, women had rendered valiant service in the struggle for the promotion of art

[20]Charles E. Brown, "The Henry P. Hamilton Collection," *Wisconsin Magazine of History*, 3(1919), 124–125; *Dictionary of Wisconsin Biography*, pp. 225, 333.

[21]A. W. Schorger, *Transactions of the Wisconsin Academy of Sciences, Arts, and Letters*, 51 (1962), 255–265.

[22]Bayrd Still, *Milwaukee: The History of a City* (Madison, 1948), pp. 115–124, 228.

[23]Still, *Milwaukee*, pp. 119–120, 401, 408.

and art appreciation in the city, and their most effective means of securing support had been to enlist the aid of industrialists. In the Industrial Exhibitions held annually, they literally united industry and art by arranging elaborate displays of paintings and, at the close, inducing men of means to purchase selections for their private collections.[24]

This commitment of Milwaukee industrial wealth to the support of the arts is stressed by Porter Butts in his *Art in Wisconsin*:[25] "It was the wealthy manufacturer who bought the pictures from the Industrial Exposition exhibits, the wealthy meat packer who donated the Layton Gallery and a collection of paintings, the wealthy brewer who sponsored artists and financed the first school, the sister of the wealthy brewer who finally bought Carl Marr's 'Flagellants', and the sons of affluent business men who could afford to go to Germany for study."

Instances of the support of cultural resources by the Wisconsin business world such as have been presented herein are suggestive, rather than exhaustive. The glimpses are too few, our knowledge of the situation is too incomplete, to admit of a valid generalization on the extent of the underwriting. We cannot detail and summarize data on cultural progress as we can on the number of bushels of rye and board feet of lumber. No overall study of the problems and prospects of the performing arts—or any other arts—was conducted for nineteenth-century Wisconsin.

Churches, libraries, colleges, orchestras, theaters, art studios, were established and supported through private channels. It is apparent that large donations, which were usually well publicized, paid only a small part of the costs of construction and maintenance. We may reasonably conclude that in the nineteenth century, as in our own time, although sizeable and sometimes magnanimous gifts were made by wealthy businessmen, a large share of Wisconsin's contributions to welfare, education, religion, and the arts came from individuals of small or moderate means.

Even less satisfactory is the attempt to gauge the breadth of the influence of the cultural activities and agencies that had been initiated. Milwaukee stood well among metropolitan centers in its support of painting, and yet, to patrons, art was more an evidence of success and culture than a living thing. The artists themselves looked to Europe for training and subjects for inspiration.[26]

Wisconsin was often unappreciative, if not downright inhospitable, to the talent which it had nurtured. It showed little understanding of the Norwegian economist from Manitowoc County, Thorstein Veblen, who hurled diatribes against the "captains of fiinance," the "conspicuous consumption of wealth" by the rich, and their concentration on the profit motive, even, he declared, in matters pertaining to culture. The architect, Frank Lloyd Wright, "acclaimed, bemedaled, and honored probably more than any other Wisconsin native," retained his residence in the state, but few in his home area commissioned his works. Not many Wisconsin writers forsook the world of agrarian simplicity to deal with rising problems of class conflicts and social

[24] Still, *Milwaukee*, pp. 571, 578–579.

[25] Porter Butts, *Art in Wisconsin* (Madison, 1936), p. 136.

[26] Butts, *Art in Wisconsin*, pp. 136–138.

unrest, but for those adventurers who essayed the change, as did Hamlin Garland, the result was most often inconclusive.[27]

The word "culture" means different things to different people. But everyone agrees that it connotes achievements which enrich the human heritage and add to the meaning and beauty of life. In the nineteenth century some instruments of culture had been established in Wisconsin. A tradition of responsibility for the encouragement of the arts had begun. A feeling that culture was a "good thing" had been spread. But that was about all. To paraphrase the Rockefeller Panelists of 1965, it was regretable in 1900, as it is today, that the lag in artistic excellence and in the commitment of people to its betterment was so great; that the gap between what there was and what there should have been, was so wide.[28]

To provide the instruments of culture is not enough. As has been often pointed out, many will remain untouched by the opportunities around them, many will reject them. The real test of the influence of a generation is not the history of that short period, but the history of what resulted when the succeeding generation appeared and made use of what had been provided. It is here that we have the opportunity to estimate the results of the period of beginnings. What headway had been made? Did the citizens read the books provided, view the pictures displayed, attend theatrical performances, seek higher educational status, find new values in life?[29]

The men and women of Wisconsin had done well. They had pushed back the frontier line, built homes and cities, developed agriculture and industry and commerce. Besides clearing the forests and effecting the miracle of an industrial revolution within a few decades, they had channeled portions of industrial wealth into institutions of culture in the expanding state. Beyond providing the agencies of culture lay the tasks of maintaining them and meeting widening needs, of raising standards within the arts, of educating the public and the donors to an appreciation of the native arts, and of providing a congenial atmosphere for their development. To do these things was the responsibility of twentieth-century Wisconsin.

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[27]For Veblen, see David Riesman, *Thorstein Veblen: A Critical Interpretation* (New York, 1953), pp. xii, 24, 80, and Veblen, *The Theory of Business Enterprise* (New York, 1935 reprint of 1904 edition), p. 377; for Wright, see Herbert Jacobs, "A Light Look at Frnak Lloyd Wright," *Wisconsin Magazine of History,* 44(1961), 163; for Garland, Henry S. Commager, *The American Mind: An Interpretation of American Thought and Character Since the 1880's* (New Haven and London, 1963 edition), pp. 60–61.

[28]Rockefeller Brothers Fund, *The Performing Arts: Problems and Prospects . . .* (New York, 1965), pp. 1–12.

[29]Benjamin F. Wright, Jr., "Political Institutions and the Frontier," in Dixon R. Fox, ed., *Sources of Culture in the Middle West: Background versus Frontier* (New York and London, 1934), p. 17.

"HITCHING SCIENCE TO THE PLOW": WISCONSIN LABORATORIES AND AGRICULTURAL PRODUCTIVITY

Morton Rothstein

In the early 1880's Dean Henry, the head and at that time virtually the sole occupant of the University of Wiscoinsin's Agriculture Department, made one of many appearances before the State Agricultural Society. On this occasion he was using his extraordinary persuasive powers to muster support for a state-financed research institution, the agricultural experiment station. Several Eastern states had supported such institutions since before the Civil War, and some of Wisconsin's neighbors had also launched them. Not until 1887, with the Hatch Act of that year, did the federal government commit itself to a program of financial contributions for these stations. The flurry of debate within the Society that followed Henry's proposal elicited what is now a classic statement from one exasperated farmer, obviously already a convert.

> The University needs a place for experiments, They should have a model farm and eight to ten good professors. The beggarly tax we'd pay would be repaid a hundred times. If someone had found a way to head off the chinch bug it would have saved Wisconsin about 100 million dollars. We don't want science floating in the skies. We want to bring it down and hitch it to our plows![1]

This famous outburst has often served to illustrate the remarkable faith in science of many Wisconsin agrarians and to explain the basis of the happy partnership in this state between the worker in the laboratory and the worker on the land. And properly so. But even the best partnership has moments of difficulty and the implications of those ringing phrases can stand further exploration.

The University was more than thirty years old when Dean Henry began pushing his idea, but Wisconsin agriculture was just finishing its pioneer stage. Settlers still poured into the state, taking up land and expending painful toil on the farm-making tasks. Over 30,000 new farms had appeared on the state's tax rolls from 1860 to 1870 and the record shows roughly the same increase for the next decade. It was a growth unmatched in any other twenty year period. The pace fell sharply after 1880 and the first signs of maturity in land-holding patterns emerged when some southern counties reported a decline in the number of farms in 1890.[2] An outstanding feature of Wisconsin's frontier economy was the concentration on wheat production. Climate, tradition, and the low labor and capital requirements made it the pre-eminent cash crop. But the pioneering conditions which justified it soon gave way, the yields declined, and rapidly expanding newer lands to the west were turning out larger crops at lower cost. By the 1880's the sharp pressures of the market-

[1] *Transactions*, Wisconsin State Agricultural Society, XXI (1881–1882), 297.

[2] "Wisconsin Agriculture in Mid-Century," Wisconsin Crop and Livestock Reporting Service, Bulletin No. 325 (June, 1954), 1–3.

place were gradually forcing Wisconsin farmers to re-organize their operations, though sometimes they did so reluctantly. In many parts of the state the chinch bug that our farmer complained about gave wheat its *coup de grace.* He apparently failed to realize that Wisconsin had lost its comparative advantage in wheat growing and had to establish new lines of production. In their search for a solution, the more responsive farmers had explored several blind alleys, as in the quest for a sugar crop from amber cane or in the hops mania. In certain areas of the state they found partial answers in tobacco cultivation or fruit orchards. The majority of agriculturists, however, found their main solution in dairying, a conversion attributable in some degree to the persistent missionary work of such leaders as Hiram Smith and William D. Hoard.[3]

The quotation also reveals an extravagant expectation of immediate returns for dollars invested in scientific research, and there are other examples of this attitude.[4] The farmers who were interested in furthering research at the University were generally more knowledgable, more influential, and certainly more successful than the majority of their brethren. As good managers they tended to measure the benefits of science in practical, monetary terms. The prodding and encouragement of such community figures no doubt helped to sensitize research policy so that it was attuned to the economic interests and needs of the state from the outset.[5] Dean Henry's institution played a demonstrably key role in the shift to dairying and to its commercial success. The researchers, too, benefited from this relationship, for their constituents subjected many findings to empirical testing, rejected others out of hand (sometimes with good reason) and occasionally brought them problems of intriguing scientific interest.[6] But the criterion of achievement held by farmers concerned with an applied science that could prove of immediate use was sometimes at variance with the standards of academicians who were increasingly conscious of their professional status and anxious to devote their energies to basic research. The work of men like Babcock and Woll was to some degree socially determined. Still, it enjoyed greater latitude and a firmer public commitment with the passage of time.

The chronicles of the state and of the College of Agriculture contain many references to early frictions and misunderstandings. The story of the problems are well known; the difficulties at first in finding a professor able and willing to teach agricultural science were second only to those of finding students willing to take this course of work. While it resulted in a kind of windfall gain in time and facilities for research, it laid the college open to much criticism. In the 1880's there were efforts to remove it from the effete surroundings of Madison so that it would be more responsive to the pressing

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[3]The details of these changes are brilliantly presented in Eric E. Lampard, *The Rise of the Dairy Industry in Wisconsin: A Study in Agricultural Change, 1820–1920* (Madison, 1963).

[4]*Transactions,* Wisconsin State Agricultural Society, XXII (1883–1884), 210–211, 217–218.

[5]Vernon Carstensen, "The Genesis of an Agricultural Experiment Station," *Agricultural History,* Vol. 34 (June, 1960), 13–20; Charles E. Rosenberg, "The Adams Act: Politics and the Cause of Scientific Research," *Agricultural History,* Vol. 38 (Jan. 1964), 3-12.

[6]For an interesting discussion of the relationship between social groups and needs and the development of biological science see Charles E. Rosenberg, "On the Study of American Biology and Medicine: Some Justifications," *Bulletin of the History of Medicine,* XXXVIII (July–Aug. 1964), 364–376.

but ill-defined needs and concerns of the rural population.[7] Interested groups rarely relaxed their close scrutiny of the College thereafter. As late as 1910 Professor McCollum had problems in obtaining rats for experimental purposes because it was feared that the feeding of farm pests would provoke criticism among the rural constituents.[8]

On the other hand, impatient scientists and sulphurous editors often castigated the farmers for their failure to accept and to act promptly upon the findings of the laboratory. The first generation of researchers spent much of their time and all of their good humor on occasion in their efforts to spread their gospel among the scientifically heathenish plowmen who were leery of any kind of "book farming" and who insisted on sticking to the "tried and true." Still, we should remember that American farmers had been—and in some areas still are—the perrenial victims of hucksters selling pseudo-scientific items. The history of nineteenth century agriculture is replete with promotions of specially improved seeds that grew nothing, of fertilizers that aggravated rather than relieved soil problems, and of implements like the hopperdozer—a horse-drawn machine for alleviating the grasshopper menace by catching and grinding the insect.[9] Furthermore, the experiment station scientists were often reluctant to accept the sound innovations and proven experience of the practitioner. Even the receptive Dean Henry was highly suspicious of the silo, an innovation in fairly wide use for many years, although he eventually became its strong champion. This was a major step forward in dairying. Introduced in the early 1870's, it had manifest advantages in preserving forage crops, particularly in northern climates. In 1883, Dean Henry agreed to test its effects on cattle feed, but the experiment was a disaster and he withheld endorsement for several years. Yet by the turn of the century Wisconsin was leading the nation in the number of silos and has retained that position to this day. Conversely, scientists made important advances when they tried to identify the principles behind the silo's effectiveness as a storehouse for feed.[10] In this respect, science learned from the farmer, as it had derived knowledge about thermodynamics from studies of the steam engine.

Nevertheless, the distrust and antagonism which necessitated the vigorous defense of science in the opening quotation was far less important than the mutual faith and harmony evident at every stage of the relationship. The scientists had been in close touch with farmers in the critical years and each had benefited from that contact. The recognition by the station's clientele that research needed more support and enlarged freedom is evident in the way that they rallied behind Dean Henry to help secure the passage of the Adams Act in 1906. The law provided additional federal funds for agricultural experiment stations and reserved the money for "pure research." The next step, to relieve the station scientists of the tasks of disseminating infor-

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[7]W. H. Glover, *Farm and College: The College of Agriculture of the University of Wisconsin, A History* (Madison, 1952) pp. 49–65, 95–111.

[8]Conrad Elvehjem, "Basic and Applied Research at Wisconsin," in *The Growth of Agricultural Research in Wisconsin* (Lectures commemorating the 75th Anniversary of the Wisconsin Agricultural Experiment Station, 1883–1958 (Madison, 1958) pp. 27–28.

[9]Paul W. Gates, *The Farmer's Age: Agriculture, 1815–1860* (New York, 1960) pp. 301–311; Fred A. Shannon, *The Farmer's Last Frontier: Agriculture, 1860–1897* (New York, 1945) pp. 152–153.

[10]Lampard, *op cit.*, pp. 155–162.

mation and performing routine tests came with the creation of the agricultural agent and his extension work.[11] Here, again, Wisconsin was in the forefront of the movement.

Such developments testify to the enduring enthusiasm of the farmers' faith in science, and to their continuing assumption that by "hitching science to the plow" they would increase their productivity. Yet there was little immediate evidence to support that contention. On surveying the record of stunning achievements by Wisconsin researchers one is struck by the fact that relatively little of the original scientific work here resulted in the kind of direct and easily identified improvement in productivity anticipated by the early sponsors until the 1930's. This is not to say that there was no direct or real "pay-off" on the taxpayers' investment. The Babcock test was early evidence to the contrary. One wonders, however, if the way in which farm leaders throughout the nation siezed upon this celebrated achievement did not also demonstrate the need for self-justification by those whose commitment was too great to admit disappointment. The simple test showed the result of applied science in an easily understood form and helped dealers and farmers improve and standardize the quality of their output. But Babcock himself regarded it as a "stunt" and was happy to turn from it to what he considered to be far more important work. To pursue this example further, the test provided no direct addition to productivity, but rather an objective standard by which producers could guage the quality of their output. It served as a guide, and indirectly as an incentive for achieving better returns. Farmers were consequently better able to meet rapidly changing market conditions.[12] This was no mean feat, nor should these remarks be taken as a denigration of one of the heroes in our Valhalla.

Other examples of research before the First World War do not seriously change this point. The gains in milk output per cow that resulted from the work on animal feeding and breeding were to some extent canceled by the losses incurred in the fight against tuberculosis. The pasteurization of milk and the cold-curing process for cheese making drew much of their effectiveness and applicability from the studies of Wisconsin experimenters. But like the Babcock test and the tuberculin test they helped to improve the quality and acceptability of products among increasingly sophisticated urban consumers rather than to increase the output of product per man-hour or the yield per acre. A broad range of other efforts were designed to counteract natural calamites, like flood and drought, or animal and plant diseases and pests. Viewed in this context, science was the farmer's shield against disaster, rather than his lance in a charge for greater output.

None of this should be startling to either scientists or agricultural historians. The first group certainly appreciates the observation that research is a slow and cumulative process, with the dramatic breakthroughs coming only after long preparation. At the opening of the century genetics and biochemistry were still in their infancy; their impact on agriculture lay in the future. Nor does basic science always follow a path that society tries to lay out. It is somewhat ironic that the marvelous advances in human nutrition of which Wisconsin is justifiably proud—the vitamin discoveries, irradiation

[11] Rosenberg, "Adams Act," *op. cit.*; Carstensen, *op. cit.*

[12] Lampard, *op. cit.*, pp. 173–174, 197–203, 273–274.

and the rest—grew out of research into animal nutrition. As in the case of quality improvement and disease protection, the general public benefited from agricultural research at least as much as did the farmer.

Recent findings by economic historians tend to confirm this observation about the relatively slow growth of agricultural productivity in the opening decades of this century. For American farmers as a whole the great advances had taken place in the mechanization of field-cropping between 1840 and 1880; the substitution of animal power for manpower in cultivating and harvesting small grains was probably the most notable item. After 1880, just at the time when scientific research in agriculture was building its institutional base in both Wisconsin and the nation, productivity increased at a significantly slower rate.[13] It picked up again in the 1920's, largely because of the tractor and the spread of electricity to the countryside. For these two periods of rapid advance much of the credit goes to the mechanic and the engineer. In an agricultural economy marked from its colonial beginnings by relatively large units of production and chronic labor shortages, the innovations represented by machinery had visible and obvious advantages that farmers could grasp immediately. The potentials of biological knowledge, in all its ramifications, were less self-evident. Before accretions to that knowledge were to prove useful to farmers, encrusted layers of folk wisdom and folk folly had to break down. Even the admirable William D. Hoard, for instance, an unusually vigorous exponent of scientific methods in dairying, persisted for years in his conviction that increased butterfat in milk resulted mainly from lavish expenditures of tender, loving care on the cow, rather than from dietary changes.[14]

If technology was the driving force behind the first two periods of productivity growth, science was accumulating a vast and pregnant fund of knowledge from which farmers could draw. In the third period of rapid production increases, the one we are in at present, the biological sciences have come into their own. Yet all branches of what used to be called "agricultural science" made steady and impressive progress. No other practical art has enjoyed such an investment of research as agriculture until very recently. At the beginning of the century the Department of Agriculture alone employed more scientists than all of American private industry. The commitment to research and development may have been unusually strong in Wisconsin, but it also existed in all parts of the country. Moreover, our farmers were as receptive as ever to innovation. They increasingly pressed our county agents and demonstration workers for additional supplies of lime, fertilizer and seed in the 1920's and sometimes embarassed the soil testers by the volume of samples they sent to the laboratories for analysis.[15] Although most

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[13]Wayne D. Rasmussen, "The Impact of Technological Change on American Agriculture, 1862–1962," *The Journal of Economic History,* XXII (Dec. 1962), 578–591.

[14]Lampard, pp. 145–196; G. W. Rankin, *William Dempster Hoard,* (Ft. Atkinson; 1925) pp. 142–181.

[15]"Minutes of; the Meeting of the Agriculture Committee of the Regents," *Reports of the Dean's Office,* College of Agriculture, (University Archives, No. 106, Oct. 11, 1927). This report discusses the cooperation between the Farmers' Institutes, the Ag. Exp. Sta., and other agencies in the College, along with the follow-up program of the agricultural extension workers introduced by Superintendent Luther. In 1927 alone "1234 farmers actually requested assistance in soil improvement work, 530 farmers wanted direct aid on swine improvement, 32 soil associations were formed" and carload lots of lime, potash, phosphate were ordered at meetings along with arrangements for the delivery of alfalfa seed and seedling trees. It was almost too much for the available personnel to handle.

Wisconsin producers went through several difficult adjustments in their farm operations in the past, they were not only willing but anxious to continue applying new ideas which would increase their profits. And here was the rub. During periods of low prices, farmers were often more interested in cutting costs and maximizing returns than in growing two blades of grass where one had grown before. Until the 1930's the government's response to economic downturns in agriculture was mostly to emphasize greater and more diversified production, while farmers grew discouraged and skeptical about this solution. At the end of the prolonged farm depression in the 1890's one leading journal showed its momentary disgust with this traditional approach, and with the efficacy of science in meeting the problem.

> The farmer is not half so deeply interested in the classification of the various kinds of lice that infest the exterior anatomy of the barnyard fowl as he is in the discovery of new customers for his surplus crop of wheat, pork, corn and dairy products.[16]

Adverse economic circumstances for twentieth century farmers were also the greatest single obstacle to the rapid application of new knowledge.

American agriculture went through an equally sharp and long period of economic stress in the 1920's. And then came the depression. The earlier achievements and adjustments that the Wisconsin scientists aided and abetted were crucial in protecting the state from some of the worst shocks of this long agricultural crisis. Dairy and cattle farmers did relatively well compared with producers of cash grain, cotton and hogs. Their operations were less mechanized and less subject to the economies of scale in land holdings. But there was serious hardship in spite of these advantages, and economic woes were intensified by disastrous drought in many parts of the state in the 1930's. Science, however, suffered no equivalent downturn in its acceleration curve, no leveling off in its productivity, even if its practitioners did take salary cuts. The drought stimulated new research and provided the occasion for pushing the results of the old. Farmers turned in greater numbers to the use of alfalfa, which Ransom Moore had been urging on them for years.[17] New varieties of oats came out of the University laboratory with special characteristics suited to the state's soil and climate. Finally, the wonderful new forms of hybrid corn made their appearance. Each of these old crops in new form—alfalfa, oats and corn—represented a triumph in plant genetics research and brought great increases in yields per acre to those who used them. Similar research with animals in Wisconsin during the 1930's, like that of Dr. Philips, helped enormously to make artificial insemination a useful technique for farmers. By the end of the decade breeders coops had appeared in the state.[18]

Still, the depression sharply reduced the ability of farmers to invest in new methods. When World War II came, there was an enormous amount of research findings, including some that went back to the nineteenth century, backed up in the laboratories and readily available to farmers who could afford to use them. Government price supports and the wartime boom pro-

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[16] *The Prairie Farmer* (Chicago), July 31, 1897, p. 2.

[17] L. F. Graber, "A Half Century of Alfalfa in Wisconsin," *Agricultural Experiment Station Bulletin 502*, (May 1953); also see report by Dean Christiansen to President Dykstra, 1938 in Reports of Deans' Office, College of Agriculture, University Archives.

[18] *Wisconsin Agricultural Experiment Station Bulletin No. 500*, January, 1953.

vided the wherewithal for most Wisconsin farmers and here, as elsewhere, the results since 1940 have amounted to a virtual explosion in productivity. Investment in fertilizer skyrocketed, alfalfa acreage doubled and re-doubled, the geographic limits of corn production were pushed to the northern boundaries of the state. Achievements in forage crops were matched by those in fruits and vegetables. Both production and processing relied on the University's scientific work to develop the best varieties for the region and to improve their preservation.

The gains since 1940 have not come from a shifting pattern of output in any major sense, as was the case in the late nineteenth century. We do not have an agriculture extensively exploiting new natural resources or production opportunities. In fact, the "product mix" of Wisconsin agriculture has been remarkably stable. Nor has there been the drastic reorganization of farm units characteristic of changes elsewhere. The number of farms and farmers in the state is shrinking and the size of farms is growing but it is happening at a significantly lower degree of speed and intensity in Wisconsin than among many of our neighbors. This is partly due to the continued dominance of dairying, which is less subject to mechanization than most forms of agricultural enterprise.[19]

In the last twenty years, Wisconsin has kept its national lead in production of milk cows and fluid milk, of cheese and of green peas, sweet corn and beets used in processing. Thus our farmers have kept pace with the accelerating national trends in specialization and productivity. Economists have rather crude instruments for measuring this pace, but one rough estimate puts it at twice the rate of productivity growth in industry. They also have come to appreciate as never before the importance of investment in research and education. One calculation puts the return to agriculture on research investment at thirty five per cent annually over the last generation. Another investigation, restricted to the returns on hybrid corn, has come up with similar conclusions.[20] At least for those who are concerned with the agricultural problems of the newly emerging nations, the Wisconsin idea of close cooperation between farming and science, of investment in human resources to use the currently fashionable term, is more alive than ever. The more specific achievements of the state's research has also spread far beyond our borders. A particularly striking example is the use of Wisconsin pedigreed hybrid corn in western European agriculture, a leading factor in the rapid changes there.[21]

The farmer who blurted out his faith in science in the 1880's has long since gone to his reward. His conceptualization of the relationship between the farmstead and the laboratory may seem naive in a day when the countryside is no longer a source of bucolic delights but a location for outdoor biological factories. In some ways the rewards of that faith in progress were a long time coming and are only now fully upon us. But the new generation of farm managers will continue to look to the institutions their forefathers created to aid them in meeting the challenges of a dynamic and changing society.

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[19]Peter Dorner, "Farming Changes in Wisconsin, 1940–1960," *Wisconsin Agricultural Experiment Station Bulletin No. 561,* (Jan. 1963) pp. 3–4.

[20]Noble Clark, "Agricultural Research in a Changing World," in *The Growth of Agricultural Research in Wisconsin,* pp. 59–60.

[21]*Wisconsin Agricultural Experiment Station Bulletin 498* (July 1952), pp. 26–27.

SOME WISCONSIN BIOLOGISTS OF THE PAST AND THE SIGNIFICANCE OF THEIR WORK

Lowell E. Noland

It would be impossible in a short paper like this to evaluate properly the contributions of more than a few of the many Wisconsin people that have added substantially to biological knowledge. Brief histories of the zoology and botany departments of the University of Wisconsin have been written (Noland, 1950; Bryan, 1950), short summaries of the lives of several early Wisconsin ornithologists have been published (Schorger, 1946), and a number of articles and books have been devoted to individual biologists, such as Sellery's "E. A. Birge" and the papers by Lawson and by Main on Thure Kumlien; but the lives and accomplishments of most of our Wisconsin biologists remain still to be treated by the historian.

In this paper I shall restrict my remarks mainly to two pioneer naturalists I have admired and six University of Wisconsin zoologists and botanists that I knew and came to respect during my forty-five years on this campus.

Increase A. Lapham of Milwaukee was perhaps the most outstanding pioneer in scientific work (including biology) in this state. Born in 1811 at Palmyra, New York, the son of a canal contractor, he learned early the arts of surveying and practical engineering, and became a self-made engineer in construction of canals and public works, principally in Kentucky and Ohio. It was this ability that led to his employment in 1836 by Byron Kilbourn, Milwaukee real estate agent and promoter, to work on plans for a canal from Milwaukee to the lead-mining region of Wisconsin. After his arrival in Wisconsin, and while waiting for the canal project to materialize—which it never did—Lapham to earn a living did many sorts of work such as surveying, map making, real estate development, notary public work and registry of land claims; but he spent his spare time studying and collecting rocks, minerals, plants and molluscan shells. He also kept systematic weather records and notes on Lake Michigan tides. He wanted very much to get a college education, but could neither borrow nor earn enough money to do it. Early in 1838 he began keeping a kind of personal journal which he called a "Gazetter of Wisconsin". By 1844 this grew into a publication: "Wisconsin: its Geography and Topography", for which there was a great demand, especially from immigrants looking for a place to settle. A revised edition in 1846, including maps of greater accuracy and detail, was even more popular than the first.

About this time Lapham developed an extensive correspondence with Eastern scientists relative to exchange of materials in geology, botany and conchology. He sent many plants to Asa Gray and supplied Louis Agassiz with many fish and reptiles from Wisconsin. He helped form a Lyceum for the city of Milwaukee. He was one of the founders of Milwaukee Downer College, and was for several years president of its board of trustees. He assembled a private collection of several thousand plants, most of which eventually became a part of the herbarium of the University of Wisconsin. He was active in the State Agricultural Society. His interest in Indian mounds led him to make many trips between 1836 and 1849 to explore them. In response to his application the American Antiquarian Society of Massachusetts gave him in 1849 $500 to continue these explorations. This resulted in the publication in 1852 of his "Antiquities of Wisconsin". He explored and described hundreds of the mounds, including the Aztalan site near Lake Mills.

Beginning in 1855 he made occasional studies on Wisconsin forests. This led to his appointment in 1867 to the chairmanship of a legislative commission to write a report on the forests of the state. In this report he urged more careful cutting, shelter belts and tax exemptions for land planted to forests, but his wise counsel fell on deaf ears in that period of ruthless exploitation.

Among other things, Lapham advocated more widespread observation and reporting of weather data and succeeded, through friends in Congress, in getting the United States Weather Bureau established under the jurisdiction of the Army Signal Corps, with headquarters in Chicago. From this station the first weather forecasts were issued in 1870. Lapham served as assistant to the Chief Signal Officer in this bureau for a time, but left it in 1872 because of the pressure of his business and scientific interests in Milwaukee.

In 1873 the Wisconsin Legislature established the Geological Survey of Wisconsin, and Lapham was named chief. Due to a change in politics Lapham lost this position after about two years. Disappointed and suffering from heart trouble he retired to a farm he had purchased a few years before on Oconomowoc Lake where he died on September 14, 1875 at the age of 64. Few men have done so much for Wisconsin science in the course of one brief lifetime.

Thure Kumlien, pioneer Wisconsin ornithologist and naturalist, was born in Sweden November 9, 1819, learned his elementary subjects from a private tutor, and as a boy assembled and mounted, with almost no professional help, a remarkable collection of birds. After four years of study at Upsala University, and after the subsequent death of his father and mother, he emigrated in 1843 to America on the same boat as his future bride, whom he married on arrival at Milwaukee. He bought from the United States Government forty acres of land on Lake Koshkonong and he and his young bride walked the whole distance from Milwaukee to their new home on foot. Later they added to this another forty acres. Kumlien farmed just enough to make a bare living, but spent all his spare time on ornithology, for which the Lake Koshkonong area afforded a most favorable location. For three years he served as a teacher of botany and zoology at Albion Academy, not far away from his home, until financial difficulties in that institution forced discontinuance of his position.

He prepared collections in natural history and botany for the young and growing University of Wisconsin at Madison, but these were unfortunately lost in the fire that destroyed Old Science Hall in 1884. He acquired an international reputation for his knowledge about birds. He was a long-time friend of the famous early ornithologist, Thomas Brewer, for whom he collected bird skins and eggs. Louis Agassiz once remarked, in connection with receipt of a shipment from his Wisconsin collector, that Kumlien was the greatest authority in the world on birds' nests.

Kumlien travelled little, except in the general region of southern Wisconsin, where he did most of his collecting. He was an early member of the American Ornithological Union and the Wisconsin Academy of Sciences, Arts and Letters. Dr. Edward A. Birge of the University of Wisconsin urged him several times to publish his observations on bird life in the *Transactions* of the Academy, but his innate modesty, retiring nature and constant occupation with other matters prevented his doing much writing. We who have come later are the losers, for much of his wealth of knowledge was buried with him. In his later years he became taxidermist and conservator at the Milwaukee Public Museum, which Increase Lapham had helped to establish. His work there involved the handling of collections of birds that had been treated with mercuric chloride preservative, and it is thought that the breathing of this poisonous dust was the cause of his death, which occurred on August 5, 1888, a few months before he would have reached his seventieth birthday. He lived a full and interesting life, though filled with hardships; and he had a profound influence on American ornithology, though his publications were few. For some twenty years there was an ornithological club at the University of Wisconsin that bore his name.

Besides the two pioneers I have mentioned there were many others who could well have been included had there been time, men such as Father Mazzuchelli after whom the Edgewood College biological laboratory is named, John Muir who contributed his love of nature to all America, George and Elizabeth Peckham of Milwaukee, those incomparable observers of insect behavior, or Dr. Philo Romayne Hoy of Racine, but the lives and work of these and other pioneers must await more thorough treatment by future historians.

In the remaining part of this paper I wish to mention six significant representatives of Wisconsin biology who lived and worked in the more recent past. Let me say at the outset that I do not wish to imply that these are necessarily the most outstanding men in this field. I have chosen them only because I knew them well personally and developed a respect for their accomplishments and their personalities. That they were all associated with the University of Wisconsin merely reflects the fact that there is where I knew them. Had I worked in another institution in the state my choice would undoubtedly have been a different one.

William Stanley Marshall is the first of three zoologists I have chosen to discuss. For forty-six years he was associated with the Department of Zoology of the University of Wisconsin. He was born December 14, 1866, at Milwaukee. His father, who had come from Pennsylvania, was one of the founders of the Marshall and Ilsley Bank of Milwaukee. The son, after taking his B. S. degree at Swarthmore in 1888, did a year of graduate work at the University of Pennsylvania, and then went to Europe, where he studied zoology under Schulze, Korschelt, Heider, Hertwig and Kny at Berlin, and under Credner, Marshall, Pfeffer, Loos and Leuckart at Leipzig. He received the Ph. D. degree from the University of Leipzig in 1892.

Returning to Wisconsin he joined the staff of the Department of Zoology at the University in 1893, where he helped Dr. Birge with the elementary biology course, and began developing his own fields of entomology and insect embryology. In those days there were no biological supply houses from which laboratory dissecting material could be purchased, and I remember Dr. Marshall telling me how much time it took to collect and preserve all the frogs, clams, crayfishes and insects needed for the beginning class. Nevertheless, he found occasion to apply the histological methods he had learned in Germany to research on local insects; and the first two doctorates granted by the Department of Zoology (to Charles Taylor Vorhies and Robert William Hegner both in 1908) were worked out under his supervision. Somehow in those early years he managed also to assemble a remarkably complete collection of Wisconsin beetles, now in the custody of our Entomology Department. It is a pity that he did not prepare a definitive monograph on Wisconsin beetles. He had both the knowledge and the reference collection to have authored such a work—one that would have rivalled Blatchley's *Coleoptera of Indiana.* Dr. Marshall died at this home in Madison on March 17, 1947, at the age of eighty.

Through the years Professor Marshall was very much interested in the University Library and especially in one branch of it, the Biology Library, now housed in Birge Hall. It was also largely through his efforts that the great Wisconsin Academy Library was built up through arranging exchanges with other academies and learned societies of the world. Even after his retirement he remained active in this library work. The numbers of students he helped by personal gifts and advice were legion, and his generous support of local charities in Madison was well known.

Since he was a man of independent means, and since his line of research was not of especial interest to either of the chairmen under whom he served, he was never adequately recognized by his department in either salary or rank; for instance, he was not made a full professor until 1933, four years before his retirement. He was a tall, slender, handsome man, with a dignified though not formal manner, somewhat brusque in speech, but full of good humor and most unselfish and helpful, as I had occasion to learn when after his own retirement he volunteered and without remuneration took over my teaching for a couple of months when I was incapacitated by an automobile accident.

Chancey Juday, World renowned limnologist, is the second Wisconsin zoologist I have chosen to discuss. He was born May 5, 1871, at Millersburg, Indiana. He attended the University of Indiana (B. A. 1896, M. A. 1897) working especially under the fish specialist Eigenmann. Thereafter he taught high school for two years, before accepting a position at Madison with Dr. Birge, as biologist in the Wisconsin Geological and Natural History Survey. In 1901, ill health (tuberculosis) necessitated his leaving for the drier, sunnier climate of the West, but he returned to Wisconsin in 1905, where (except for the year 1907–1908 spent visiting limnological stations in Europe) he remained for the rest of his life, with only brief research excursions to other places, for instance to Central America in February of 1910 and to the Finger Lakes of New York in the summer of that same year. During July and August of the years 1921 to 1924 he did limnological research on Green Lake; and in the summers of 1925 to 1941 he carried out similar work in the region of Trout Lake, Wisconsin. Under his leadership the Trout Lake

Station became widely known as a center for summer research on limnology, attracting such biologists as Woltereck from Germany, Kozminski from Poland, Henrici from Minnesota, Potzger from Butler University, Minna Jewell freshwater sponge specialist from Illinois, Frank C. Baker authority on molluscs from the University of Illinois, and Harring and Myers, rofifer specialists from Washington, D. C. In 1931 he was made Professor of Limnology in the Department of Zoology of the University. In 1941 he retired from teaching but was retained as research associate by the University to round out his lake researches. He died on March 29, 1944.

Best known among his publications, which number over a hundred, are his books on the hydrography and morphometry of Wisconsin lakes, and two extensive reports (jointly with E. A. Birge) on the dissolved gasses and plankton productivity of Wisconsin lakes. He maintained fruitful working relationships with the Wisconsin Conservation Department and directed many studies on the growth of freshwater fish. When the Limnological Society of America was organized in 1935 he was elected its first president. He received the LL. D. degree from Indiana University in 1933, and the Leidy medal from the Academy of Natural Sciences of Philadelphia in 1943.

He was a quiet, faithful man, never seeking public acclaim, even tempered, always willing to listen and give helpful advice. Unassuming and modest, his eminence in his field was not always appreciated, even by some who knew him well. With few words, guiding by example rather than by precept, he led his students to proficiency in the field of his special interest.

He was for many years secretary-treasurer of the Wisconsin Academy and editor of its *Transactions*, which became the repository of a large quantity of the published research of the Birge–Juday team and their associates. In this team Birge was the more aggressive member, the project-proposer, money-getter, and public relations man; Juday was the day-by-day director of research, student adviser, follow-up man in contacts with other agencies, and editor of the published results. Both were active researchers; their personalities and strong points were complementary; they accomplished more as a team than the two of them could have accomplished working separately. Although Juday's name often took a secondary place in the published papers, only those who were engaged in the work knew the major role that Juday played in the actual working out of most of the projects. Early in my graduate years I spent one summer working as an assistant in the limnological program at Green Lake, and I shall never forget the breadth of knowledge, the quiet steadiness, and the calm imperturbability that Professor Juday showed in his work. He was always interested in developing his assistants as scientists as well as in making the research program move ahead.

Michael Frederic Guyer is the third personality which I wish to consider in the development of Wisconsin biology. He was chairman of the Department of Zoology of the University of Wisconsin for thirty-four years —from 1911 to 1945. Born at Plattsburg, Missouri, on November 11, 1874, he did his undergraduate work at the University of Chicago, receiving the B. S. degree there in 1894. He then studied at the University of Nebraska for a year, taught high school for a year, returned to Nebraska to take his M. S. degree in 1897, and then went to the University of Chicago for three years of graduate work under C. O. Whitman. After receiving the Ph. D. degree there in 1900 he served for the next eleven years as chairman of the Department of Biology at the University of Cincinnati, being on leave during the year 1908–1909 for research at the Naples Biological Station in Italy. In 1911 he was brought to Wisconsin by President Van Hise to succeed Dr. Birge as chairman of the Department of Zoology, since Dr. Birge, then Dean of the College of Letters and Science, was too busy with his other duties to serve effectively also as departmental chairman.

Guyer's interests lay especially in the fields of cytology, serology and eugenics, as well as in the general field of medical education. His publications totalled more than a hundred. Of these his *Animal Micrology* was a standard textbook in microtechnique for over fifty years, and his general zoology text, *Animal Biology*, was a leader in the field for several decades. His interest in human heredity led to the organization of his course in Heredity and Eugenics and to the writing of a well-known associated text in this field, *Being Well Born.* In his later years he gathered together some of his reflections on human biology in a popular book entitled *Speaking of Man.*

With respect to his leadership in university matters, he was one of the organizers of the Graduate Biological Division the main purpose of which was to insure that Ph. D. candidates in biology at the University of Wisconsin would have adequate backgrounds of course work in sciences basic to their special fields. His influence in developing physiological and biochemical approaches to research and teaching in zoology was one of his important contributions. His activities relating to medical education included membership on national committees in this field and presidency for many years of the Wisconsin Basic Science Board set up to examine physicians, who were applying to practice medicine in the state, in the sciences fundamental to medicine. He was recognized nationally by being made president of the American Society of Zoologists in 1923; the American Microscopical Society 1916–1918; and vice-president of Section F (Zoology) of AAAS in 1928.

Strong in his convictions, firm in his decisions, and vigorous in action, Dr. Guyer was always a force to be reckoned with in the formulation of policy in any group to which he belonged. His method of supervising his graduate students was to provide them with facilities and allow them freedom to work out their own ideas in their own way, with the door left open for consultation with him when they wished. He furthered personal acquaintance and friendly relations within his department by occasional informal gatherings at his home or departmental picnics at his cottage on Lake Mendota. His faculty colleagues who had the opportunity to go to his home for dinner will remember his wit, his incisive comments and his graciousness as a host. One of his incidental interests was in band music; he once won a prize in a national contest for a march which he composed.

In the course of his long teaching career thousands of students listened to his lectures and did laboratory work outlined in his manual that went through many editions. Generations of teaching assistants and instructors gained experience working in his course, each adding his bit to the whole. As a lecturer in beginning biology Guyer was forceful and well organized, but tended to cover in his lectures the same material presented in his texts without adding a great deal of supplementary information. He seldom taught laboratory or discussion sections himself, and he let the laboratory and lecture work each go its own way, without much attempt at integration. He was rather sensitive to criticisms regarding his courses, though occasionally suggestions made by assistants or instructors were later offered as modifications which he was making. In revisions of his elementary text he often hired assistants to help him in the preparation of plates and manuscript, but he never accepted anyone as coauthor. Only now, years after his death, has his text been revised by one of his former students.

He was respected—I might almost say feared—by his graduate students and assistants, as well as by some of his younger staff members. He held the reins of departmental administration tightly in his own hands, though he occasionally conferred with certain of his colleagues on matters of more than usual importance. He did not enjoy bookkeeping, and left the routine handling of fiscal matters largely to Professor Wagner, a faithful member of the Zoology staff, whom I wish I had time to mention in greater detail. Dr. Guyer died on April 1, 1959, fourteen years after retiring. For some years he had lived mainly in Texas to avoid the Wisconsin winters and conserve his failing health. He left a bequest to his Department that will eventually provide a fellowship or instructorship in his memory. It is cause for reflection to note how soon such a dominating figure as Professor Guyer can fade from the consciousness of the general zoological community in which he moved. Today, twenty years after his retirement and six years after his passing, his name is hardly known to undergraduates, assistants and younger members of the department he did so much to develop.

In the forty-five years I have spent at the University of Wisconsin it has been my privilege to know a number of the members of the Department of Botany reasonably well, and I should like now to present brief vignettes of three of these men that especially impressed me.

Charles Elmer Allen was one of Wisconsin's outstanding botanists. He was born at Horicon, Wisconsin, on October 4, 1872. He received his B. S. degree in 1899 and his Ph. D. degree in 1904, both from the University of Wisconsin, and taught in this institution for forty-three years. As an undergraduate he had some course work in botany under Charles Reid Barnes, who had taken his doctorate under Asa Gray at Harvard; but during Allen's stay at the University, Barnes left to go to the University of Chicago, and was repleced by Robert Almer Harper, who had taken his doctorate in Germany under the famous botanist Strasburger. Through these two outstanding men Allen was heir to the best in the American and German botanical traditions. Also after receiving his doctorate Allen spent a year at Bonn working under Strasburger. Returning to the University of Wisconsin he rose rapidly through the ranks and became a full professor in 1909. When Harper left for Columbia in 1911, Allen became his distinguished successor.

Allen joined the Wisconsin Academy in 1902, served as its secretary from 1907 to 1908, was its vice-president (1918–1921), and president (1931–1933), and was elected to life membership in 1946. In 1915 he helped organize the Graduate Biological Division of the University and served as its first chairman.

Even as an undergraduate he had shown capacities for leadership, having been editor of the *Daily Cardinal* student newspaper, and of a humor magazine, the *Sphinx*, as well as chairman of the editorial board of the *Badger*.

He was a member of Delta Upsilon fraternity and of the Hesperia Debating Society. He was also on the University debating team. Later he edited the *Wisconsin Alumni Magazine* for its first three years. Perhaps it was because of the understanding thus gained of student activities that he was appointed and served for twenty years on the University's Student Life and Interests Committee.

Nationally also his ability was repeatedly recognized. He was for many years a member of the National Research Council, and served in 1929 and 1930 as chairman of its Division of Biology and Agriculture. He was president of the Botanical Society of America in 1921, of the American Naturalists in 1936, and of the American Microscopical Society in 1944. He was editor of the American Journal of Botany from 1918 to 1926, was elected to the National Academy of Science in 1931, and was vice-president of Section G (Botanical Sciences) of the American Association for the Advancement of Science in 1928. The University of Chicago conferred upon him the honorary degree Doctor of Science in 1941. He served as secretary of the Genetical Section of the International Congress of Plant Science in 1926.

He was especially known for his work on plant cytology and cytogenetics. He was the first to demonstrate sex chromosomes and sex linkage in plants (specifically in the liverwort Sphaerocarpus) and did important work on life histories and polyploidy in plants. He was an expert in the use of Flemming's triple stain. With Dr. E. M. Gilbert and others he shared the authorship of the popular, so-called "Wisconsin Botany" textbook. His published papers totalled about forty.

Allen was at his best, however, as a teacher of advanced courses in botany and as adviser to graduate students. His lectures were truly unusual in their clarity, succinctness, up-to-date-ness and accuracy. Especially remarkable was his thorough familiarity with the botanical literature, both past and present, in his own and related fields. He was meticulous, methodical and systematic in all his work. Personally he was a man of formal dignity and calm, soft spoken and judicious, with a never failing interest in his students. He was searching in criticism, yet constructive in suggestions. His own scientific papers were models of writing and illustration. He was imaginative and original with a quiet but infectious enthusiasm that made him a leader in his field.

I remember him well from many years of personal contact. I was minor professor to some of his students, and I was secretary of the Wisconsin Academy at the time he was president. On several occasions I was invited to ride with him and Mrs. Allen to out-of-town meetings. I enjoyed very much the conversations with him on these trips, and incidentally also the chance to speak French with Mrs. Allen, who, by the way, is still living in Madison. I sat with Dr. Allen on many graduate examining committees, and I used to watch with admiration his capacity for finding out what graduate students knew, pointing out ways in which they could improve their knowledge, all without any suggestion of humiliating them or parading his own knowledge. Dr. Allen died on June 25, 1954. Truly his department may look back on him with the greatest pride.

Edward Martinius Gilbert was born at Blair, Wisconsin, September 20, 1875, of immigrant Norwegian parents. Introduced to biological study during his high school days by a local physician he attended Stevens Point State Normal School, and then, beginning in 1901, taught and served as principal at Hayward High School in northern Wisconsin. Following this he came to the University of Wisconsin, where he received the Ph. B. degree in 1907 and then taught for three years at Superior State Normal School. Returning to the University in 1910 he began his graduate work under the supervision of R. A. Harper, and completed the requirements for the doctorate under C. E. Allen in 1914. After a year's postdoctoral study at Harvard under Farlow and Thaxter, he returned to the University of Wisconsin and began offering courses in mycology, which contributed much to the training of generations of graduate students in this institution. In 1922 he was made Professor of Botany and Plant Pathology, a rank that he held until he retired in 1946.

His research was in the field of fungal cytology and on various fungi pathogenic to plants and insects. His eminence in his field was recognized in 1924 by his election to the chairmanship of the Mycological Section of the Botanical Society of America. Locally he was chairman of the Department of Botany for nearly twenty years. He played an important part in the organization of the Wisconsin chapter of the Phi Sigma National Honorary Biological Society, in 1915, and of the Wisconsin Junior Academy of Science in 1946. He helped in the establishment of the University of Wisconsin Arboretum. His most significant accomplishment was the training of outstanding students in the field of mycology. He was one of the principal authors of the "Wisconsin Botany" textbook. He loved students and never delegated the laboratory work in his advanced courses wholly to graduate assistants. He was always there himself, pointing out the structures and explaining the processes which he knew so well.

His students will never forget his distinctive high-pitched voice, his quick reactions to their questions, and his willingness to help anyone who was really trying to learn. He never forgot a student he had had in his advanced courses. He had an emotional temperament, easily aroused to anger at injustice, easily touched to the point of tears by the sufferings or strong emotions of others. He was a strong fighter for the rights of his own department.

He died on April 23, 1956, at San Marcos, Texas, his winter home, at the age of eighty-one, after a brief illness that culminated several years of heart trouble.

Benjamin Minge Duggar, discoverer of aureomycin, was perhaps the best known of Wisconsin botanists to the general public. He was born at Gallion, Alabama, September 1, 1872, the son of a physician who had served as Confederate army surgeon. He attended the University of Alabama for two years and then completed his undergraduate work at Mississippi Agricultural and Mechanical College with a B. S. degree in 1891. A year later he received the M. S. degree from Alabama Polytechnic Institute. Following two years of work on forage grasses at the Canebreak Station in Uniontown, Alabama, he went for further study to Harvard where he worked under Farlow and received the M. A. degree in 1895. Then came a year at the State Laboratory of the Illinois Natural History Survey, followed by five years at Cornell, during which time he completed the requirements for the Ph. D. degree, which he received in 1898. While at Cornell he published papers on diseases of fruit trees and sugar beets. He spent several months in 1895–96 in Europe, including a period with Julius Kuhn, who had described *Rhizoctonia solani,* a fungus on which Duggar himself had previously done some work. He returned in 1896 to Cornell for one year, but in 1901 accepted a position as physiologist with the Bureau of Plant Industry of the U. S. D. A.

In 1902 Dr. Duggar was appointed professor of botany at the University of Missouri, and remained there for five years, after which he was called back to Cornell as professor of plant physiology. During his second period at Cornell he published his book on *Fungus Diseases of Plants* (1909). In 1912 he moved again to Missouri, this time as professor of plant physiology at Washington University and the Missouri Botanical Garden in St. Louis. While there his well known book on *Mushroom Growing* was published (1915). He supplemented his studies on physiology of fungi by researches on tobacco mosaic, and incidentally, during World War I, served as acting professor of biochemistry while a colleague was on leave for military duties.

In 1927 Dr. Duggar was called to the University of Wisconsin for teaching and research in plant physiology and plant pathology. His broad interests, encyclopedic knowledge and helpful attitude made him a much sought colleague and graduate student adviser. When he retired in 1943 after sixteen years of service to Wisconsin he accepted an appointment as consultant in mycology at the Cyanamid Company's laboratory in Pearl River, New York. There he directed the investigations that led to the discovery of aureomycin, for which he is so well known.

Dr. Duggar was active in many organizations and programs of national significance. He helped organize the American Phytopathological Society and the American Society of Agronomy and held office in both. He was elected to the National Academy of Science and the American Philosophical Society. He served as president of the Botanical Society of America and the American Society of Plant Physiologists. He was also for one year vice-president of Section G (Botanical Sciences) of the American Association for the Advancement of Science. In 1925–26 he was chairman of the Division of Biology and Agriculture of the National Research Council. He was a trustee of the Marine Biological Laboratory at Woods Hole and of the Bermuda Biological Station. For seven years he was editor in plant physiology for *Biological Abstracts.* He also edited the *Proceedings* of the International Congress of Plant Sciences for 1926, as well as a two-volume work on the biological effects of radiation in 1936. He received honorary degrees from the University of Missouri, Washington University and the University of Wisconsin. He was elected a fellow of the International College of Surgeons in 1952, and received a medal of honor from the Venezuelan government for contributions to public education.

He loved fishing, bowling and gardening, and he even liked to cook and make preserves from his own garden produce. He was a man of slightly less than average height, lithe and wiry, and possessed of indefatigable energy. In spite of the tremendous load of work he carried, he was always friendly and approachable. He was major or minor professor to over a hundred graduate students during his period of service at Wisconsin. His contributions to the biological effects of radiaton, plant physiology, photosynthesis and antibiotics are contained in over fifty papers and five books. How he could accomplish so much in one lifetime it is difficult for us ordinary mortals to understand.

He died on September 10, 1956, after nearly seventy years of active service in the field of biology. Although only sixteen of those years were spent at Wisconsin, they were inordinately fruitful ones, and the University can be deservedly proud and grateful for them.

Let me emphasize again that this is a very fragmentary account of the contributions that Wisconsin has made to biological science. Many prominent figures have been left out. For instance no mention has been made of men like Dr. J. J. Davis and Norman C. Fassett who did so much to build up the Herbarium of the Botany Department. Nor has there been time to discuss Professor J. B. Overton who contributed much to the development of plant physiology and mycology at the University. Such men as William Trelease, Charles Reid Barnes, and Robert Almer Harper who were pioneers in development of botany at the University have not been adequately treated. Omitted also is John T. Curtis, outstanding plant ecologist, recently deceased. Outstanding teachers like R. H. Denniston and George Bryan have not been considered. In zoology, Dr. E. A. Birge has not been discussed in any detail, partly because his life and work have been thoroughly treated elsewhere by others. The contributions of Geroge Wagner, Bennett Allen, Samuel J. Holmes and Arthur Sperry Pearse have not been described. Biologists outside the departments of botany and zoology, such as Leon J. Cole in genetics, L. R. Jones in plant pathology, H. F. Wilson in entomology have not been mentioned. Biologists in other colleges of the state, such as Marsh at Ripon, Mullenix at Lawrence have not been brought into the picture. A comprehensive treatment is obviously beyond the possibilities of this brief account.

Enough has been said, however, to show that our state has had its own Wisconsin-born sons that greatly furthered the development of biology such as Allen, Gilbert and Marshall. In addition it has received the best from European scholarship through such men as Marshall, Allen, Harper and Birge. It has been strong enough to attract and keep for a time outstanding biologists from other institutions such as Duggar, Guyer and Juday. Through men like these, Wisconsin has made outstanding biological contributions of signifiicance to the entire world. In conclusion I would like to thank Dr. Herbert M. Clarke, of the Botany Department of the University of Wisconsin, for his help in supplying data and references regarding the botanists mentioned in this paper.

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SOME CONTRIBUTIONS OF WISCONSIN'S GEOLOGISTS AND SOIL SCIENTISTS

Robert F. Black

It was with considerable hesitation that I accepted the invitation to speak today on the contribution of Wisconsin's geologists and soil scientists to the "good life" in Wisconsin. Quickly rationalizing, however, I thought it would do me good to delve more deeply than I had into the early geologic writings on Wisconsin. Frankly, I was amazed at how much I didn't know about the early writings, but more than that I was actually enthralled with the spirit of the times those papers represented. Above all it is truly fantastic how much has been learned of the geology of this State considering the times and in spite of the less than favorable political environment that existed in the early years. Most geologists are historians, but of earthly events other than those of man's doing in historical time. In this intriguing task I had both.

How can I pass something of both the spirit and the content to you? In so short a time one cannot even recite the names of all geologists and soil scientists who have contributed to the knowledge of Wisconsin, let alone say something of the nature of that contribution. What criteria do we use to distinguish the most important contributions? From my vantage point as a geologist, it is inevitable that any furthering of basic knowledge of the earth leads ultimately to some practical gain whether directly or indirectly. Hence, it follows that any geologic surveys of the state or any part of it that add new data contribute to the "good life" sooner or later. In 1857 Edward Daniels, in writing on state geologic surveys, stated the case succinctly: "The utility of such surveys is not at this day to be questioned, after being so abundantly proved by the experience of every important State in the Union, and the united concurrence of the most intelligent nations of Europe" (Daniels, 1858, p. 62). Although a man ill with dysentery, fighting inclement weather and savages in a strange wilderness, months of travel by canoe from anything even remotely called civilization, might disagree, still those first bits of knowledge hastily garnered come easier than those bits of new truth that must be gained after laborious evaluation of large stores of knowledge. In many ways, then, the first writers made the most important contributions, because they started with nothing. Others later who reevaluate and add to that knowledge can make equally important contributions, but often only time will prove their value. Consequently I shall dwell mostly on the early contributions. It will be only a haphazard sampling, but I hope it will show something of the amazing amount of information that was garnered with relatively little support. I shall not be particular whether a man can be considered a native son or not—after all, who was in the beginning?—nor whether

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a man's studies were financed by the state or not. If through a man's work, the direct mining of ore deposits was helped in any way, fine. Conversely, if tourist dollars increased because a geologist was able to unravel the history of a natural phenomenon like the Wisconsin Dells to later help "sell" it to the public, fine also. They contribute to the "good life" just as much as does the addition of certain chemicals to the soil to increase crop yields. To me at least, knowledge for knowledge's sake in just understanding the geologic history of the earth around us is a worthy contribution. No better documentary can be had than the millions of people who each year flock to our National and State Parks to see and learn of the history of the land-forms and rocks of which they are made.

The recording of basic knowledge of geology and soils of Wisconsin begins with the earliest recorded history of exploration of the State—in 1634 when Samuel Champlain's agent, Jean Nicolet, first set foot in the State apparently at Death's Door Bluff on Door Peninsula. In those days the dream of vast mineral wealth was second only in importance to the fur trade as an incentive for exploration. Such anticipation was obviously heightened by chunks of native copper passed in 1610 and thereabouts to Champlain and other officials of New France by Indians from what we now know was Keweenaw Peninsula in Upper Michigan. Twenty years followed Nicolet's visit before Europeans again returned to Wisconsin to record their adventures and the environment. The bush merchants, Radisson and Groseilliers, in 1654 to 1660, ascended the Fox River and apparently reached the Mississippi River. They possibly heard about the lead deposits near Dubuque, Iowa (Thwaites, 1908, p. 155), and the subsequent journals of Marquette, Hennepin, and Lahontan allude to the mineral wealth of the area. Hennepin's map (1687) even showed the location of a lead mine at Galena, Illinois. Many others contributed to the knowledge of the State, but generally only the Jesuit efforts were recorded faithfully. It is history's tragic story that Nicolet's papers and crew were lost in 1674 in rapids above Montreal, so much of his actual findings comes only through the writings of Jacques Marquette who died in 1675 on the east side of Lake Michigan. His maps and naratives published in the Jesuit "Relation", in 1673–74 particularly, led to the opening of Wisconsin to commerce, missionary enterprise, and settlement. French exploitation followed.

In 1697 Le Sueur obtained permission from the ministry to work "lead mines and colored earths" on the Mississippi River, and copper deposits near Lake Superior. He was delayed several times by "politics" and other reasons and did not reach the lead mines near Galena, Illinois, until 1700. In 1701–1702, not being a geologist, he laboriously sent back to France by canoe and ship more than 3,000 pounds of worthless greensand (Cambrian-age quartz sandstone of the Franconia formation with abundant green glauconite—a complex hydrous silicate of potassium, iron, and other elements) which he mistook for copper ore. Although he died discredited, the deposits of the zinc-lead district he first explored have been worked with only slight interruption ever since. (Bain, 1906, p. 2, credits Nicholas Perrot with the actual discovery in 1690 of the lead deposits.) Incidentally in Wisconsin alone those deposits have yielded conservatively at least $435,000,000 of zinc and lead, using an average price of 15 cents per pound. Without question those deposits have dictated policy at all levels from the individuals directly involved to the remote Federal Government. They led to the first permanent settlement by United States citizens in Wisconsin beginning in 1819. Hazel Green and New Diggings were settled in 1824, and 10,000 people flooded into the Upper Mississippi Valley from 1825 to 1828. Lead production jumped commensurately.

Certainly those deposits, or more specifically the wealth they represented, were involved in the abortive attempts to establish the Wisconsin–Fox River route for steamships between the Mississippi River and Lake Michigan. They were paramount in the planning of the Milwaukee–Rock River canal which never got started, in the Lake Michigan–Illinois River canal which was completed, and later, in 1858, the railroad linking Milwaukee and Prairie du Chien. One can only reflect on the special 20-ton hand-propelled river boats that carried lead to Louisiana or the hundreds of ox-drawn wagons that hauled lead to Milwaukee via Madison or Janesville. However, a not so rosy picture can be painted of the Black Hawk war which broke out in 1832 between the miners and local Indians.

In the 1700's fur was king, but lead took over by 1830 and reached its peak in the decade 1840–1820. Zinc mining dominated by 1900 and still leads today. Farming, because of excellent soils and good distribution of moisture through the growing season, surpassed mining even though lumbering had its fling in 1890 to 1905. Iron and copper prospecting in the north dominated the 1880's. Our major mineral production for the past several decades now comes from stone and ordinary sand and gravel. Few may realize that in 1964 mineral production in Wisconsin was almost $70,000,000, of which $25,000,000 was sand and gravel and $19,000,000 was stone. Zinc accounted for $7,000,000, double that of 1963 and I believe an all-time high; lead only $450,000; iron small but not disclosed to avoid violation of individual company confidential data. Only one mine, the Cary mine, produced ore and it is now closed. Thus, about 85 percent of mineral wealth produced today in Wisconsin is nonmetallic. Time has brought many changes since the early settlement of the state just over a century ago.

To get back to my theme—in the 18th century, geologic exploration in the lead district was done largely by individual Frenchmen, and little or no record was kept except of actual mining operations. As the states of Illinois, Michigan, and Minnesota were established, parts of the territory that was to have become Wisconsin were whittled away, losing for the State abundant mineral wealth and valuable farm land. A general land survey was not made until 1834 when townships, ranges, and sections were established in the lead district. The first geologic study of consequence was that under the direction of David Dale Owen, M.D., who with 140 men mapped 11,000 square miles from September to November, 1839, in the mineral lands of Iowa, Wisconsin, and northern Illinois (Owen, 1840). This was the first of several United States geological surveys of the lead region and perhaps the first important geological survey in the country by the Federal Government. The preliminary report on that first survey was followed by a more complete report (Owen, 1844). Owen with others later expanded the geologic work in Wisconsin, Iowa, and Minnesota in an area of 200,000 square miles, publishing a series of preliminary and annual reports (e.g., Owen, 1848), which were summarized in a final report (Owen, 1852). One needs to look at only a few of the wood cuts of natural features in those various reports to appreciate true artistry. Little escaped the keen eyes of the observers, and all was faithfully recorded. Without question those works provide the base upon which all future surveys depended. Most observations are still pertinent, and many conclusions are still valid. Considering the times, Owen had every right to compare closely the lead region of the Mississippi Valley with that in the north of England and in Scotland. In his letter of transmittal Owen (1840, pp. 6–7) stated "that the district surveyed is one of the richest mineral regions, compared to its extent, yet known in the world. The chapter on 'soils' also shows that, unlike most other mineral regions, it is fertile, and capable of yielding to the farmer a liberal reward for his labor". Some items from the table of contents of that first report (Owen, 1840, p. 10) provide insight to the wealth of information contained:

Country exlored, situation and extent of
Its geological character
Cliff limestone, the lead-bearing rock of Iowa and Wisconsin . . .
Lead-mines
Copper ore
Zinc ore
Iron ore
Coal
Salines
Building rock
Millstones
Other Minerals
Soils
Altitudes of table-lands, hills, mounds, and mountains . . .
Terrestrial magnetism
Earthwork antiquities of Wisconsin
Climate and meteorology . . .
Report on the timber, soil, and productiveness of the mineral district

Owen (1840) recognized most major stratigraphic units in the Paleozoic sequence of Wisconsin, and one term, the Lower Magnesian Limestone, still lingers on in spite of its current official designation as the Prairie du Chien. He presented, I believe, the first chemical analyses of virgin soils in the State (Owen, 1840, p. 49). He continued the use of the Lower Magnesian Limestone in his final report (Owen, 1852) and introduced the term St. Peter's sandstone which has merely been shortened today to St. Peter sandstone. Inclusion in "Giants of Geology" (Fenton and Fenton, 1952) is recognition of his renown as a geologist.

In Owen (1840), earthwork antiquities refer to effigy mounds on which precise measurements were made by John Locke, M. D. (Owen, 1840, pp. 136–141). It was astonishing to Locke, having accidentally stumbled on some, to have supposedly well-informed people still pretend to dispute their man-made or "artificial" origin. "The same ambition to exercise an independent judgment might lead the same individuals to dispute that the ruins of Herculaneum are artificial; the same argument might be used—'that they just come so in the earth' ". Regretfully many such effigies have been destroyed; only a few localities remain in the public trust.

The final report with its greater detail on topics and districts also included systematic catalogs of plants, birds, and fossils. Certain conclusions reached, some contrary to the then current wishes of promoters and public at large, have stood the test of time. For example, Col. Charles Whittlesey in his report (Owen, 1852, pp. 424–473) stated flatly (p. 438), "Within the District on which I am now reporting, I find no lands that I deem worthy of reservation as mineral lands, under the terms of the act of 1847." This statement was specifically with reference to copper showings in northern Wisconsin on which many claims had been filed and much trading was going on. The copper rush of the 1880's showed again the gullibility of the public, for people believed that every surface showing of copper led axiomatically to a rich ore body. Such opinion as Col. Whittlesey's was not welcomed.

Col. Whittlesey also recorded (Owen, 1852, p. 463) that "At Appleton, on the Fox River, in a well, pieces or splinters of well-preserved wood were found at the depth of thirty feet." Down through the years many more such finds have been recorded, and some wood has been dated by the carbon 14 method. It is now agreed that most such wood in the area correlates with the world famous Two Creeks horizon on the shore of Lake Michigan at the boundary of Kewaunee and Manitowoc counties and averages about 11,850 years old. The ancient spruce forest and soil of that horizon were overrun by the last glacier to enter the state—the Valders—and incorporated in the drift derived from that glacier. Although many papers have appeared on it (e.g., Thwaites and Bertrand, 1957) much still needs to be done to unravel the complex history portrayed by the site. When another area of the state is set aside as a scientific preserve, this privately owned area should be the first. Otherwise the limited exposure will be lost to science and posterity.

While Owen's parties were conducting the federally supported geological surveys in the mineral districts, Increase A. Lapham at Milwaukee was compiling his most useful volumes on Wisconsin (e.g., Lapham, 1846). In the title nothing was left to the imagination—for it reads in its entirety—"Wisconsin: its geography and topography, history, geology and mineralogy: together with brief sketches of its antiquities, natural history, soil, productions, population, and government". As stated in the preface, "The work was originally given to the public with the hope, not only of furnishing the thousands of newcomers, who are annually flocking to our Territory, and to others, in a cheap and convenient form, a large amount of useful information, which it would be difficult for them to obtain from any other source; but also to preserve for the future historian many interesting facts which might otherwise soon be forgotten and lost." This work must surely have been equally important as the Bible to many newcomers.

Lapham (1846, p. 52) refers to the hasty travels, mostly in small canoes along principal rivers and lakes, of several geologists whose works had been published. They include Schoolcraft, Keating, Featherstonhaugh, James Hall, I. H. Nicollet, H. King, and J. P. Hodge. (See Martin, 1932, for a partial résumé.) Lapham (1846, pp. 52–62) divides the territory into four geological districts, differing materially from each other in physical character, dependent upon the rocks prevailing in each. These were called 1. primitive, 2. sandstone, 3. mineral, and 4. limestone. Their distribution would be clear to anyone cognizant of the prevalance of the ancient Precambrian crystalline rocks of northern Wisconsin and the arcuate border of Paleozoic sandstone and limestone to the south. The mineral district of those days, of course, was only in southwest Wisconsin. Moreover, Lapham (1846, pp. 63–70) listed all minerals known to occur in the Territory, with comments on their occurrence, distribution, and value. No bones or teeth of the extinct mammoth or mastodon had yet been discovered in the Territory (Lapham, 1846, p. 70), but numerous specimens showed up in the following decades. One skeleton of mastodon was found in 1897 near Boaz, Richland County; it was mounted and still resides in the wasting (to my regret) museum of the Geology Department of this University. Although the museum is literally "drawn and quartered", we have so far survived numerous pressures to dispose of the ancient beast. Many people think new students with only 17 to 20 years of experience in this world are more important or at least have more rights to space in our buildings than a beast that roamed Wisconsin up to perhaps 8,000–10,000 years ago. There seems to be no respect for the elders. When I see the eager looks and hear the breathless query of the youngsters who constantly visit Science Hall and ask for the "dinosaur", I remain convinced that this specimen and others have a rightful place in our educational system.

In excavating the canal in Milwaukee, in a gravel bank some ten or twelve feet below the surface of the ground, three pieces of native copper were found, one of which Lapham (1846, p. 69) mentions is safely deposited in the Cabinet of Yale College, New Haven. He points out rightly that "These fragments of copper have evidently been transported from their native beds, probably at Lake Superior, with the boulders of primitive and trappean rocks, and by the same cause, they are, therefore, not to be regarded as indicating the existence of copper mines where they may happen to be found." Remember, the concept of glaciation in Wisconsin had not yet been born. However, he refers to a mass of copper west of Lac Vieux Deserte "which is said to exceed in magnitude" the celebrated copper rock from the Ontonagon. It was such rumors that Whittlesey attempted to squelch with but little success for several decades.

Lapham (1946, pp. 130–134) demonstrates his breadth of knowledge and forward thinking during his discussion of the periodic rise and fall of the surface of Lake Michigan and its relationship to precipitation and runoff in the Great Lakes System, and to the effects of wind. He points out, too, that "the mouths of every considerable stream evinces *(sic)* that they once were lower, wearing their beds some fifteen or twenty feet below the present surface of the water. The subsequent elevation of the lake has caused the water to set back on these rivers, in some cases two or three miles, causing deep pools of 'back water', and affording convenient basins for the accommodation of shipping. In what other way could these river beds have been excavated to so great a depth?" Of course today those basins are filled with the fertile soils washed from the de-timbered slopes and from the farms adjoining those streams. He also proposed an hypothesis for the former discharge of great volumes of water down the Illinois River from the combined

Lakes Superior, Huron, and Erie by slight changes in the elevation of the land. Such we now know took place during the Ice Ages.

In 1848 Wisconsin became a state, but it was five years later before action was taken by the legislature to further geologic exploration. This was done with an appropriation of $2,500 per annum for four years and the appointment of Professor Edward Daniels, who was directed to make a geological survey of the state, first surveying that portion known as the "lead mines", because of their great intrinsic value and the general misapprehension which then existed about them. The misapprehension referred to the knotty yet critical problem of whether the lead veins continued at depth into the Lower Magnesian Limestone or whether they terminated in the St. Peter sandstone. Daniels (1854) presented his first annual report the same year as his appointment after spending six months in the field in southwest Wisconsin. Perhaps some words of the State Committee on Mining and Smelting that year (Earnest, 1854) would be better than my own:

> This report, although he had but about eight months previous to submitting it in which to discharge his duties, shows that he has performed a large amount of labor, and developed facts which are deeply interesting to the man of science, and of incalculable benefit to the practical miner. No one in the least degree acquainted with the science of geology can rise from a candid perusal of his report, without being forced to acknowledge that Professor Daniels is a man of talent and of extensive information in every department of his profession.
>
> The perculiar *(sic)* friends and advocates of a geological survey of the state predicted for it results, the value of which would be beyond all calculation. These predictions have been fully realized . . .
>
> The only recommendation of the committee, in reference to the Geological Survey is purely negative; that it be let alone, and that Prof. Daniels be allowed to work out, without the interference of either the Legislature or Executive branches of Government the results he has so hapily commenced.

Any further comment I might make would seem redundant, yet I must mention that Daniels predicted that the lead veins would extend at depth into the Lower Magnesian Limestone and that the zinc ores could and should be worked as Owen before him had urged. He issued a circular April 20, 1853, soliciting specimens and information of the geology of the State from all citizens, and truly showed his great interest in the State. Also I refer you to his description (Daniels, 1854, pp. 10–12) of the surface clay in the lead district. In it Daniels found what he called fresh water shells *(Limnea galbana)* in great abundance about twenty feet below the surface, and bones and teeth of the elephant and mastodon were found at Fairplay, Potosi, and Sextonville. He postulated a great lake over all southwest Wisconsin and thus contributed to the later controversy over the origin of what we now call loess.

If you felt I was leading up to something with my quotation from the State Committee on Mining and Smelting, you were right. A new governor. William A. Barstow, peremptorily removed Daniels and appointed James G. Percival State Geologist on August 12, 1854, again to study the lead district first. His first annual report (Percival, 1855) follows in large measure those of his predecessors and has been reviewed by Blake (1893) in the *Transactions* of this Academy along with Percival's second but posthumous report (Percival, 1856) in which visits to thirty-eight of the northern counties are described.

The State Survey was suspended in 1856 on Percival's death and for lack of funds (Daniels, 1858, p. 61). It was revived in 1857 when James Hall, Ezra S. Carr, and Edward Daniels were appointed Commissioners to make a geological, mineralogical, and agricultural survey of the State. The political situation obviously was still poor for Daniels had not permanent assistant and even paid personally for much assistance he could not do without. The total expenses of his department for the year were $1,997.91, ". . . . including outfit, team, transportation of specimens, fitting up rooms, assistance, together with the cost of analyzing the iron ores, which was necessary to determine their value, before the publication of my report." That he was an unhappy man is shown by his remarks (p. 62), "It is but just to allow the Geologist time to mature his results, before finding fault that he has not done more. In this State we have thus far had constant interruptions and no one has been allowed to carry out to completion any branch of the survey . . . ."

The division of responsibility under the three commissioners was far from satisfactory (Bean, 1937, pp. 206–210), and in 1860 Hall was appointed principal to the commission. Subsequent annual reports of progress were brought together in a large volume (Hall and Whitney, 1862) embracing a chapter descriptive of the general geology of the State, but emphasizing again the lead district. Whitney differed strongly from his predecessors' conclusion that lead could be mined profitably in the Lower Magnesian Limestone. Time has shown both somewhat correct although only few commercial deposits have been found in the Lower Magnesian Limestone (Prairie du Chien) (Heyl, *et al.*, 1959).

In 1862 the legislature repealed the act authorizing the geological survey. Carr and Daniels left, no doubt in some disgust, but Hall fought on contending that his contract could not be broken. Although he completed his original commitments, he was never reimbursed, and published his paleontological works outside the state.

The legislature cautiously in 1870 acted to provide a survey of the lead district again (Murrish, 1871), and in 1873 went "hog-wild" in appropriating $13,000 per annum for four years for a complete geological survey of the State, with Increase A. Lapham as State Geologist. He and his assistants, R. D. Irving and T. C. Chamberlin, need little comment from me on their numerous contributions to the State. However, the situation was far from serene in spite of the eminent personnel involved in the survey. Part was due to Irving's entirely correct but perfectly candid, unreserved, and unpopular report on the geology of the Penokee iron range, but mostly it was "politics" again. Governor Taylor in 1875 appointed O. W. Wight in place of Dr. Lapham. Chamberlin took over in 1876 and finally managed to bring the State Survey into proper perspective, culminating in a four-volume report (1877–1883) that stands today as the only "complete" work on the state (Bean, 1937, pp. 213–216). A perusal of its contents shows its scope is far broader than just geology and soils. Certainly Chamberlin's contribution to the State and to science in general, cannot be over emphasized. As a world leader in glacial geology, a "giant of geology" (Fenton and Fenton, 1952), and a former great President of this University, it is fitting that it is done in part by the placque on the glacially transported rock on Observatory Hill on this campus.

It was 1893 before sufficient people in the right places realized that the State could not afford to be without a continuing geological survey to provide everyday services. That group came from the members of this Academy. The committee report (1894), the vote of the Academy, and the influential efforts of the committee chairman, Dr. Charles R. Van Hise (later Chairman of the Department of Geology and another truly outstanding geologist and great President of this University), finally led in 1897 to the establishment of the State of Wisconsin Geological and Natural History Survey with an appropriation of $5,000 per year. The President of the University of Wisconsin was regularly president of the governing commission, which included the president of the Academy, until 1931 when the Survey was placed under the Regents of the University. In 1909 a third division, Soils, was added to the Survey. For decades the plans of E. A. Birge and Van Hise largely determined the policies of the Survey, but still today the goal of its founders has not been reached. Part is due to changing needs and part to the fact that other state agencies have taken over certain functions envisioned for the Survey. I cannot list here the accomplishments of the men associated with the Department of Geology (Hone, 1962) and with the Survey, many of whom worked only for the love of it and received only reimbursement for actual field expenses. The latter can be found in the commissioners' reports, in the four series of publications—Economic, Scientific, Educational, and Soils—and in the Information Circulars and miscellaneous publications outlined in the free list to be had from the State Geologist. One finds many famous names such as: Samuel Weidman, Rollin D. Salisbury, Wallace W. Atwood, Ulysses Sherman Grant, Ernest R. Buckley, N. M. Fenneman, W. O. Hotchkiss, Edward Steidtmann, J. W. Goldthwait, H. Foster Bain, Edward A. Birge, Chancey Juday, C. K. Leith, Fredrick T. Thwaites, A. H. Winchell, W. H. Twenhofel, R. H. Whitbeck, A. R. Whitson, Lawrence Martin, and E. F. Bean. Would that I could name all. Those I did are now gone, and new ones are taking their places.

At present the Soils Division of the Survey is most active, with several employees working jointly for it and the Soils Department. Interest in the zinc-lead district continues, with recent studies being done by personnel of the U. S. Geological Survey in cooperation with the State Survey. A small inadequate cooperative program also maintains interest in the Precambrian (Primitive) rocks and ore deposits in the north. Finally after all these decades the State and Federal Surveys have completed base maps of at least one inch to the mile of all the State; many are still planimetric or out-dated topographic, but continued progress can be foreseen in part because of the interest and activity of the Committee on Acceleration of Topographic Mapping of this Academy. Now interest of necessity is gaining in projects on the water resources of the State, and this Academy also has a committee in this field. Most research is done in cooperation, on a fifty-fifty cost-sharing basis, with the U. S. Geological Survey. Unquestionably the water resources will demand increasing emphasis for some time to come. Unfortunately, the glacial, engineering and other aspects of geology and natural history of the

State are being neglected. For example, when one realizes the rapid rate of depletion of suitable construction aggregates in the vicinity of many cities and the rise in costs of bringing such aggregates from greater and greater distances, the need for study and appraisal of our resources of sand and gravel and of non-dimensional stone become uppermost. Requirements on quality become evermore strict, yet those nonrenewable resources are being exhausted in many places. Without dwelling on the justifications, would it not be appropriate for this Academy to appoint a committee, as it did in 1893, to look into the means of expansion of activities of our present Geological and Natural History Survey? Efforts to expand each biennium have met with only limited success. The University of Wisconsin has a huge reservoir of talent in its Geology Department which now for lack of funds the State Survey cannot utilize. For the good of the State this situation must be rectified.

In conclusion let me say unequivocably that the State of Wisconsin has received to date far greater return on her investment in geological surveys than she really has a right to expect. When we look at the Surveys of our neighbors, we can appreciate how much more she should be doing for her own good. In spite of at times an unfavorable environment, Wisconsin's heritage in earth science is long and distinguished. I hope and trust that the future will be even brighter.

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CHARLES FARRAR AND THE LADIES' ART AND SCIENCE CLASS OF MILWAUKEE

Katherine G. Nelson

"Continuing Education for Women" is not so new. Back in the 1870's, while the men of some Wisconsin families were finding an outlet for their intellectual interests in the young Wisconsin Academy of Sciences, Arts and Letters; while sons and a few daughters were being educated at private colleges and the University of Wisconsin; the ladies of the family did not necessarily confine interest to the home. At least one group of married ladies was pursuing higher education at Milwaukee College.

Charles Farrar, who just one hundred years ago (in 1865) became the first chairman of the science departments at Vassar College, resigned his position there in 1874 to accept appointment as Principal of Milwaukee Female College. He had been "tried out" by the Trustees that spring, when he was brought to Milwaukee for a series of lectures, and even in early April it was rumored that he would be offered the presidency.[1] He accepted in June, and arrived in Milwaukee in time to attend Commencement exercises on June 26.

One of Professor Farrar's first innovations was the introduction, in the winter of 1874–75, of a course of lectures on chemistry for the women patrons of the college.[2] This met with such enthusiastic response that the fifty-three ladies who enrolled the first year organized a class which became an important auxiliary of the college, with several hundred women paying $5.00 each to attend a series of ten lectures every winter.

In order to understand how a chemistry course could meet with such overwhelming success, and lead to the establishment of one of the finest collections of art books in the Middle West, it is necessary to know a little more about Professor Farrar.

Charles Samuel Farrar was born in 1826 at Pepperell, Massachusetts. He was educated at Lawrence Academy, Amherst College, and Dartmouth College, where he was elected to Phi Beta Kappa, and was graduated in 1850. The Milwaukee City Directory of 1875–76 puts an A.M. after his name. The first two years after his graduation, he read and practiced law in Gilmanton, New Hampshire, but his greater interest in the sciences and humanities led him to give up his practice to become the principal of the local academy. In 1854 he moved to Elmira, New York to teach natural science and mathematics at Miss Thurston's Seminary. At this time, Elmira Female College had already been chartered, and it opened in 1855. A year later, Farrar was made Professor of Natural Sciences at the College, a position he held for eight years. Thus began his lifelong work in higher education for women, at three differ-

[1]Milwaukee Sentinel, April 6, 1874. (Microfilm, Milwaukee Public Library).

[2]Kieckhefer, Grace Norton, *The History of Milwaukee–Downer College,* Milwaukee, 1851, p. 33.

ent colleges, and in three different communities where, although his name is rarely heard today, results of his work and influence are still prominent.

He believed in active participation by students, and in the use of visual materials. He started the custom of college field trips at Elmira. In 1857, he had a ten foot globe built and suspended from the cupola of Elmira's central hall.[3] The continents and mountains of the earth were represented to scale, and raised relief was used. Two years later, he built and equipped Elmira's observatory, the first ever used exclusively by women students.[4] He personally selected the site and raised the funds to purchase it, to build the observatory, and to buy an eight inch telescope.

Probably it was his experience in planning this observatory, as well as his reputation and esteem as a teacher and a scientist that drew Professor Farrar to the attention of Dr. Milo Jewett. At that time, Dr. Jewett was president of Vassar Female College, which had been founded in 1861 with nearly half a million dollars provided by Matthew Vassar. Jewett's presidency consisted of planning, supervision of building, and assembling of instructional materials and a faculty, for he resigned before the first classes opened in 1865. One of his accomplishments was to induce Professor Farrar to join him in Poughkeepsie, New York in 1863, to oversee the construction of Vassar's science departments and observatory. No doubt the salary of $2500, compared with $900 at Elmira,[5] had some influence on this move, along with the challenge of helping to build the new institution.

With Charles Farrar as the architect, Vassar's observatory was its first building to be completed. Surprisingly, in spite of his great interest in Astronomy, it was not he, but Miss Maria Mitchell who was appointed to the Chair of Astronomy when the college opened in 1865. (There was only one other woman among the nine department heads, and she was the college physician.) Professor Farrar was head of the Mathematics and Physics Department. In addition to the nine professors, there were twenty-one women teachers.[6]

In the spring of 1866, Professor Farrar had his trigonometry class make a survey of the college property, and the resulting map was printed in all the early accounts of the college. Further projects that he assigned are described in a letter by one of his students: "(I have) chemistry in lectures from Professor Farrar, and work in the laboratory twice a week, that is, I, with my own hands, have made paint and inks, and dabbled with CO_3 and CO_2 and almost everything else."[7] Small wonder that the ladies of Milwaukee, eight years later, were fascinated by this able teacher's lectures and demonstrations on "The Application of Chemistry to the Art of Living", which covered such topics as the use of chemistry in cooking, in the manufacture of pottery and porcelain, and in the dyeing and printing of textiles.[8]

In 1870, President Eliot of Harvard visited classes at Vassar, and he told Professor Farrar that "the boys at Harvard could not recite nearly as

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[3]Barber, W. Charles, *Elmira College—The First Hundred Years*, New York, 1955, p. 94.

[4]Ibid., p. 103.

[5]Ibid., p. 93 and Plum, Dorthy and Dowell, George, *The Magnificent Enterprise—A Chronicle of Vassar College*, Poughkeepsie, N. Y., 1961, p. 8.

[6]Plum and Dowell, op. cit., p. 8.

[7]Ibid., p. 14.

[8]The Milwaukee Journal: Tuesday, March 16, 1965, p. 8., (Article by Patricia Roberts on the Milwaukee–Downer College Endowment Association).

well in German, French or Latin, or even in mathematics as the girls did here." And a year later, one of Farrar's major students began graduate work in chemistry at Massachusetts Institute of Technology, the first woman to be accepted there.[9]

It would seem that Professor Farrar should have been content to remain at Vassar for many years, with security, equipment, and able and enthusiastic students assured. But perhaps, as one of the author's professors once said, "the monotony of an ideal existence became unbearable." At any rate, he was ready to accept a new challenge when it came in the offer of the Principalship of Milwaukee Female College.

Miss Mary Mortimer, who had headed the college in Milwaukee from 1852 to 1857 and from 1866 to 1874, had spent one of her interim years as substitute headmistress of the Seminary in Elmira, while Miss Thurston was on leave, and there she had come to know and admire the ability of Charles Farrar. It was she who invited him to lecture at the College in the spring of 1874, and "to become acquainted with the Trustees and the College."[10] Vice-President of the Board of Trustees of Milwaukee Female College at that time was Dr. Milo Jewett, who had moved to Milwaukee sometime after resigning the presidency of Vassar Female College, and certainly he must have been influential in persuading Farrar, for the second time, to move from one college to another. This move was to a college established in 1851—earlier than either Elmira or Vassar, so that it was a going concern, but there was no such assured salary as the professor had been receiving at Vassar. His sole revenue would come from the tuition and fees of students, and from this he was to pay for all repairs, taxes, insurance, assessments, teacher's salaries, and other small items. In turn, the contract provided that he could lease the buildings rent-free, and it gave him nearly complete authority in the hiring and firing of teachers, in establishing entrance requirements and curriculum, and in determining rates of board and tuition. He was astute enough to sign this contract only after being assured that he would have a clean start, with no debts, and with the plant in good physical condition, and well-equipped.[11]

It is not surprising, then, that Professor Farrar should have introduced a series of lectures to bring in some additional revenue. Perhaps far more important, though, than the lecture fees was the good-will that he brought to the college as he entered the cultural life of Milwaukee. He had much in common with its influential citizens, and their support continued long after he left the college in 1889.

Farrar believed in equal education and opportunity for women. In line with the idea that there should be no difference in the quality of education for women from that of men, he followed the move that Vassar had made some years earlier of deleting the word Female from the college name.

Several men who at one time or another were members of the Milwaukee College's Board of Trustees were among the founding Wisconsin Academy of Sciences, Arts and Letters in 1870—Increase A. Lapham,

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[9]Plum and Dowell, op. cit., p. 20: Ellen Swallow, Vassar College '70 was the first woman accepted by M. I. T.

[10]Kieckhefer, op. cit., p. 29.

[11]Ibid., p. 31.

Edward D. Holton, Alexander Mitchell, and Samuel S. Sherman[12]—and as time went on, others of the long line of trustees became Academy members. So it is not surprising that the Second Semi-Annual (Summer) Meeting of the Academy was held at Milwaukee College in July 1878. Among the men elected to Academy membership at that meeting were Professor Charles S. Farrar, "Dr." Thomas A. Greene, Mr. William P. Merrill and Mr. William P. McLaren, all of them important contributors to the advancement of Milwaukee College. What's more, Mrs. Charles Farrar also became a member that day, as did twenty-seven other women, in comparison to twelve men. Academy President P. R. Hoy prefaced the ballot with the remark "science knows no distinction of race, color or sex."[13] Surely Professor Farrar must have had some influence on this sudden rise in female membership. The first three women members, all from Madison, had joined a year earlier.

At Milwaukee College, as earlier at Elmira and Vassar, Professor Farrar's interest in Astronomy led to the building of an observatory. It was the aforementioned Academy member William P. McLaren who had given the funds to build it, to house a telescope presented to the college by Mr. Hiram Barber in 1875.[14]

Professor Farrar, himself, was the donor of much equipment, and as the success of his lectures added to interest in the college, not only did gifts come from others, but his revenues increased, so that he could invest money in expansion of the college. It was his own revenues that paid for an addition to the college buildings in 1879, and the following year for the modernization of the heating plant. After a fire in 1883, the Ladies' Art and Science Class replaced furnishings and art objects, and later that year they asked for larger quarters than the reading room that had been set aside for them. They offered $650, to which Farrar himself added $1800 more, and another addition was built.[15] The Class provided furnishings, and continued to add art objects and reference books for many years.

While the early lectures had been on science—chemistry, optics, astronomy, natural history—Farrar's interests were extremely varied, and he soon digressed into the field of art. This appealed especially to the ladies. He had brought with him to Milwaukee a large number of lantern slides on all subjects, and a large, steam-operated machine with which he projected a series of pictures on quick succession on a twenty-two foot screen, to illustrate his lectures. He was an early user of the stereoptican lantern.[16] As the interest of the ladies' class turned more and more to art, and as the library of rare and beautiful books on art was added to by them, the professor traveled to Europe and brought back a great number of new slides of the works of art in museums there.

Even after he retired, in 1889, and moved to Chicago, he continued to direct the Art and Science Class. Eventually, because of a duplication of membership, the Class became absorbed into the Milwaukee College Endow-

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[12]Wisconsin Academy of Sciences, Arts and Letters, *Bull.* No. 1, Madison, April, 1870, p. 2.

[13]Wisconsin Academy of Sciences, Arts and Letters: *Trans.*, V. 4, 1877, Madison, 277–278.

[14]Kieckhefer, op. cit., p. 33.

[15]Ibid., p. 36.

[16]The Milwaukee Sentinel, Nov. 28, 1877.

ment Association, which this year (1965) celebrated its 75th Anniversary, and which continues to sponsor a series of weekly lectures in Milwaukee each winter, for its members. Among the professorships which it endowed at Milwaukee–Downer College was the Charles Farrar Chair of Art. And just recently, Dudley Crafts Watson, first Director of the old Milwaukee Art Institute, predecessor of the Milwaukee Art Center, credited the Ladies' Art and Science Class with an odd role in its establishment when he said "It all started with an overheated samovar" which the class was using to serve tea at the opening of an art exhibit in 1892. The resulting fire led eventually, a few years later, to another exhibit by the same artist, and a sale, the proceeds of which helped to found the Art Institute.[17]

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[17]The Milwaukee Journal, Sunday, May 2, 1965, Part 5, p. 6—article by Donald Key. The artist whose paintings were burned was F. Hopkinson Smith.

HISTORICAL AND STATISTICAL REVIEW OF THE DOMESTIC TRAFFIC OF THE PORT OF MILWAUKEE

Eric Schenker

Like other Great Lakes cities, Milwaukee's shipping traffic antedates its existence. In the eighteenth century, the confluence of the Milwaukee, Menominee and Kinnickinnic Rivers made the site a good location for visiting fur traders, most of them French; in 1795 the Northwest Fur Company established a trading post there, which flourished for some years and developed into a small village, but declined after 1810. John Jacob Astor's American Fur Company established a post in 1818. The fur trade, however, could only prosper in a relatively unpopulated, backwoods area, and it declined after 1820.[1]

The development of the lead-mining industry in southwestern Wisconsin during the 1830's provided a greater stimulus to Milwaukee's shipping, particularly after 1836 when capitalists from Buffalo, New York, bought a shot tower at Helena, and began to develop an eastern market for lead and shot. These commodities were hauled overland to lake ports; Racine is known to have received a two-ton shipment in the same year, and by 1838 in Milwaukee, "it was a common thing to see oxen hauling wagons laden with lead from Grant and Lafayette Counties appear at the wharves after a journey of eight or ten days." By 1842 and 1843 Milwaukee was shipping over 1,000 tons annually to Buffalo, but the production of lead declined after 1844.[2] Grain also began to be shipped from Milwaukee in 1841, and grew steadily in importance; Milwaukee was the leading wheat center by 1862, shipping over fifteen million bushels. It reached a peak of twenty-five million by 1873, then declined, largely due to competition from St. Paul and Minneapolis. Meanwhile, however, shipment of other grains grew in volume, and Milwaukee surpassed its 1875 record for all grains in 1892, growing steadily to seventy-six million bushels in 1914.[3]

Other commodities also began to play a part in Milwaukee's traffic. Coal receipts soon came to dominate the port's tonnage, first exceeding 1,000,000 tons in 1888 and never going below that figure after 1891. At first most of the receipts were anthracite, but by 1897 bituminous coal had become more important, and in the 1911–1920 decade bituminous receipts accounted for over 3,500,000 tons of the annual average of 4,700,000.[4] At that time coal

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[1]William George Bruce, *History of Milwaukee City and County* (Chicago: S. J. Clarke Publishing Co., 1922), Vol. 1, Chapters VI–XI, contains a great deal of material on the history of the early fur trade in Milwaukee. Bruce was chairman of the city's original Harbor Commission from 1911 to 1920, and President of the Board of Harbor Commissioners from 1920 to 1949.

Some historians contend that the fur trade declined because of the decline of fur bearing animals and the shift of European hat styles and not overpopulation of Milwaukee and environs in 1820.

[2]*Ibid.*, Chapter VII.

[3]*Ibid.*, Chapter XX.

[4]Edward F. Hamming, *The Port of Milwaukee* (Rock Island, Illinois, Augustana College Library, 1953), pp. 88–89.

accounted for 78 per cent of all receipts and 63 per cent of all traffic, which averaged about 6,100,000 and 7,500,000 tons respectively.

The record of Milwaukee's Great Lakes traffic between 1890 and 1940 can be traced in the accompanying table (Table I). The figures include both domestic and Canadian tonnage, which until 1933 comprised all of the port's shipping.[5] In this period the peak was reached in 1913, with 8,647,230 short tons. This was the record for both Great Lakes and total tonnage until 1950, when the port handled 8,926,964 tons, of which 28,409 was overseas. Most of the traffic was in bulk commodities, such as those already discussed, but Milwaukee also was one of the leading "package freight" or general cargo ports on the Great Lakes. Over 1,700,000 tons of the 1913 traffic were package freight. This service was disrupted and eventually killed by the "Panama Canal Act" of 1912, which forbade railroads to own domestic water carriers as of July, 1914; they had owned and operated the service between Chicago and Milwaukee on one hand and the Lake Erie ports (including Detroit) on the other. The railroads now became competitors for the package freight business, which in 1916–1920 dropped below half the 1911–1915 average. Later, competition from trucks hastened the decline of the business, and the federal government delivered the *coup de grace* in World War II by requisitioning the remaining freighters.[6]

Statistics on Milwaukee's domestic commerce are compiled by the Army Corps of Engineers. The Engineers distinguish between "vessel" and "car ferry" traffic, a distinction which will be useful in the rest of this analysis. The car ferries are a unique feature of certain Lake Michigan ports, in effect providing direct rail service between the eastern and western shores of the lake. Railroad cars can be loaded directly onto the car ferries on either shore and shipped to the other without break of bulk, avoiding the necessity of switching through the Chicago terminal district, which raises the risk of damage and may involve delays as well. The car ferries also eliminate the cost of stevedoring at both ports, which has been one of the major obstacles to a revival of the package freight trade.[7]

There are five ports on the western shore of the lake participating in the car ferry traffic, but Milwaukee has by far the largest share. The city is served by two ferries: the Chesapeake and Ohio Railway connects it with Ludington, Michigan, and a subsidiary of the Grand Truck Western Railway operates a ferry service to Muskegon. The C & O ferry carries a greater volume of traffic. In 1963, it brought 797,000 short tons to Milwaukee, as compared with 278,000 handled by the Grand Trunk Western; eastbound traffic amounted to 820,000 tons to Ludington and 463,000 to Muskegon. In that year, Milwaukee received about 53 per cent of all westbound traffic and originated approximately 42 per cent of the eastbound traffic.[8]

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[5]Milwaukee's trade with Canada since World War II is treated as foreign commerce, in accordance with Census Bureau foreign trade data. There is no point in differentiating between Canadian and domestic Great Lakes traffic for the earlier period, however, since the two were similar in nature and the Canadian usually amounted to less than two per cent of the whole. There was no overseas traffic until 1933 and less than 25,000 tons per year from 1933 to 1941.

[6]Hamming, *op. cit.*, pp. 113–116.

[7]*Ibid.*, p. 117.

[8]Army Corps of Engineers, *Waterborne Commerce of the United States, Calendar Year 1963.* The C & O also operates ferries from Ludington to Manitowoc and Kewaunee. The Ann Arbor Railroad ferry connects Frankfort, Michigan, with Manitowoc, Kewaunee, and Menominee and Manistique in the Upper Peninsula of Michigan.

TABLE I. GREAT LAKES COMMERCE, PORT OF MILWAUKEE, 1890 TO 1940 INCLUSIVE (IN SHORT TONS)

YEAR	RECEIPTS	SHIPMENTS	TOTAL	VALUE
1890	1,706,973	655,149	2,362,052	figures not
1891	2,155,311	761,167	2,916,478	available
1892	2,181,730	838,741	3,020,471	"
1893	1,926,604	735,233	2,661,827	"
1894	2,160,706	718,889	2,879,605	"
1895	2,238,404	826,651	3,065,055	"
1896	2,328,196	1,118,301	3,446,497	"
1897	2,656,889	1,093,457	3,750,346	"
1898	2,753,243	1,357,443	4,110,686	"
1899	2,720,097	1,226,423	3,946,520	"
1900	2,630,348	1,072,892	3,703,240	"
1901	3,031,163	1,006,434	4,037,597	"
1902	2,579,157	1,014,965	3,594,122	"
1903	3,935,816	1,135,952	5,071,768	"
1904	3,895,255	1,032,912	4,928,167	"
1905	4,197,533	1,256,874	5,454,407	"
1906	5,013,304	1,190,720	6,204,024	"
1907	6,091,333	1,604,669	7,696,002	"
1908	5,027,416	1,314,529	6,341,945	"
1909	5,619,155	1,395,350	7,014,505	54,344,305
1910	6,396,348	1,348,637	7,744,985	86,786,200
1911	6,224,239	1,388,002	7,612,241	119,653,735
1912	6,360,216	1,419,411	7,779,627	129,231,850
1913	7,116,434	1,530,796	8,647,230	140,734,750
1914	6,542,694	1,942,135	8,484,829	152,870,899
1915	6,437,885	1,681,990	8,119,875	150,348,921
1916	6,616,416	1,309,072	7,925,488	267,155,651
1917	5,745,601	1,075,263	6,820,864	309,582,900
1918	5,475,340	1,611,210	7,086,550	362,564,868
1919	5,689,300	1,418,900	7,008,200	320,079,300
1920	4,666,272	1,094,297	5,769,659	216,381,900
1921	4,766,463	1,664,684	6,431,147	201,660,800
1922	4,012,993	1,529,942	5,542,935	281,415,200
1923	6,351,726	1,353,315	7,705,041	415,936,200
1924	5,099,899	1,376,515	6,476,414	349,913,900
1925	5,611,274	1,296,537	6,907,811	450,001,200
1926	6,111,730	1,425,786	7,537,516	411,139,900
1927	6,512,243	1,720,955	8,233,198	466,726,000
1928	6,197,513	1,787,281	7,984,794	514,399,650
1929	6,698,674	1,866,189	8,564,863	486,228,800
1930	6,122,289	1,580,893	7,703,182	380,551,900
1931	4,873,909	1,702,368	6,576,277	255,868,400
1932	4,203,765	1,043,502	5,247,267	167,197,100
1933	4,848,263	1,503,235	6,351,498	210,146,200
1934	4,889,387	1,194,013	6,083,400	238,139,100
1935	4,621,243	1,217,340	5,838,583	270,752,800
1936	5,641,639	1,310,325	6,951,964	302,208,100
1937	5,305,361	1,312,441	6,617,802	325,079,000
1938	4,351,192	1,498,274	5,849,466	239,105,320
1939	5,038,526	1,291,276	6,329,802	304,491,635
1940	5,544,661	1,335,427	6,880,088	348,327,887

Sources: U. S. Army Engineers, *Annual Reports;* William George Bruce, *History of Milwaukee City and County.*

The car ferries are long-established participants in Milwaukee's shipping. The Grand Trunk Western ferry has operated since 1906 (until 1933 it connected Milwaukee with Grand Haven, Michigan), and the Chesapeake and Ohio since 1897.[9] Generally, the ferry traffic has amounted to between 25 and 35 per cent of all Great Lakes tonnage, averaging the annual figures for each

[9]The car ferries were originally a subsidiary of the Flint and Pere Marquette Railroad. In 1901 this road merged with the Chicago and Western Michigan Railroad to form the Pere Marquette Railway. The Pere Marquette merged with the Chesapeake and Ohio in 1947. Pere Marquette Railway, Annual Report, 1901.

of the last four decades. (See Table II). The average has increased in recent years because of the decline of the tanker and coal trade.

The presence of the car ferries is the reason why Milwaukee has one of the most diversified trades on the Great Lakes. The contrast between the composition of vessel and car ferry traffic is exemplified in Table III, listing the most recent year for which figures are available. While vessel traffic consists almost entirely of bulk commodities or goods which can be easily loaded or unloaded, such as motor vehicles, the car ferry traffic includes a large quantity of "general cargo," or what would be classified as general cargo were it shipped in any other way. Using the definition of general cargo as the Census Bureau,[10] and also excluding newsprint, it appears that general cargo commodities accounted for about 73 per cent of all car ferry receipts and 76 per cent of all shipments. The Army Corps of Engineers has not kept statistics on the value of domestic shipments since 1940, but it is certain that the general cargo commodities would be a still higher percentage of the value. For the years 1928–1938, the car ferry traffic was valued at $100.86 per ton, about four times the value of vessel traffic.[11] An extremely rough guess at current value can be made by using the ratio of Commerce Department price deflators for 1957 and 1929–38 on the basis of which the current value would be something over $222.01 per ton of car ferry traffic.[12] A better estimation of current value may be achieved by using I.C.C. wholesale value per ton at destination figures for 1959. For example, the value for total manufactures and miscellaneous products is $281 per ton, products of agriculture $101, and animals and products $601.[13]

No individual commodities account for an especially large share of the car ferry traffic. The largest single item among receipts is "non-metallic minerals and manufactures, not elsewhere classified," with 142,519 short tons. However, in the Corps of Engineers statistics this classification includes salt, in order to avoid inadvertent disclosure of the output of individual salt com-

[10]The Census figures exclude grains, soybeans, flaxseed, and oil seeds, unmanufactured cotton, coal, coke, bulk petroleum products, limestone, sand, gravel, sulphur, mineral ores and concentrates and all Department of Defense, special category of low value shipments.

[11]Hamming, *op. cit.*, p. 77.

[12]U. S. Department of Commerce, Office of Business Economics, *U. S. Income and Output*, Table VII–2, pp. 220–221.

[13]Interstate Commerce Commission, *Freight Revenue and Wholesale Value at Destination of Commodities Transported by Class 1 Line Haul Railroads, 1959*, Washington, D. C. October 1961. Other wholesale value per ton at destination are as follows: products of forests, $58 and products of mines, $11.

TABLE II. MILWAUKEE'S CAR FERRY AND TOTAL GREAT LAKES TONNAGE, 1921–1960

DECADE	CAR FERRY TONNAGE (ANNUAL AVERAGE) (SHORT TONS)	TOTAL GREAT LAKES TONNAGE (ANNUAL AVERAGE) (SHORT TONS)	CAR FERRY AS % OF TOTAL GREAT LAKES
1921–30	2,018,566	7,308,690	28%
1931–40	1,578,655	6,272,615	25%
1941–50	2,720,108	7,996,082	34%
1951–60	2,430,449	8,164,998	30%

Source: U. S. Army Corps of Engineers, *Waterborne Commerce of the United States*, Annual Reports (1953–1960); *Annual Report of the Chief of Engineers*, (before 1952).

Table III. Port of Milwaukee—Domestic Freight Traffic, 1963—Short Tons

No.	Commodity	Lakewise			
		Vessel Traffic		Car Ferry	
		Receipts	Shipments	Receipts	Shipments
	Total	3,564,956	33,599	1,075,377	1,282,630
010	Meat and products, fresh				390
020	Animal oils and fats, edible			501	1,021
033	Condensed and evaporated milk			843	8,684
035	Dried milk			762	7,326
037	Cheese			145	814
039	Dairy products, nec			1,291	5,142
040	Fish and products, fresh				57
060	Hides and skins, raw			3,548	3,979
065	Leather and mfrs			3,499	183
100	Corn		9,398	30	100,298
101	Rice				665
102	Barley and rye			790	39,191
103	Wheat			60	7,093
104	Oats			20	12,736
107	Wheat flour			2,261	18,745
108	Grain sorghums			385	7,350
109	Flour, flour-grain prep, nec			8,043	132,183
110	Animal feeds, nec			4,988	146,275
120	Vegetables and prep, fresh			2,313	3,197
123	Vegetables and prep, canned			12,000	28,071
150	Vegetable oils, fats, edible				1,195
180	Sugar			25	842
185	Molasses, sugar prod, edible				1,431
190	Liquors and wines			334	103,131
200	Rubber, crude, and allied gums			....	....
205	Rubber tires and inner tubes			507	188
207	Rubber manufactures, nec			320	....
220	Drugs, herbs, roots, crude			....	330
240	Oils, fats, waxes, veg, crude			....	1,170
260	Seeds, except oilseeds				85
320	Cotton manufactures			1,173	350
405	Posts, poles, and piling			330	1,545
408	Wood, nonmanufactured, nec			10,919	14,756
413	Lumber and shingles			7,637	84,827
417	Railroad ties			40	....
421	Wood manufactures, nec			690	
440	Pulpwood			36,653	12,588
441	Wood pulp			16,124	10,066
445	Paper base stocks, nec			1,492	2,041
450	Standard newsprint paper			98,944	676
475	Paper and mfrs, nec			13,978	13,030
501	Anthracite coal			20,225	14
502	Bituminous coal and lignite	1,628,296		89,879	41
503	Coal-coke briquets, liquid coal			25	7,628
504	Coke, including petroleum coke		5,100	5,355	46,505
507	Gasoline	477,876			
510	Gas oil, distillate fuel oil	271,402	2,481		
513	Kerosene	8,936			
514	Residual fuel oil	89,563	1,656	24	35
519	Lubricating oils and greases			1,705	410
523	Building cement	388,962		64,305	179
526	Stone and mfrs, nec				....
530	Glass and glass products			16,980	
540	Clays and earths			398	6,081
543	Brick and tile			10,013	424
547	Clay products, nec				32
548	Gypsum or plaster rock	9,900		51	20
551	Limestone, crushed	373,141	....	25	....
554	Sand, gravel, crushed rock	60,246		37,522	41,049
555	Nonmetallic minerals, mfrs nec	145,131	....	142,519	2,393
556	Slag, metal refuse	8,008	....	....	....
600	Iron ore and concentrates			415	7,654
601	Pig iron	20,646		359	
602	Iron and steel scrap		7,080	3,667	21,621

TABLE III. PORT OF MILWAUKEE—DOMESTIC FREIGHT TRAFFIC, 1963—SHORT TONS—CONTINUED

No.	Commodity	Lakewise			
		Vessel Traffic		Car Ferry	
		Receipts	Shipments	Receipts	Shipments
603	Iron, steel semifinished prod	658		100,652	40,724
605	Ferrous castings and forgings			27,571	2,542
607	Kitchen and hospital utensils			46	39
608	Iron and steel pipe			13,482	19,346
609	Rolled, finished stl mill prod	15,903	6,765	529	909
612	Metal mfrs and parts, nec			4,347	3,296
617	Aluminum ores, concent, scrap			86	1,058
618	Aluminum metal and alloys			1,953	698
620	Copper ore, concent, scrap			117	1,647
622	Refined copper in crude forms			105	152
624	Copper semifabricated forms			566	384
632	Copper alloy forms and scrap				330
640	Lead ores, concent, and scrap			61	....
670	Zinc ore, concent, and scrap			1,170	350
672	Zinc forms				50
682	Nonfer ores, metls, scrap nec			12,375	7,966
700	Electrical machinery			17,099	16,064
710	Engines, turbines, parts, nec				4,405
722	Const, mining mach, parts			4,276	25,743
742	Industrial mach, parts, nec		448	1,735	4,200
770	Agricultural mach, parts			6,150	10,804
780	Motor vehicles	66,283	667	37,215	300
782	Motor vehicle parts			56,236	146,057
786	Railway equipment			370	....
796	Vehicles and parts, nec				1,499
827	Sodium hydroxide, caustic soda			8,635	100
829	Industrial chemicals, nec			61,008	4,245
846	Chemical specialties, nec			8,134	364
848	Pigments, paints, varnishes			136	509
851	Other nitrogenous fert, mat			298	1,177
855	Potash fertilizer materials			837	2,436
859	Fertilizer and materials, nec			5,819	9,234
860	Miscellaneous chemical prod			23,571	7,833
900	Commodities, nec	5	4	56,035	61,735
930	Waste materials, nec			651	727
		Internal Shipments		Local	
	Total			1,283	
040	Fish and products, fresh			1,283	

Source: U. S. Army Corps of Engineers, *Waterborne Commerce of the United States,* Annual Report, 1963.

panies. Salt probably does, in fact, account for nearly all of the reported tonnage. The Chesapeake and Ohio ferry had most of this traffic, with 121,410 tons, and salt is produced near its lines in Michigan. The C & O also carried most of the second and fourth ranking commodities, iron and steel semi-finished products and bituminous coal respectively, with 94,322 out of 100,652 short tons of semi-finished iron and steel and 79,645 out of 89,879 short tons of bituminous coal. These figures, however, are dwarfed by comparison to the 1,628,296 tons of coal brought to Milwaukee by regular vessel. Newsprint, the third ranking commodity, accounted for the largest share of the Grand Trunk Western's westbound traffic, with 69,164 short tons, though Milwaukee also received 29,780 short tons via the C & O.

Grains were the leading commodities in the port's car ferry shipments, with 464,536 short tons. About two-thirds (363,132 tons) went to Ludington. On the other hand, about two-thirds of the lumber shipments were to Muskegon (53,847 tons).

The car ferries are of particular importance to Milwaukee in several ways. They operate all year around, in contrast to the shortened vessel season of eight to nine months. Secondly, they bring Milwaukee closer to Michigan and Eastern cities in terms of both time and distance. For example, it is 368 miles from Milwaukee to Detroit by way of Chicago; by Chesapeake and Ohio car ferry the distance is 358 miles, including the 97-mile car ferry route to Ludington, and by Grand Trunk Western ferry it is only 273 miles, eighty of them across the lake to Muskegon. The ferries take from six to six and one-half hours to make the journey, at an average speed of sixteen to eighteen miles per hour.[14]

What is perhaps the most important general benefit of the car ferries is a corollary of the fact that they bring Milwaukee closer to the Eastern seaboard. By means of the car ferries, Milwaukee is no farther from many east coast cities than is Chicago, in terms of rail miles. Since distance is the basis for many rail rates, in particular "class rates," this means that Milwaukee and Chicago have the same rates to many places on the Seaboard. Further, the rates apply whether the traffic is routed via the car ferries or through Chicago, even though in the latter case the actual mileage to Milwaukee is greater. The car ferry service has caused Milwaukee and the other western shore ports with the service to be placed in the Official or Eastern freight rate territory, with a different and lower rate structure to the east than to the west. For goods moving at the class rates the rate is lower from Milwaukee to an Eastern city than it would be for, e.g., goods moving from Madison or Minneapolis an equal distance into the Eastern territory, because part of the rate for the latter movement would be based on the higher rates of the Western Trunk-Line territory. It would be next to impossible to calculate the benefits to Milwaukee industries and the community at large from the rate equalization with Chicago and the lower rates to the east, but the transport cost savings over the years have surely been very large. Similar savings may accrue on every commodity which may move to Milwaukee, both overland and by water, but the car ferries present the most striking and most concrete example.

It is possible that the favorable rail rates induced by the car ferries has exerted some influence on the location of industry. In the words of the Board of Harbor Commissioners, "an industry can have all the advantages of location in Milwaukee; but ratewise, it is in the fortunate position of having the same rate structure as though it had been established in the more central location of Chicago."[15]

Milwaukee's regular vessel traffic may be described more briefly. It is presented in Table III for 1963. The most significant aspect of Milwaukee's vessel lakewise traffic is the remarkable imbalance. Receipts by general cargo

[14]Hamming, *op. cit.*, Chapter V.

[15]Board of Harbor Commissioners, City of Milwaukee, *Impact of the Milwaukee Public Port Development on the Community Economy, A Report to Hon. Henry W. Maier, Mayor* (Milwaukee, 1962), p. 12. Hereafter cited as *Impact of the Milwaukee Port.*

vessels are about 100 times its shipments and this underlines the lack of material resources in the Milwaukee area. Furthermore, only sixteen commodities were received in domestic vessels, and only nine were shipped, but it should be stressed that these few commodities amounted to 3,598,555 short tons, well over half of the port's entire 1963 traffic of 6,626,442 short tons. Receipts of bituminous coal and gasoline in turn make up about 60 per cent of the vessel traffic, with 2,106,072 tons. Other petroleum products, crushed limestone, building cement, and "non-metallic minerals" (probably salt), account for most of the rest. About the only commodities which might be considered as "general cargo" are gypsum, semi-finished iron and steel products, kitchen and hospital utensils, and rolled and finished steel mill products, which together totalled only 34,470 tons. Motor vehicles are a somewhat special case; the Wisconsin and Michigan Steamship Company operates an automobile carrier, the "Highway 16," between Muskegon and Milwaukee, and also uses the "Milwaukee Clipper," the last remaining excursion boat on the Great Lakes, for automobile transit. Cement, sand and gravel, and stone are shipped in special self-unloading vessels.

Although it retains its leading position in Milwaukee's shipping, the coal traffic has shown a sharp decline in recent years. According to the 1964 progress report of the Chairman of the Board of Harbor Commissioners, lakewise coal receipts have continuously drifted downward since World War II, reflecting the continual shift away from coal toward natural gas and petroleum. A brief improvement in 1963 coal traffic marked the first reversal of this downward trend since 1948, but the downward drift in lakeborne coal again was manifest in 1964, with coal receipts dropping to the lowest volume in a half-century.[16]

A similar but much sharper drop in petroleum receipts has manifested itself since 1962, the first year of operation for the West Shore Pipe Line. According to the 1964 progress report of the Chairman of the Board of Harbor Commissioners, the city government consented to the construction of the West Shore Pipe Line in 1961 and permitted its interconnection to the outer harbor petroleum terminals, on the premise that expanded petroleum terminals and distribution facilities would be constructed in the City of Milwaukee. As expected, the first three years of petroleum pipeline operation have had a drastic effect on the waterborne commerce in petroleum at Milwaukee. Prior to the pipeline, waterborne petroleum had been developed to the range of 2.5 million tons or more per year. More than 600 tanker vessels per year regularly called at this port, and petroleum became a major commodity.

Waterborne petroleum dropped from the previous level of approximately 2.5 million tons to a little more than 1 million tons in 1962, the first year of pipeline operation. A further sharp decline occurred in 1963, petroleum cargoes dropping to approximately 800,000 tons; and to little more than 600,000 tons in 1964.

To summarize, the impact of the pipeline has been such that marine petroleum deliveries at Milwaukee have dropped from 2.5 million tons, to about 600,000 tons, in the third year of pipeline operation. Whereas nine marine terminals in Milwaukee relied on tanker delivery in 1961, by 1964 only

[16]*Port Progress in 1964*, Annual Report by the Chairman of the Board of Harbor Commissioners, City of Milwaukee, p. 5.

three terminals were receiving tanker deliveries, and several of those only spasmodically. The 600 tanker deliveries of previous years dropped to approximately 150 in 1964.

The eight petroleum terminals in the public port area continue in operation as distribution terminals, now served by rail, water, highway and pipeline. The city receives the equivalent of warfage charges for the product delivered by pipeline. Thus, despite the shift from waterborne to pipeline delivery, the financial return from the outer harbor oil terminals continues comparable to the revenue levels of earlier years.[17]

In the light of the continued decline in coal and petroleum it is not surprising that lakewise traffic has reached the lowest level since World War II. In its efforts to meet the challenge, the port is trying to develop its foreign traffic through the St. Lawrence Seaway.

Conclusion

Until the opening of the Seaway, Milwaukee's port traffic was primarily domestic bulk commodity receipts, notably coal and petroleum and cross-lake car ferry traffic with Muskegon and Ludington in Michigan. The presence of the car ferries has placed Milwaukee on a parity with Chicago in respect to rail rates to the Eastern cities, whether or not the goods are actually shipped via the ferries; their service thus goes far toward overcoming a handicap that Milwaukee has had for over a century: it is not located on the major land transportation routes of the country.

The Port of Milwaukee's domestic commerce has received several setbacks more or less simultaneously; the problem which appears to require the most urgent attention is the continued development of overseas cargo. In the long run, the port's growth prospects seem to depend on its ability to utilize the St. Lawrence Seaway.

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[17] *Ibid*, p. 7.

A NEW METHOD FOR PREDICTING THE BLOOMING DATE OF SPRING FLOWERS

Katharina Lettau[1]

The special problem of predicting flowering dates for pink lady's slippers (Cypripedium acaule) was recently brought to the attention of the Wisconsin Phenological Society. Flowering dates for a stand of lady's slippers growing on the south shore of Lake Shishebogama near Minocqua in northern Wisconsin have been observed for six years by Mr. Alonzo Pond, owner of "Wisconsin Gardens", a wildflower preserve. He wanted to know if there were a way of predicting the time when the flowers would be in full bloom.

The influence of temperature on plant phenology has long been recognized. Plants need a certain amount of heat over a period of time to produce flowers. The usual method for determining this special amount of heat is to accumulate daily averages of air temperature from a starting day to a flowering day. To apply this method to predict the flowering date of a particular plant, three factors must be known: (1) the date at which to begin the summation, (2) a constant reference value of air temperature, characteristic for the plant species considered, and (3) the amount of heat, or number of degree days, which this plant needs for flowering.

Several possibilities for determining these three characteristics are described and discussed in the comprehensive book on plant phenology by Fritz Schnelle. The purpose of this present study is to show that the conventional reliance on air temperature alone is not satisfactory with regard to lady's slippers. Therefore, a detailed description of the conventional method will be omitted and only the results of its application quoted in order to establish a basis for comparison with the improved method described later.

Flowering dates were observed at "Wisconsin Gardens" from 1959 to 1964, inclusive. But the dates for only five years, 1960 to 1964, were used to determine the characteristics for the lady's slippers. From these dates and available temperature recordings degree days and their deviations were calculated. These are based on (1) a starting date of April 1; (2) a reference temperature of 41° F; and (3) a sum of 291 degree days at that particular location. Based on this system the data for 1959 did not seem to agree with the other years. Table 1 shows the results of the temperature accumulation for individual years, including 1959.

In 1960, 1961 and 1963 the temperature sums are close to the average value of 291 which means that the actual flowering date coincided with the expected. In 1962, flowering occurred two days early (the daily average temperature was low at that time); and in 1964, one day late (it happened during a hot spell). Assuming that the average value of 291 degree days, as derived from the 1960 to 1964 observations, is applicable to the 1959 ob-

[1]This research was supported by the National Science Foundation Grant GP–444.

Table 1. Phenological Data for Pink Lady's Slippers at Minocqua, Wis. Using the Conventional Method

	Year					
	'59	'60	'61	'62	'63	'64
Flowering date	5/25	5/25	6/5	5/23	5/31	5/24
Degree days (A_{41})	443	285	285	262	297	324
Deviation from mean 60 to 64						
in degree days	+152	−6	−6	+29	+6	+33
in calendar days	+7	0	0	−2	0	+1

servation, it would mean that the flowering in 1959 was seven days late for some unknown reason.

The shortcomings of this method seem to have two major causes: (1) employment of a uniform starting date each year, and (2) use of daily averages of air temperature for the summation. As an example of the first cause let us consider the year 1959 and 1960 when the flowers opened on May 25. With the uniform starting date of April 1, the degree days represent the sum of fifty-five days in each year. However, during this period, air temperatures were considerably higher in 1959 than in 1960, as indicated by the degree days in Table 1. An increase (or decrease) of the reference temperature of 41° would not improve the discrepancy since the same constant would be added, or subtracted, in both years. To overcome the second cause of shortcomings, the summation based on daily averages of air temperature, other authors have suggested the use of "degree hours" instead of degree days. This method would necessitate either continuous temperature recordings, or the development of a scheme for finding the number of hours effective on plant growth during each day. Such a method is described by A. Lindsey and J. Newman.

It seems logical to assume that the initial growing phase of spring flowers is more influenced by soil temperature than by air temperature. If this assumption is accurate then the accumulation of daily mean soil temperature should begin in late winter while the plant is still dormant, but add only values above the freezing point since thawing of the ground is a natural prerequisite for growth. Thus a naturally variable starting date replaces the fixed date because frost leaves the ground on different dates from year to year. After the soil degree days achieve a certain value the change to air temperature measurements should be made since the final flowering date will surely depend on air temperature.

Soil temperatures were not observed at "Wisconsin Gardens". Fortunately, about ten miles west of Minocqua, at Rainbow Reservoir, measurements are made at several depths. Temperature data for one inch and six inch depths are published by the US Weather Bureau. The thermometers are read only once a day, at 4 p.m. The temperature at six inches was selected for the accumulation because, due to phase retardation and amplitude reduction in the process of heat conduction from layer to layer, the temperature at six inches at 4 p.m. corresponds approximately to the daily average at this level.

Two natural events, the thawing of the ground and the flowering of the plant, are used for any individual year to determine empirically the necessary accumulation of heat in both, soil and air. The main problem is to find at what intermediate point the change from soil to air temperature should be made. The solution of the problem consisted essentially in computing for each year the soil degree days above 32°F. (B_{32}) forward from late winter, and the air degree days above 41°F. (A_{41}) backward from the observed flowering date, using in a first approximation the same reference air temperature as in Table 1. As an example, Fig. 1 illustrates the two curves A_{41} and B_{32} both plotted as a function of time for the year 1964. The point of intersection has no direct significance. It only means that at this point A_{41} is equal to B_{32} which is a rather arbitrary partition of the desired total of A+B. From such graphs, individually drawn for the six years available, it was suggested that the "switching" should take place somewhere between 200 and 400 soil degree days. However, a more precise determination is necessary and can readily be obtained with the following scheme.

Let the soil temperature at the "switching" point be denoted by B^*, and let A^* be the air temperature sum between the flowering date and the point when B reaches B^*. To determine the values of A^* and B^* another type of graph was prepared in which one single curve for each year shows the interdependence of A_{41} and B_{32}. Fig. 2 illustrates such curves for the six years of observations at Minocqua.

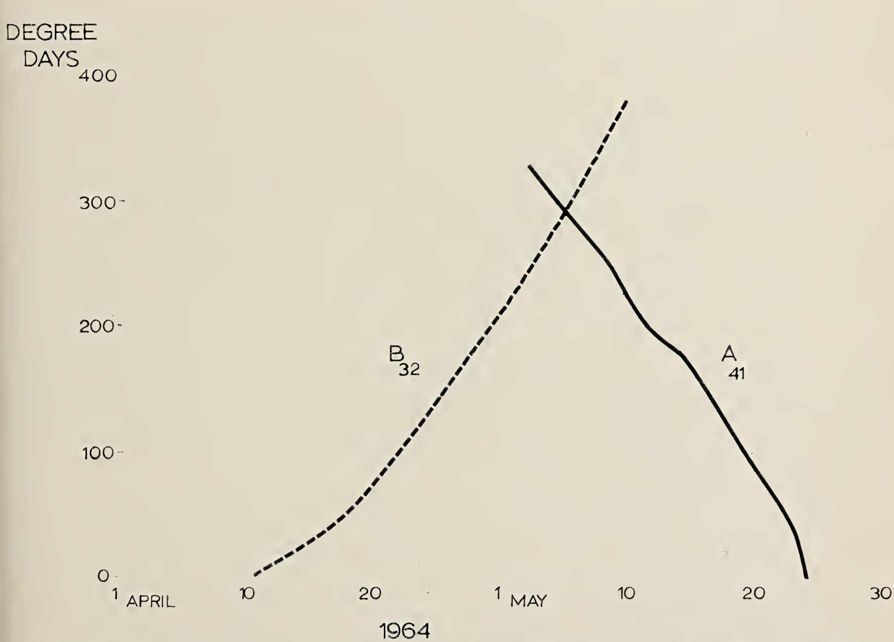

Fig. 1.—Soil temperatures accumulated above 32° F (B_{32}) from thawing date forward, and air temperatures above 41° F (A_{41}) from flowering date backward, spring 1964.

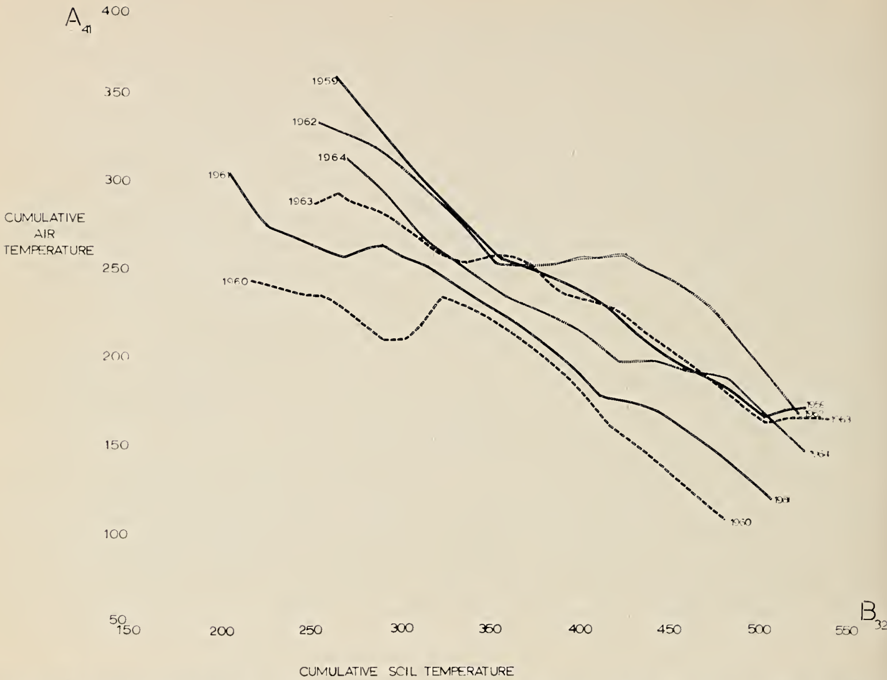

Fig. 2.—Relationship between soil and air degree days for the six years 1959 to 1964.

The time element is now eliminated. The lines show the relationship between air and soil degree days based on a certain reference temperature and two dates of natural events. The purpose of this graph is to find the particular point in this diagram at which the curves come closest together for all the years of observations. Obviously, this point must have the coordinates A^* and B^*. The knowledge of these two values permits one to predict the blooming time, namely when the B^* value is reached in any individual year further temperature accumulation should be switched from soil to air, and flowering will occur when forward computation of A approaches A^*.

The A data in Fig. 2 are plotted with a reference temperature of 41°F as a first approximation. Closer inspection later showed that the curves come somewhat closer together if 43° instead of 41° is used as a reference temperature. It is interesting to note that M. Jackson found similar threshold values for spring flowers, e.g. 42° for hepatica, and 44° for trillium from long records of observations in Indiana.

It can be concluded from the graph that $B^*=350$ degree days, and $A^*=244$ degree days. If the reference temperature is raised from 41° to 43°, A^* decreases from 244 to 209 degree days. The results of the combined soil-air degree days with 43° as the reference temperature, are presented in Table 2. When compared with Table 1 the improvement is obvious. Most striking is the fact that the data for 1959 now agree well with those from the other years. The maximum deviation in calendar days is reduced from seven to less than one day.

TABLE 2. PHENOLOGICAL DATA FOR PINK LADY'S SLIPPERS AT MINOCQUA, WIS. USING THE NEW METHOD

	Year					
	'59	'60	'61	'62	'63	'64
Flowering date	5/25	5/25	6/5	5/23	5/31	5/24
"Switching" date	5/7	5/13	5/22	5/6	5/1	5/9
Difference in days	18	12	14	17	30	15
Soil–air degree days $(B_{32}+A_{41})$	573	549	551	574	544	560
Deviation from mean						
in degree days	+14	−10	− 8	+15	−15	+ 1
in calendar days	<1	<1	0	+1	<1	0

In Fig. 3 the soil-air degree days are plotted versus time only for four years. The years 1960 and 1962 are omitted to reduce overlapping thus making the chart easier to read. The lines end with the flowering date. Especially interesting is the year 1963. Although frost was very early out of the ground, on March 28, the lady's slippers flowered late, on May 31, due to two pro-

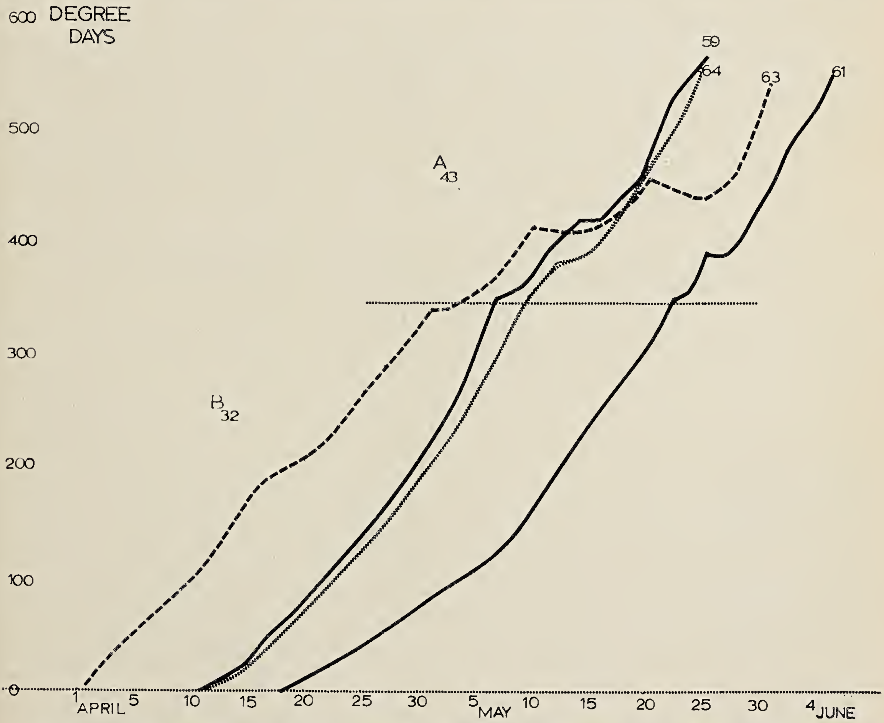

Fig. 3. Combination soil-air degree days from thawing date of the ground to flowering date of the lady's slippers. Switch from soil to air temperatures after 350 soil degree days were accumulated.

longed cold spells in May. Each year shows a different pattern of advance from winter into summer, but when this particular combination of soil-air temperature degree days reaches the value of about 559, the lady's slippers at the Minocqua site began to flower.

As mentioned at the beginning, the purpose of this study was to explore possibilities for predicting the time when the lady's slippers will be in bloom in a particular spring. Basically, the described method should be applicable to other spring flowers. With this in mind it may be practicable to utilize the phenological characteristics of another species which flowers at the same site earlier than the lady's slippers and refer to it as an "indicator plant". Once the difference in soil-air degree days between indicator plant and lady's slippers is established, one could use the observed flowering date of the first to predict the blooming day of the second. If the interval between the two dates is normally one week, the five day weather prognosis for the area could be used to estimate the number of calendar days which will be equivalent to the needed degree day difference.

As an example, the new method was applied to swamp laurel (Kalmia polifolia) growing at the same location as the lady's slippers and observed for the four years 1961 to 1964. A graph, correspondent to Fig. 2 was constructed for A_{43} and B_{32}. It was found that the individual curves came closest together for B^*=290 degree days. The phenological data for swamp laurel and lady's slippers are summarized for comparison in Table 3.

Tentatively, it can be concluded from only four years of observation that swamp laurel needs an average of 429 degree days in order to produce flowers; that is 128 degree days less than the lady's slippers. During 1961, 1962 and 1964, the 128 degree days were accumulated within six calendar days, but ten days were needed in 1963. The phenological data for 1963 indicate that the swamp laurel flowered approximately at the expected time. The lady's

TABLE 3. COMPARISON OF PHENOLOGICAL DATA FOR LADY'S SLIPPERS (B^*=350) AND SWAMP LAUREL (B^*=290), AT MINOCQUA, WISCONSIN, USING A REFERENCE AIR TEMPERATURE OF 43°F

	YEAR				AVERAGE
	'61	'62	'63	'64	
Lady's Slippers:					
Flowering date	6/5	5/23	5/31	5/24	
Switching date	5/22	5/6	5/1	5/9	
Soil–air degree days (B^* = 350)	551	574	544	560	557
Swamp Laurel:					
Flowering date	5/31	5/17	5/21	5/18	
Switching date	5/18	5/3	4/27	5/6	
Soil–air degree days (B^* = 290)	425	444	420	426	429
Difference in:					
Flowering days	6	6	10	6	
Switching days	4	3	4	3	
Degree days	126	130	124	134	128

slippers blooming time was retarded by a cold period which lasted for six days. Fig. 3 shows this very well. The temperature accumulation above 43° was halted completely for several days. On May 25, it became warm again, and after six days the lady's slippers bloomed.

The results of this scheme look promising. But caution is necessary in view of the limited number of years used in this study. The conditions of the current year 1965 are likely to produce a severe test of the method because of the exceptionally late spring in northern Wisconsin.

Postscript

In essence, the above discussion was presented as a scientific report at the Annual Meeting of the Wisconsin Phenological Society on May 7, 1965, at Madison; that is prior to the flowering season of the lady's slippers. As already noted, spring came unusually late to northern Wisconsin this year. At Rainbow Reservoir, frost finally left the six-inch level of the ground on 24 April. After this date the temperature rose rapidly from day to day. On May 6, that is within twenty-three days (the shortest time span of all seven years of observations reported here), B_{32} reached 358 which is the total of degree days previously obtained as the threshold for making the switch from soil temperature accumulation to air temperature accumulation. The lady's slippers at "Wisconsin Gardens" came into bloom on June 3, 1965. Between this date and the switching date of May 16, the air temperature accumulation produced an A_{43} value of 150. Thus, the previously described soil-air temperature combination method yielded a total of $358+150=508$, as compared with the average of 557 degree days for the six preceding years; see Table 3. This discrepancy of 49 degree days would correspond to three or four calendar days.

The result may appear somewhat disappointing. There are, however, several circumstances in the light of which the result must be considered. First, the conventional method (i.e. exclusive use of air temperature and accumulation in excess of 41° with April 1 as a starting date) would have given only the low sum of 208 degree days on June 3, due to the unusually cold April. In comparison with the previous average of 316 degree days (see Table 1), this would have to be called a failure. This deviation of 108 degree days corresponds to at least seven to nine calendar days, i.e. more than twice the error of the new method.

Second, in 1965, the swamp laurel also came into bloom at less than the average degree days, namely at 381 instead of 429 as formerly derived and summarized in Table 3. It is noteworthy that the difference in degree days between the flowering of this indicator plant and the lady's slippers agrees perfectly with the average value of the preceding years; that is 127 in 1965 as compared to 128 shown in Table 3. It means that even under severe conditions the swamp laurel served very successfully as a predictor for the flowering date of the lady's slippers. With the information on the swamp laurel's flowering date the author traveled from Madison to "Wisconsin Gardens" on June 4 and had the satisfaction of observing the pink lady's slippers which had come into bloom just the previous day.

Third, it can be suspected from the 1965 results that the use of subsurface temperatures measured at a station ten miles away from the flowering plant in a different kind of soil, can hardly be expected to be representative for the conditions at "Wisconsin Gardens". There, the lady's slippers are growing in a wet, spongy, soil under tamarack and other trees. Inspection of the site at Rainbow Reservoir during the above mentioned trip showed that the climatological observation site is fully exposed to the sun and open to the winds, and the soil thermometers are in sandy loam mixed gravel, under mowed clover and timothy sod. It can very well be that in an exceptional spring—and 1965 certainly was one—the difference in exposure could produce the observed departures. After all, the choice of the six-inch level of soil temperature data at Rainbow Reservoir was dictated only by availability and convenience. The derived criteria in the terms of A_{43} and B_{32} can have only relative meaning, and not absolute significance. It must be concluded that the new method can be truly tested only if actual soil temperature measurements at a variety of levels and at the site of the stand are made. Future plans include such soil temperature measurements.

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WATER POLICY EVOLUTION IN WISCONSIN: PROTECTION OF THE PUBLIC TRUST*

Walter E. Scott

Many Wisconsin citizens do not realize or appreciate the valuable heritage they share in our public surface waters. Next to Alaska and Michigan, we have the greatest acreage of fresh water, covering about 18% of the state's land area—over two acres per person. Michigan may be known as the "Water Wonderland," but she has less than half the inland water area or potential hydro power capacity in Wisconsin's lakes and streams. Wisconsin waterways include about 9,000 miles of trout habitat and 3,500 miles of bass waters which thousands of fishermen use and enjoy. Generally, our almost 9,000 lakes and 1,500 streams are easily accessible and heavily used for outdoor recreation.[1] The "blessing from heaven" which keeps these lakes and streams in usable condition is an average annual precipitation of thirty inches.[2]

Including the Great Lakes, each of us owns a share of the more than seven and one-half million acres of navigable waters in Wisconsin.[3] In addition, the state owns or controls hundreds of miles of shoreline on these lakes and streams as part of the public trust. Riparian lands owned by the people, including county and federal acreage, assure us of a direct property interest in almost every watershed.

Applied to navigable waters, the "trust doctrine" asserts that the State of Wisconsin holds the beds underlying such waters in trust for all of its citizens, subject to the fact that a riparian owner on a navibable stream has a qualified title to the center. The state's ownership of land covered by this water therefore gives it authority to control all developments or encroachments on the bed of public waters or anything that would affect the natural character of the water itself.[4]

Water policies evolve differently in each state, which holds true even in those created out of the Old Northwest Territory. The Ordinance of 1787 stated that "the navigable waters leading into the Mississippi and St. Lawrence, and the carrying places between the same, shall be common highways and forever free." This wording, including the idea of "concurrent jurisdiction" over boundary waters with adjacent states, later found its way into the enabling act to form our state, the State Constitution and the Statutes of 1853. In this legislative act, Wisconsin expressed conformity with the so-called "common law" of water use based on the Riparian Doctrine earlier perfected by the English courts. Actually, the Constitution retained "such parts of the common law as are now in force in the Territory, not inconsistent with this constitution . . . until altered or suspended by the legislature."[5]

One of the most cherished books in my library, published in 1746, is titled "An Essay to Prove that the Jurisdiction and Conservancy of the River

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Thames is Committed to the Lord Mayor and City of London Both in Point of Right and Usage." Written by the Water Bailiff, the words "conservator" and "conservancy" are used frequently, and the navigation and fishery of this river are recognized as "a great trust" which their ancestors have defended on numerous occasions. In fact, they were "so well persuaded of their Rights herein, and the common Benefits resulting to the Publick thereby, that they contended for, and defended the same, not only against the Encroachments of private Persons, but with Archbishops, Lord High-Admirals, and even with Kings themselves . . . . ."[6]

It is heartening to know that other people hundreds of years ago faced up to the difficult problem of protecting the public trust in navigable waters successfully. That their situation over 400 years ago was not unlike what we experience today is shown by a partial quotation from a law they enacted in 1535:

> For the Reformation thereof, be it enacted . . . that if any person, or persons, hereafter do, or procure any Thing to be done, in the Annoying of the Stream of the said River of Thames, making of Shelfs by any Manner of Means, by Mining, Digging, Casting of Dung or Rubbish, or other Thing, in the same River . . . . or dig, or undermine any Banks or Walls, on the Waterside . . . then the same Person, or Persons, and every one of them, shall forfeit and pay . . .[7]

Wisconsin today stands in a position of leadership among all the states in its preservation and protection of rights of the public in navigable waters.[8] To some extent, this may have been good fortune or just plain luck, but a careful analysis undoubtedly will show it was a combination of circumstances related to conditions at the time—and always influenced by the state's exceptional natural beauty and opportunities for high quality outdoor recreation——especially fishing and hunting. Some other important factors were the early fur trade, lumbering industry, cranberry culture and water power development based on reservoir systems. Although we started with the same foundation as other states carved out of the Old Northwest, none of them have retained as great a percentage of their original water area in the public trust—not even Michigan or Minnesota.[9] However, Wisconsin's position would have been even stronger had she kept title to the bed of all streams and rivers. Actually, Wisconsin has gained water use rights for the public in many thousands of acres of reservoirs and flowages created or extended by dams.

Just as each lake and stream is an individual biological and ecological entity which must be considered separately as an integral part of its watershed, water policies evolve differently, depending on many local conditions. Differences in basic constitution, legislative enactments, judicial decisions and administrative action all influence policy growth—whether related to surface or ground waters. In Wisconsin, public rights in ground waters have been declared and protected only to a small degree even though they usually are directly related to surface waters.[10] It is in the so-called "navigable waters" that the public rights are most clearly recognized—and it has been said that in Wisconsin they include any waters in which a trout can swim on its side. Of course, much of the controversy centers around the legal definition of "navigable waters" and the group of public rights which are a part of this concept by legislative enactment and judicial decree—boating, swimming, fishing, hunting, wading, skating, and the enjoyment of scenic beauty.

In the last two decades a new type of humid area agricultural irrigation has expanded in Wisconsin. Different from the ditch system used for years in the arid West, it calls for watering by aerial sprinklers. Such use of water is highly consumptive and little is returned to the water course from which it was removed.[11] Many conflicts arose with other riparian water users on the streams from which water was taken for this purpose, and also with the state which attempted to preserve the public rights. The dispute led to extensive studies of water rights law, supported primarily by agricultural interests.

Numerous articles, theses and study reports recently have been published to show how Wisconsin's "Riparian Doctrine," based on the English common law, has been "watered down" through franchise grants or other legislative action, interpretations by the courts and Attorney General, and even by prescription. The Doctrine of Prior Appropriation has been reviewed to determine any such elements in Wisconsin law. Some model laws were prepared which did not even recognize such a thing as public rights in navigable waters.[12] At the same time, there were a few studies aimed at more constructive goals such as the development of controls over water pollution and authority for development of access to public waters.[13] It would be appropriate to state that the everlasting "War of the Waters" continues on a fluid battlefield with individual engagements and skirmishes being won or lost each day.

A survey of continuing efforts to preserve our heritage from dangers such as obstruction, diversion, pollution, encroachment, drainage and, in some cases, complete annihilation, shows that much already has been lost. Acts of the legislature favoring mill dams, lead and zinc mining, cranberry marsh improvement, drainage schemes, hydro-power development (such as the infamous "County Board" law),[14] and more recently the taconite mining and agricultural irrigation concessions are examples of private use of public water resources which often produce negative results. Lower riparians on the watercourse may experience a reduction in their theoretical "rights" to have reasonable use of the water "unimpaired in quality and undiminished in quantity." Even more important, the people's rights often suffer due to radical ecological reactions affecting the quality of fish and other wildlife—another natural legacy.[15] Perhaps such developments do offer recreational opportunities to larger numbers of people—though seldom, if ever, do they retain equal quality.

Frequently, there is a strong public reaction to private uses of the public domain and each time the door is closed a little tighter on their remaining more precious heritage. The pendulum swings from private economic development toward preservation of the public trust—and back again. Some of these more significant floods of public reaction and the "high water marks" which they left will be discussed here in chronological order and integrated on the broad base of conservation concepts. Together, over the years, strengthening actions helped to form the state's present policy of surface water conservation, development and use. Many citizens and their civic organizations—and especially educators, biologists, attorneys, judges and public administrators—have played important roles in the effort to save for future generations the great public trust of navigable waters as nearly unspoiled as possible. The key question in this continuing struggle is the definition determining the scope and meaning of "navigable waters" which carry with them the complete bundle of public rights in such waters. It must be remembered that this term gains greater meaning and scope with passing years.

Time and space limitations dictate that only highlights of this evolutionary process can be mentioned, and much of importance is omitted. Early historical backgrounds for the first fifty years of statehood are cited only briefly so that more recent significant anecdotes can be related in greater detail. This does not mean that sound foundations were not established before the turn of the century. Arguments between private riparian water users did result in vital decisions recognizing public rights. Also in the early years, some first faltering steps were taken toward research, education and recognition of potential future value in this public heritage. The record starts before 1848 with a territorial rule that all rivers meandered and returned as navigable by the U.S. Surveyor were declared navigable and no dams could be built on them without consent of the legislature.[16] All dams, except the so-called "Milldams," were required to have fishways even in the decade prior to statehood.

Title to the navigable streams and lakes and soils under them was held by the original states for common use of the people and the enabling act gave Wisconsin equal footing in this respect when it became a state.[17] In fact, it has been held by the Wisconsin Supreme Court that the United States never had title to lands under lakes, ponds and navigable rivers except in trust for public purposes.[18] The public's rights in navigable waters under riparian law were the same as in the English tidal (or salt) waters at common law and it is this decision by United States courts which preserved the extensive fresh water resources in America for the public. In Wisconsin, this was incorporated into the Statutes in 1853.[19] Unfortunately, the Wisconsin courts have given a qualified title to the beds of navigable watercourses to the riparian owners, thereby slightly reducing the public rights in such waters as compared to navigable lakes.[20]

I. Highlights of Wisconsin's First Fifty Years

Wisconsin's water policy evolution during the first fifty years of statehood will be summarized by citing highlights in each decade. Possibly none of the early developments equal the "high water marks" of later years but these were vitally important formative years, when outside influences played a significant role and almost any kind of private enterprise was given full freedom for growth. Usually it was only the conflicts between riparian water users which brought recognition of public rights by the courts during the state's lumbering era.

At the beginning of the first decade, the new state was vested with title to all lands under navigable waters. The next year a legislative act was passed aimed at artificial obstructions—but actually the first pollution control regulation—which named a forfeiture of $5.00 for each conviction for obstructing navigation by felling trees into rivers or "putting into any river or stream declared a public highway, any refuse, lumber, slabs, or other waste materials."[21] In 1850 the federal government's "Swamp Land Grant" gave Wisconsin several hundred thousand acres of property which often contained shoreline on navigable waters,[22] but within two years the legislature had passed the first of a series of acts to encourage drainage.[23] Most everyone agreed that swamp lands were unhealthful and the 1853 *Transactions* of the Wisconsin Agricultural Society published an article encouraging drainage with almost poetic language:

> To change a marsh from its foetid, cold and vaporous atmosphere, into a fruitful, smiling plain; to render a bog or swamp, where no sure footing can be found, into solid and substantial earth; to make aquatic plants give place to rich and feeding herbs . . .[24]

This same year the legislature enacted Chapter 72 declaring the common law of England (including decisions of the courts and customs and usages of the People), insofar as it was applicable under Wisconsin conditions, to be our law in determining "the boundaries of lands adjoining waters, and the several and respective rights of individuals, the state and its citizens, in respect to all of such lands and waters."[25] Both in England and Wisconsin navigable waters are public waters.

The first statement of the Wisconsin Supreme Court regarding the right of navigation was handed down in 1853 and included this sentence: "If the stream is *navigable in fact,* the public have the right to use it for the purpose of navigation, and the right of the owner of the streambed is subject to the public easement."[26] This is an important change from the English idea of "navigability in law" to the American riparian doctrine concept of "navigability in fact." Before the first decade closed, our Supreme Court had handled their first case on dams as nuisances in navigable waters and ruled that no prescriptive rights in water use could be gotten against the state.[27] Considering the fact that so-called "Milldams" could be built—even from the first territorial days—on any non-navigable stream without consent of anyone or any controls whatever, the urgent need for a better definition of what constituted navigable waters is evident.

The second decade began with re-enactment of legislation to prevent obstructions in watercourses, such as fallen trees and waste materials.[28] No reference will be made of such cases in the future unless the law was clearly strengthened. Also, the State Supreme Court (which will in the future be called the Court) held that Wisconsin had adopted the English common law of riparian rights with the only difference being deletion of the "tide water" limitation.[29] Pollution control gained a bit by legislation to prevent slaughterhouses from dumping wastes into streams where they flowed through cities or villages,[30] and charter for dams on the Root and Big Plat Rivers called for fishways.[31]

At the end of this decade there were two very significant developments. One was the report of the state's first Forestry Commission by Increase A. Lapham, a founder of the Wisconsin Academy of Sciences, Arts and Letters, as its Chairman. He clearly pointed out the importance of forest management on the headwaters of streams to the maintenance of continuous adequate water supply. He also embodied his basic argument into the title—as if wanting to be sure that legislators and lumber barons would read it: "Report on the Disastrous Effects of the Destruction of Forest Trees Now Going on so Rapidly in the State of Wisconsin."[32] The second development was passage of the so-called "Cranberry Act" to encourage the state's fledgling cranberry industry which needed water rights for flooding of their beds, to provide irrigation or protection from frost.[33] Although this legislation gave cranberry growers such special privileges that the law often has been considered unconstitutional, the Court at that time and since has avoided such determination.

The Cranberry Act often is cited as an example of weakening of both public and private riparian rights, or in legal terms, the common law rule was "enlarged." There is evidence of lakes half drained away and of substantial portions of rivers diverted many miles from their natural watercourses.[34] The law permitted a cranberry grower to dig a ditch to water over another man's land and take the water to his own bog—before he had acquired permission from anyone. All he had to do was pay the damages—and be sure his operation did not injure any dam or ditch another cranberry grower had developed. It is not surprising that a number of court cases have arisen from such legislation. However, this type of agricultural water use later led to enactment of Wisconsin's agricultural irrigation permit system[35] and the cranberry growers were the first to pay lower riparian hydro power companies for water they diverted from a watercourse.[36] These subsequent decisions were vital elements in the evolution of Wisconsin's water policy.

By the time the third decade began in 1868, the legislature had declared nineteen streams navigable—usually for floating logs—including a number of little creeks such as Scarboro Creek in Brown and Kewaunee Counties. Another thirteen were added in this ten-year period, with fishways specified for several. It must be remembered that Milldams could be built on "non-navigable" streams and such structures interfered with floating of logs. Also, this still was the steamboating age and a law was enacted prohibiting any dams below the "first impassable barrier" to steamboat navigation existing above the river's mouth. In 1870, propagation of brook trout was encouraged by legislation permitting private individuals to build dams for this purpose on any lands owned by them so long as they didn't "obstruct navigation of navigable water."[37]

At this early date a "watercourse" was not clearly defined nor were the conditions under which it should be considered navigable for public purposes. One court decision said "there must be a stream *usually* flowing in a particular direction, though it need not flow continually. It may sometimes be dry . . ."[38]

A number of definitive cases settled by the Wisconsin Court in this decade are noteworthy. It was ruled that: watercourses were navigable if they could float a sawlog only part of the year;[39] the state had a right to prevent unauthorized obstructions in rivers;[40] a stream as small as Levis Creek in Jackson County was navigable for floating logs even if possible only part of the year and natural obstructions and barriers had to be cleared away;[41] the public right included the taking of water by municipalities for domestic use;[42] pollution by a distillery on the Kinnickinnick River in Milwaukee County could be abated;[43] and, in a case involving Lake Michigan, Chief Justice Ryan explained that in Wisconsin, "Waters are . . . held navigable when capable of navigation in fact, without other condition."[44] Little Levis Creek has a watershed of only twenty square miles, but the court said:

> It is the settled law of this state, that streams of sufficient capacity to float logs to market are navigable . . . it is sufficient that the stream have periods of navigability ordinarily recurring from year to year, and continuing long enough to make it useful as a highway.[45]

In this decade, the Board of Railroad Commissioners (1874; later Public Service Commission), the Commissioners of Fisheries (1874), and the State Board of Health (1876) were created. The latter two lost no time in getting to work and in 1877 both made efforts to call water pollution problems to the public's attention. Also, the state trout hatchery at Madison was established to restock small trout streams, thereby indicating public concern for them. While the Commissioners complained of the effect on rivers of "the offal of sewers, the filth of oil refineries, the workings of breweries, of stills, of gas works . . . and of accumulation of sawdust," the Board of Health started testing both ground waters and rivers such as the Black, Chippewa, Fox, Wolf and Yellow. Their report the next year called water in lakes and streams "common property" and claimed no one had the right to destroy or injure its potable quality. Earl Finbar Murphy's recent excellent and exhaustive book on the subject of "Water Purity" refers to this Wisconsin experience with the comment: "It found also that the public had acquired a taste for any discolored, odorous and nauseous-flavored water under the belief that it had medicinal qualities."[46] Further, it was in 1875, now ninety years ago, when Increase Lapham made the first hydro-graphic maps of the Oconomowoc Lakes and related his finding to their capacity to produce fish.[47]

Publication of the Revised Statutes of 1878 marks the beginning of the fourth decade. This book carried a list of twelve rivers "declared to be navigable" at least in the part described, and ten additional watercourses which were "navigable for driving logs." The fact that this distinction still existed indicates a continuing conflict between the lumbering industry and other private riparian water users.[48] Besides repetition of existing laws, a new one made it illegal to remove rock or stone from the natural bed of navigable waters of the state by non-riparians—unless they first secured approval of the local authorities.[49] This also was the year when over 50,000 acres of state virgin timber lands in lake-studded Iron and Vilas Counties were set aside as a "state park" forest reserve. Unfortunately, most of this watershed vital to the headwaters of Wisconsin's two largest river systems was sold nineteen years later at an average price of $8.14 per acre to feed the lumber mills in need of more quality timber.[50] Another indication of water policy in a state with expanding agriculture was the fact that over one-half million acres in the state's "Swamp and Overflowed Land Account" were dedicated to a "Drainage Fund" to assist activities of local drainage districts.[51] The overselling of this vast drainage program later reacted strongly for the damming of drainage ditches to raise the water levels in many places.

Several court decisions enhanced the concept of public rights in navigable waters during this period, but again they resulted from conflicts between private users or developers and indicated more interest in hydro power. One stated that the "private right of the riparian . . . is subordinate to the public use of a navigable right" and that "the public right must always prevail over the private exercise of the private right."[52] Another said the "riparian's right . . . rests . . . upon a passive or implied license to the public, and is subordinate to the public use and may be regulated or prohibited by law."[53] A third quoted from Lord Selbourne in an earlier English case (1876) that "the title to the soil constituting the bed of a river does not carry with it any exclusive rights of property in the running water of the stream . . . The word, 'riparian' is related to the bank, and not to the bed of the stream . . ."[54] The ten-year period closed with a new state law prohibiting dumping of refuse in the Rock River in Rock County.[55]

With the start of the fifth decade of statehood, the Board of Health published its twelfth report, featuring an article by University of Wisconsin Professor W. W. Daniels on "The Sanitary Examination of Water." He warned that "A pleasant taste, sparkling brightness and crystal clearness may accompany a degree of contamination unpleasant to contemplate." This report also carried notes on problem cases such as butchers dumping their wastes in the Hustisford pond and a slaughterhouse above Wonewoc using the stream flowing into the village for their refuse.[56] Also, the first fish and game warden was appointed during this period; a report recommending six reservoirs on the Wolf River headwaters failed to get sufficient financial backing;[57] the Commissioners of Fisheries opposed three more lumber dams on the Brule River and hired E. A. Birge to study fishery values of lakes and adjacent marshes;[58] F. H. King of the University of Wisconsin Agricultural Experiment Station carried on a series of experiments in agricultural irrigation at Madison;[59] T. C. Chamberlain started the first state soil erosion surveys[60] and Birge published the first of his pioneering studies of plankton in Lake Mendota in the *Transactions* of the Wisconsin Academy.[61] Probably most important was this organization's successful sponsorship of legislation which established the State Geological and Natural History Survey and its prompt publication of hydrographic studies by Birge and Chancey Juday. Charles Van Hise headed up this committee, supported by most of these men which included, counting himself, four presidents of the Wisconsin Academy during that time.[62]

The public trust in navigable waters was further strengthened by new laws and court decisions. In the two years before 1890 our Court held that streams "navigable in fact" also are "navigable in law."[63] The next year a federal opinion by Mr. Justice Field, in the argument between Illinois Central Railroad and that state, decided that "the trust devolving upon the state for the public . . . can not be relinquished by a transfer of the property . . . except . . . in promoting the interests of the public therein . . ."[64] The following year a Minnesota Supreme Court decision held that boating and sailing for pleasure on public (or navigable) waters "should . . . be considered navigation, as well as boating for mere pecuniary profit."[65]

The stage was being set for greater things to come, and before the end of this decade, the Wisconsin Court went on record favoring the Trust Doctrine for all citizens, holding the beds underlying navigable waters for them subject only to the qualifications that the riparian owner had a "qualified title" in the stream bed.[66] Other court cases found that a cranberry marsh developer could not use the "Cranberry Act" to destroy the paramount public rights;[67] that a dammed up stream creating a pond became public waters and that riparian owners on such impounded waters could restrain the owner from tearing down the dam.[68] A victory also was recorded against water pollution when the Court affirmed a judgment against the Waupaca Starch and Potato Company and ordered them to stop dumping their wastes in the Waupaca River.[69]

The legislature was active during this time before the turn of the century. Their enactment to the effect that "all fish in the public waters of the State of Wisconsin are hereby declared to be the property of the State . . ." was used effectively by the Court in a "public rights" case a few years later.[70] They also decided all meandered lakes were public waters and stated that if such lakes had not been returned as navigable by the United States Surveyors, the test for this determination would be whether they were "navigable in fact" and they added that on these waters "all persons shall have the right and privilege to pass to and fro . . . and to have and enjoy all other rights and privileges thereon . . ."[71] Three other enactments of interest declared Rice Creek in Barron County navigable for steamboats,[72] required all dams on the Brule River in Douglas County to have fishways maintained in good shape,[73] and declared the dumping of garbage in Lake Michigan a public nuisance.[74]

II. New Hope in the New Century

In the sixty-eight years since 1897 there have been many battles for control of the right to use waters in lakes and streams for various kinds of development in industry, agriculture and outdoor recreation. It may be best to continue discussing these by decades and special attention will be paid to those actions which strengthened Wisconsin's policy on public waters. The period starts at a time when the harvest of quality timber put Wisconsin in a leadership position throughout the country. In addition, two other slumbering giants were stirring in the north—agriculture and recreation. As the big sawlogs disappeared, the paper industry increased its use of pulp and many timber companies pushed the sale of their cutover lands for farms. They also sold water frontage for summer resorts, camps, and cottages. In 1899 Congress passed an act asserting all its authority over navigable waters within its jurisdiction, and this expanded continually since then through the definition of "navigable waters of the United States."[75]

The report of the State Fish and Game Warden at this time refers to clubs which "have endeavored to gain a monopoly of some of the best hunting and fishing grounds," and cites the decision in favor of the public handed down by the Court in the Willow River Club case.[76] A man named Wade deliberately fished in St. Croix County's Willow River at a point where the Club owned both banks to set up a test case of public vs private rights. He entered the stream from a public road, not touching the banks, and therefore he was not trespassing—except in what the Club claimed were private waters. After he caught ten trout they had him arrested and brought an action to recover $20.00 for the fish he took while "trespassing." The Court held in favor of the fisherman, saying that although state policy had given title to the bed of streams to riparian owners, "Such ownership is of a qualified character as not in any way to interfere with the character of the stream as public waters . . . public in the common-law test of navigability."

Mr. Justice Marshall, in a concurring opinion, explained that he did not think it made any difference whether or not the fisherman was in a boat at the time, but he could have been "traveling upon the bed in the shallows, or anywhere in any manner, between the lines of ordinary high water mark." He also stated that "for all the purposes of the trust for which the lands under navigable waters were vested in the state, the title thereto is still subject; and that only for such private purposes as do not interfere with such public purposes, has the title been surrendered to the riparian proprietors." This settled the question of whether riparian owners could stop fishermen from fishing in navigable waters if they could get on them without trespassing.[77]

A number of other Court decisions are worthy of note and some must be cited. In the Mendota Club case it said that even on waters raised artificially by a dam, "the riparian proprietor takes only to the water's edge."[78] The Portage levee case stopped the state from entering on works of internal improvement;[79] the Pewaukee case said that private riparian use was subject to such rights as are incident to public waters at common law;[80] the Lathrop case at Racine declared the artificial channel for a waterway as navigable;[81] the Dancy Drainage District case refused them power to drain Little Rice Lake on the Little Eau Pleine River;[82] and in the Rossmiller case the rights of the people in navigable waters were considered beyond the power of the state to interfere with except by police regulations.[83]

Even more important for preservation of public rights were three other cases. In one a riparian owner stopped the Wisconsin State Land Improvement Company from following through on a scheme to drain a navigable lake after securing approval from the legislature. The Court said:

> The Legislature has no more authority to emancipate itself from the obligation resting upon it which was assumed at the commencement of statehood, to preserve for the benefit of all the people forever the enjoyment of the navigable waters within its boundaries, than it has to donate the school fund or the state capitol to a private purpose.[84]

A second declared:

> The United States never had title, in the Northwest Territory out of which this state was carved, to the beds of lakes, ponds, and navigable rivers, except in trust for public purposes; and its trust in that regard was transferred to the state, and must there continue forever, so far as necessary to the enjoyment thereof by the people of this commonwealth. Whatever concession the state may make without violating the essentials of the trust, it has been held, can properly be made to riparian proprietors.[85]

In the third case a family living below the City of Waukesha on the Fox (Illinois) River secured an injunction to abate the nuisance caused by the city's sewer system which drained 550 closets into the river, making conditions "offensive" for a period of years and the water unfit for bathing or the watering of stock. This was a victory for both private and public rights in stream purity, as well as aesthetic attractiveness and public health.[86]

The "Wisconsin Idea" was now budding and beginning to flower. The newly created Geological and Natural History Survey cooperated with the recently appointed State Forestry Commission to secure Forester Filbert Roth of the United States Department of Agriculture for a study of the "Forestry

Conditions of Northern Wisconsin." His publication was the first of the Survey's economic series and his observations on the relationship of "forest, climate and waterflow" were a valuable contribution to an understanding of these matters.[87] The Survey conducted biological and hydrographic studies of Wisconsin's waters and published books on "The Lakes of Southeastern Wisconsin"[88] and "The Plankton of Lake Winnebago and Greeen Lake."[89] Also of significance was a dissertation by Alfred R. Schultz on "The Underground and Surface Water Supplies of Wisconsin,"[90] and a report by William A. Kirchoffer on "The Sources of Water Supply in Wisconsin," all of which he said "were contaminated to some extent with sewage."[91] The U. S. Geological Survey started stream gauging work in Wisconsin about this time.

In 1905 two state agencies which were destined to play vital roles in water resource regulation, the Railroad Commission (later Public Service Commission) and the State Board of Forestry (subsequently part of the Conservation Commission) were created. Other legislation cancelled all charter franchises for construction of dams unless used within four years;[92] set aside as a nucleus of a forest reserve all the state lands in northern counties;[93] required the State Commissioners of Fisheries to inspect all dams in the state as to needed fishways[94] (soon changed to permit them to require fishways wherever needed); and created a forest reserve on the Brule River with the restriction: "It is hereby declared to be the purpose and policy of the state to forever prohibit the building or maintaining of any dam or dams upon the Brule River or any of its tributaries in Douglas County."[95] There were strong feelings among local summer cottage owners that dams warmed the water, restricted movement by fish, and spoiled the trout fishing.[96]

Another statute, in 1907, authorized the Wisconsin Valley Improvement Company to construct, operate and maintain water-storage reservoirs for stream regulation and power production with a generous franchise which resulted in strong political and social reactions expressed in the newspapers, the legislature and the courts. By this act, the State Board of Forestry was empowered to hire a hydraulic engineer to help them set levels on the reservoirs, and required to approve or disapprove all new reservoir dams after public hearings.[97]

Several related activties may help explain the court decisions and legislative acts. The Commissioners of Fisheries were headed by President Edwin E. Bryant, who also was Dean of the University of Wisconsin Law School. He advised them on the power of the legislature to prevent pollution that killed fish in streams and to declare pollution a public nuisance. He also argued that "the benefit of state stocking (of fish) should not be monopolized by riparian owners" and that where public fishing was not allowed, stocking should be withheld.[98] These Commissioners expressed concern over the increasing number of power dams and questioned the justification of stocking large numbers of fish "for such obstructed waters."[99]

Meanwhile, the State Board of Forestry, under Chairman Charles R. Van Hise, President of the University, also was concerning itself with water resource matters. This should have been only natural, for the Board also included Edward Birge, William Henry of the Agricultural College and State Forester Edward M. Griffith. Their Board minutes include discussions of state water powers, a legal suit by the Brule River Winneboujou Club against proprietors of the so-called "Muck Dam," the Nebagamon Lumber Company gift of about 4,000 acres of land in the Brule River basin; legislation to give them responsibility to establish levels on proposed Wisconsin River reservoirs and contacts by Van Hise and Birge with Senator Robert La Follette in Washington, D. C. regarding the sale of federal lands in Wisconsin to the state.[100]

Many beautiful waterfalls in Wisconsin have been destroyed in the process of building hydro power dams but there was surprisingly little public complaint over this loss in the early days. It was not until a franchise granted by the legislature in 1901 for a dam at Kilbourn (now Wisconsin Dells)[101] was purchased by the Southern Wisconsin Power Company and building began in 1905 that aesthetic values were public concern.[102] The new seventeen foot head of water was to cover many of the unusual formations in this sandstone gorge which pioneer photographer H. H. Bennett of that city had immortalized with his exceptional photographs. Bennett and others fought a losing battle to try to preserve this rare bit of scenic beauty and he said, "With me, every rock that is to be hidden from sight is a sacrilege of what the good God has done in carving them into beautiful shapes."[103] John Nolen, in his classic on "State Parks of Wisconsin," agreed, with the comment: "When . . . the level of the water is raised, the present generation . . . will have covered forever more of the essential natural beauty of the State than future generations can re-create."[104]

III. The Conservation Movement

Possibly the decade from 1908 through 1917 was the most controversial so far as public rights in navigable waters were concerned, but also the most formative for state water policy. A statement made by Forester Griffith is a good key to the argument: "The rivers of the state furnish water power to the extent of 1,000,000 horse power and the region of their headwaters should be kept under forest cover to maintain a more uniform stream flow."[105] It seems that both the public resource administrators and the private water power developers generally agreed with this recommendation (although some hydrologists questioned the theory), but the battle developed over public control of these potential water powers and possible effects on navigation caused by dams and fluctuating reservoirs. When the smoke cleared in 1915, after two water power control enactments by the legislature and the forestry program itself had been declared unconstitutional,[106] the public had received some unexpected benefits in stronger protection of public rights in navigable waters. Not unrelated was the strong national conservation movement starting in 1908.

Just prior to the landmark "Governor's Conference on Conservation of Natural Resources" called by President Theodore Roosevelt at Washington, D. C. in May 1908,[107] articles previewing the subject appeared in national magazines. Two of these, by W. J. McGee on "Our Inland Waterways" in *Popular Science Monthly*, and by John Lathrop Matthews on the "Future of Our Navigable Waters" in the *Atlantic*, caused quite a stir in Wisconsin. The former referred to the present needs being intensive development and conservation and especially "the retention of rights in power developed by private means, the time limitation in grants for state and private works, and the leasing of power developed on public works." It referred to the vast inherent value of forests as "a bagatelle in comparison with the inherent value of our living waters," claiming that "the time is ripe for taking stock of this immeasurable resource; and it behooves the people through their representatives . . . to claim this greater heritage on which the lives of the generations must depend."[108]

The latter article by Matthews spoke eloquently of the "white coal" of hydro power potential, stating that the "public domain is a public grab-bag" and suggested a federal commission to consider possible by-profits of public work, "such as that from water power." He used the Wisconsin River as an example of good public development as compared to a give-away type of water power development on the headwaters of the Mississippi River in Minnesota. However, some of his ideas did not please Wisconsin's private corporations, such as the fledgling Wisconsin Valley group, when he referred to federal partnerships for the development of power in navigable streams, the fear of monopolization of water powers by private concerns and of bills in Congress "giving to such concerns rights in perpetuity, without any return whatsoever, in public streams and depriving the government of the power to benefit from any of the improvement . . ."[109]

Governor James O. Davidson led Wisconsin's representatives at the Governor's Conference, with State Forester Griffith and three others interested in forest conservation and utilization advising him. Two past-presidents of the Wisconsin Academy—T. C. Chamberlain and C. R. Van Hise representing the American Association for the Advancement of Science and the National Association of State Universities—addressed the Conference. Van Hise, who already was an authority on conservation of natural resources and was preparing a book on the subject (published in 1910),[110] pointed out how a few large corporations were in a position rapidly approaching monopolization of the coal and iron resources of the nation, which "are the inalienable heritage of our People, and not of a chosen few." He said these corporations "must so administer their trust that the people shall possess their heritage" and maintained that unless this were done willingly and fairly to the advantage of the People, "the Nation and the States not only ought to but will prescribe all regulations necessary to accomplish this."[111] It should be noted that Senator Robert M. La Follette, Sr. very probably was in the audience listening to his friend who was President of the University of Wisconsin.

Promptly on his return from this Conference, Governor James O. Davidson appointed a State Conservation Commission (on July 24, 1908)[112] containing most all of those who had attended the Washington meeting with him, plus Professor E. A. Birge, Director of the State Geological and Natural History Survey, and member of both the fishery and forestry commissions. In this capacity, Birge also knew something about the state's hydroelectric resources, for the Survey published Leonard S. Smith's book on "The Water Powers of Wisconsin" that year. Federal flow measurements on the larger rivers since 1902 were recognized and he claimed that "the water power resources are as certain and eternal as the sunshine." It was predicted that the Wisconsin, Chippewa and St. Croix Rivers could "produce power equaling and even exceeding that of the lower Fox."[113]

In this setting, Governor Davidson's message to the 1909 legislature observed that "in many cases a public utility is a natural monopoly, and without regulation by the state the people are oppressed by inadequate service or by imposition of excessive rates." He explained that recently the Railroad Commission's powers and duties had been expanded to include regulation on many things as well as water and water power.[114] The next month he sent a detailed statement to the Legislature transmitting the first report of his Conservation Commission, calling attention to the section written by Edward Birge on the need for conservation of the state's undeveloped water powers. He himself added five recommendations asking the legislature to have some state agency administer issuance of franchises, carefully define their terms and conditions, impose an annual franchise tax and stipulate a fixed date for expiration of both old and new franchises for maintaining dams on navigable streams.[115]

The Birge report referred to "unlimited franchises" such as was given to the Wisconsin Valley Improvement Company in 1907 and called for a general law both to encourage industrial development and secure "to the public some share in the control and in the future worth of this valuable asset . . ." He advised that the European policy of leasing water powers be considered and claimed that to date Wisconsin had treated them "as if they had no value to the public . . . Now we suddenly awake to the fact that these water powers are the most valuable possession remaining to the state, and the problems of their control and utilization must be settled now if ever."[116]

The 1909 legislature responded by passing three joint resolutions assigning duties and creating a special legislative committee to investigate "Water Powers, Forestry and Drainage."[117] They started their work at a joint meeting with the Conservation Commission and held a series of hearings throughout the state.[118] At one in Milwaukee both Birge and Van Hise gave testimony and were subjected to intensive questioning by Attorney Neal Brown or Wausau, representing the private water power interests, but not as "a paid advocate" because he was one of them. He was noted for his eloquence and not only criticized Birge and Van Hise for carelessly implying "that the state has . . . control, and that this is a natural resource of the state in a sense of the state's being proprietor or owner . . ."[119] He claimed many people were "victims of the phrase monger" (a field in which he was an expert) and delivered a document to the committee containing this classic complaint about the new conservation movement:

> The man who can invent a good mouth-filling phrase is assured of a certain leadership or prominence. The new phrase of this obsession is "Conservation of Our Resources." It has the endearing element of indefiniteness; it sounds well. It may mean much; it may mean little; it may mean anything. It is interpreted differently by the different led captains of our altruistic army of reformers. They apply it to water powers which the state does not own, never did own, and never can own, except by purchase or by condemnation under the eminent domain. The "resources" they refer to do not belong to the state but to private citizens.[120]

It is fortunate that the legislature published the report of this Committee on Water Powers, Forestry and Drainage—all 779 pages of it—but most valuable are the original verbatim hearing notes which contained arguments for and against public rights in water still present today.

Some of these ideas are:

1) Extensive arguments over the wish of farmers to drain the mill pond at Delavan, which "the people look upon as a beauty spot and as a place for recreation," because this milldam backed up the water. University agriculture experts testified the value per acre of the farm lands would change from two to four dollars per acre up to forty to sixty dollars per acre. "Prior rights" of milldam owners here obstructed "public" drainage plans.[121]

2) Proposed legislation for changing the drainage statutes would have changed the definition of the word "navigable" so as to nullify the decisions of the Supreme Court in that respect and give drainage districts full powers of condemnation (even over milldams and water powers) and right to deepen or change the channel of rivers and even drain meandered lakes. One Committee member wanted to classify all streams into "floatable" and "navigable" categories.[122]

3) A Conservation Commission bill which also would have included full regulatory power over all water resource matters and employment of a hydraulic engineer was considered. The decision eventually was to put most of this regulation under the "Rate Commission" because they were "out of politics." Forester Griffith favored an all-inclusive natural resources agency.[123]

4) Reference was made by Senator George P. Hambrecht of Grand Rapids to agricultural irrigation going on in central Wisconsin: "They are irrigating semi-arid lands along the irrigation ditches, which is practical if they can get authority to do that." He also stated that "there ought to be some scheme for renting water from the irrigation ditches which should be worked into the drainage bill."[124]

5) A prediction was made that the contest between water power developers and summer resort proprietors or "pleasure people" would become sharper over the question of water level control on the reservoirs and evidently considerable conflict already existed.[125]

6) The constitutional restriction on internal improvements stopped the State of Wisconsin from developing its water powers as a public policy, a move favored by President Van Hise. National Conservation Commission reports showed an apparent countrywide trend toward such a program. Van Hise felt strongly that the principle of public control was basic in a natural resource of this kind and it "should be not the privilege of one or a few, but should be to the advantage of the entire state."[126]

7) Key witness for the Conservation Commission representing the public's interest in water resources was Professor Eugene Allen Gilmore of the University of Wisconsin Law School and one of the Birge, Griffith and Van Hise Wisconsin Academy group.[127] His detailed brief on "Riparian Rights in Wisconsin" was published the following year by the Government Printing Office after presentation by Senator Robert M. La Follette. A subtitle referred to these riparian rights in relation to "Limitations Thereon Growing Out of the Public Nature of the Water." One argument in his syllabus stated in part:

> All navigable waters, in addition to being subject to equal use by all riparian owners, are also subject to use by all members of the public . . .

> As between riparian proprietors and the public, the public right of use is paramount and may be enjoyed to the total exclusion of the private right.

It further was indicated that this subject was becoming a political matter with the "Progressive Republicans and Democrats" supporting public rights, and Senator La Follette had several messages about it.[128]

8) Legislation was pending for a Wolf River Improvement Company to construct reservoirs on the headwaters of that river and detailed revised plans for six reservoirs dating back originally to 1891 were ready for use.[129] Consulting Engineer C. B. Stewart testified that publicity to the effect that "the water powers belong to the public and that they would confiscate them from people who owned them originally, has done a great deal of hurt, and has stopped the development to a certain extent." It was pointed out that a Wolf River dam was one so affected.[130]

9) Senator Paul O. Husting, a Mayville attorney (later United States Senator) was a member of this Committee and emerged as a champion of public rights in navigable waters. With Senator Henry Krumrey, he submitted a minority report strongly recommending curtailment of the rights given away with franchises for dams and urging recall for revision and better public control and limitation of all such authority wherever possible.[131] In essence, these two felt that "the state should declare that the beneficial use and natural energy of the water of the navigable streams and lakes of this state for all public uses belong to the state in trust for all the people."[132] A proposed bill they recommended dropped the idea that rivers had to be meandered to be navigable and added "all rivers and streams navigable in fact for any purpose . . ."[133] In the Committee hearings, Birge, Griffith and Van Hise all urged, regarding the rights which still belong to the state, that they be asserted as far as possible, and Birge added "for every inch of right that belongs to the State—and that was the feeling of the Conservation Commission."[134]

As indicated earlier, battles involving riparian rights as related to public rights in navigable waters continued through several sessions of the legislature and were not resolved until after both the 1911 and 1913 Water Power Acts had been found unconstitutional by the Court. The 1915 Water Power Law[135] gave the Railroad Commission exclusive jurisdiction and power to issue permits for the construction of dams in navigable water as well as some jurisdiction over the Milldam Act and responsibility to settle many problems arising from obstructions in navigable water.[136] In the State Historical Society's collection of the Husting Papers and publications of the time, a "Preliminary Report on the Storage Reservoirs" published by the State Board of Forestry points out that these waters have been used for streamflow regulation on the Wisconsin River from as early as 1897.[137] Also, the rapidly growing summer resort business was in conflict with impoundment developments, especially in periods of drought, and the problem needed to be resolved for the benefit of both recreational and industrial water uses.[138]

Political ramifications of this controversy were evident in the 1910 Democratic and Republican platforms, with the former favoring "the conservation of all the natural resources of the state for the benefit of the many instead of the few. We believe that the resources of the state are the heritage of all and should be conserved for the benefit of all." The latter stated that "We pledge legislation that shall encourage the earliest and highest development of these resources, while we claim all the rights of the people in them . . . Private monopoly should be controlled by the leasing of water power on limited permits subject to regulation and valuation compensation." Significantly, these platforms were quoted in the biennial report of the State Forester![139]

A third document of interest is the "Supplemental Argument" of Neal Brown presented to the special committee at a later date. In this he sarcastically criticizes the entire conservation movement from its national leaders, Gifford Pinchot and Theodore Roosevelt, to Wisconsin's protagonists, President Van Hise of the University and a number of his faculty members—but not all of them. It is an invective classic of the type for which he was famous.[140] He called the attack on water power owners "Socialistic," claimed Pinchot was "dreaming dreams and seeing visions of Monopoly,"[141] accused the University heads of lobbying with members of the legislature and tore great holes in the article in which Matthews spoke so highly of the work being done by State Forester Griffith. "The state forester may well pray to be saved from such friends as Matthews."[142] In the end, he also quoted extensively from court decisions which favored his own point of view, maintaining that water powers were the private property of the riparian owners and they should be permitted to develop them with the least possible amount of regulation and control.

Several items found in the Husting papers (1910–1913 period) are worthy of mention. They include materials presented to legislative committees of which he was a member in the 1911 and 1913 sessions. One is a letter from Attorney Thomas Kearney, a specialist on drainage law, to Senator Hambrecht, in which he observed that the State Supreme Court "has gone to very great lengths in giving to insignificant streams and ponds the character of navigable waters because at some time during some high stage of the water, some hunter or trapper has been able to navigate the same with a skiff or canoe."[143] He urged revision of the law to declare all such waters to be private waters unless they "are actually used for floating lumber and logs and other products of the country to mill or market and for public travel from place to place in boats . . . ."[144]

Another item related to the work of State Forester Griffith, who not only was credited with securing the 4,321 acres of land valued at over $43,000 from his friends the Weyerhaeusers, for the Brule River State Forest, but also for two federal grants of land—some 40,000 acres in the headwaters country worth $200,000 and from 500 to 600 unsurveyed and unallotted islands in Northern Wisconsin lakes worth $12,000. In addition, he recommended "a forestry investment fund" to be provided by a two-tenths of one mill tax on property in the state and helped to promote adoption—through two sessions of the legislature and an affimative referendum vote—of a constitutional amendment allowing the state to appropriate money for the purpose of acquiring, preserving and developing the water power and forests of the state.[145] A majority of over 16,000 voters favored the measure in 1910,[146] only to have the court rule several years later that it was not properly ratified in 1909 and all the proceedings were null and void.[147] Griffith, when he left Wisconsin in 1915, feared that the largest part of the 375,000 acre forest reserve built through a decade of work, would be "thrown upon the market and sold."[148]

One of the leaders in these battles was Senator Paul Husting of Mayville. In a brief before the Court supporting the State Attorney General against the Wausau Street Railway Company (Water Power Case), he stated:

> The people of this country . . . finally have awakened to the importance of conserving our natural resources, or at least as much of the same as they have within their control. They have recognized that . . . the navigable waters of this state are the heritage of all the people and should be conserved for the benefit of all the people. The recognize that they have parted with the fee of some of these resources, but they insist that whatever dominion that is left in them shall be asserted to the utmost so that these things which were designed not for the benefit of the few should so far as possible be conserved for the benefit of humanity.[149]

On another occasion, when appearing before Joint Assembly–Senate Committees on the 1913 bill, Husting said that "the state . . . has certain rights and duties in regard to navigable rivers; and each individual is the trustee of these highways and it is its duty to safeguard them for the best interests of all the people."[150]

In 1913 Senator Husting had fairly frequent contacts with Senator Robert M. La Follette in Washington, D. C. and received compliments from him when the second Water Power Act passed in 1913. La Follette wrote that he was glad "to receive your assurances that the changes made from the bill as it was considered . . . are changes of form rather than substance, and that the bill safeguards the rights of the people so far as the state constitutional limitation permits."[151] Another fact to be noted is that Attorney Theodore W. Brazeau of Grand Rapids was representing the water power interests then and his firm also worked for the cranberry growers both before and after this time.[152] The fight continued on many fronts through 1915, and the legislature had already repealed the 1913 law and enacted a new Water Power Law before the old one was found unconstitutional by the Court. The Railroad Commission now was given responsibility to investigate stream flow and dam obstructions "so as to conserve and protect all public rights in navigable waters" and not only was authorized to consider applications for dams (instead of the legislature) but directed that they be concerned with scenic beauty in removal of standing timber from proposed flowages.[153] During the seventy-three years from 1836 to 1909 when the legislature considered franchises, 849 dams received approval.[154]

Several years later, after a critical 55–38 vote in the Assembly on June 10, 1915, political aspects of this legislation were evident in newspaper comments. Headlines in the *Wisconsin State Journal* reported that "Power Interests Suffer Defeat—Water Power People Get Adjournment to Work on the Members."[155] But the final revised bill, with its limitations on dam franchises and recapture clauses for the public welfare (whenever the constitution would so permit), prevailed as a compromise between the hydro power interests and the Husting forces in the end. Timely comments (quoted here in part) about public rights appeared in the state press, discussing the bill sponsored by private developers:

> *Milwaukee Journal:*
>
> If the water power bill is passed in its present form, giving away the people's right to the most valuable resource left in the state, a resource that will be increasingly valuable as time goes on, there will never be a chance to undo the evil. It must not be lost sight of that this measure will take away from the people of Wisconsin and their children and children's children a share of their priceless heritage.[156]
>
> *Milwaukee Leader:*
>
> In spite of the efforts of the lobby to entrap the legislature into passing a water power act that would surrender and sacrifice all that is good in the existing law (Husting's 1913 Bill), the assembly has stood firm for a provision that will enable the state or the municipalities of the state to acquire any waterpower at its present price, precluding the riparian owners from compelling the public to pay them for the privilege to erect dams on the public streams.[157]
>
> *Milwaukee Daily News* quotes Theodore Brazeau of Grand Rapids, who represented the water power owners:
>
> While I do not think the assembly bill is just to the owners of waterpowers, it does not absolutely retard development as did the Husting law, and there will unquestionably be waterpowers developed in Wisconsin under the proposed law if enacted.[158]

In passing on the application for a dam in 1916, the State Railroad Commission explained the difference between the so-called Husting Act (1913) and the Water Power Act of 1915 by saying:

> The policy of the state is changed in that the state now directs the present valuation of the property in connection with its use for developing water power but denies to the owner any increase in the value of that property and water power which shall take place during the 30 years after the issue of the permit.[159]

Important to note is the fact that a franchise granting a "perpetual right" to construct dams in the Chippewa and Flambeau Rivers also was granted to the Chippewa–Flambeau Improvement Company in 1911 on a basis similar to that of the earlier Wisconsin Valley Improvement Company franchise.[160] However, Adolph Kanneberg, in his definitive article on "Wisconsin Law of Waters," stated that "the Public Service Commission has jurisdiction over the activities of those corporations such as the approval of plans for the dams and other structures, determination of costs, apportionment of tolls, etc."[161]

This decade was so full of action in revising statutes and setting precedents by the courts for strengthening state water policy that a listing with pertinent comments is essential. Probably most important was the changed definition of "navigable waters" done simply by adding after words "not navigable" in the statutes, the clause "in fact for any purpose whatsoever." Now, finally, the determining element in each problem case would be whether or not the water was "navigable in fact."[162] Legislation in 1911 also effectively killed the old Milldam Act because any stream so small that it was not "navigable in fact" would not possess enough power to run a mill.[163] That year legislative acts were passed to prevent the "malicious waste of natural resources"[164] (all-inclusive, but aimed at the waste of flowing ground water resources and the negative court decision in the Huber Case);[165] gave the State Board of Health control over sewage works built before 1905[166] (and they immediately acted against an industrial polluter and approved the first set of plans for an industrial waste treatment plant);[167] and required that all future sales of state lands

> be subject to the continual ownership by the state, of the fee to all lands bordering on any . . . stream, river, pond or lake, navigable in fact for any purpose whatsoever, to the extent of one chain on every side thereof, and shall reserve to the people the right of access to such lands and all rights necessary to the full enjoyment of such waters . . .[168]

In the four decades after this law was passed, the State Land Commission religiously recorded these reservations in every deed so that the public has, somewhere in Wisconsin, a substantial easement for access and conservation on thousands of acres of land. Even as amended in 1951, the present law requires public access to navigable waters over such lands. Recently these riparian lands still in public control have been mapped and their value and importance is being studied.

Of the "Malicious Waste" law, Chairman Van Hise of the Conservation Commission said he was very enthusiastic for its possibilities:

> This is believed to be the most comprehensive law for the protection of natural resources which has been enacted by any state. At the onset its effect may not be great, but it will have a steadily increasing power through the years to come.[169]

This statute remains on the books today as Sec. 348.425 but somehow is not even included in the separate "Wisconsin Conservation Laws."[170] Because it is almost impossible to prove "malicious intent" to impair natural resources, the fine of $50 for the first offense and up to $200 for a second offense probably never has been assessed in such a case in the past forty-four years! It might be a good law to protect public rights in water if the word "maliciously" were deleted.

Other legislation in this period included correction of an inconsistency in the law so the test for "navigable lakes" was the same as for streams;[171] greatly strengthened pollution investigation powers and control of the State Board of Health by making it a penal offense to throw or draw "into any stream . . . waste or refuse arising from . . . manufacture . . . deleterious to fish life . . .";[172] gave important refinements to the Water Power Act;[173] enacted a code of rules for the State Board of Health governing drainage installations in connection with buildings;[174] and consolidated the several boards and commissions for fish, game, parks and forestry into a unified three-man paid "Conservation Commission" which directed the Conservation Department's work.[175] Two bills by the Wolf River Improvement Company asking approval for a series of reservoirs failed to secure the results desired by the developers.[176]

Among the several later Court cases, public rights in water were improved in various ways, and especially in the drainage cases, reflecting a mounting conflict between agricultural and recreational uses of land. One of these involved a drainage ditch at the outlet of Camp Lake in Kenosha County. A resort owner brought suit to have the level of the lake maintained and the court agreed with him, saying that "the drainage laws . . . do not authorize the draining away of the waters of the state which have been declared navigable."[177] In another scheme, to drain Horicon Marsh for agricultural purposes, by removal of the dam at Hustisford and draining the pond impounded there for over forty years, the Court declared, "The policy of this court as shown by a long line of decisions has been to scrupulously protect the navigable waters of the state from impairment."[178]

To this, Mr. Justice Marshall added a concurring statement to the effect that these waters had

> passed under the great trust vested in the state for public purposes . . . which trust . . . the state is powerless to abdicate . . . That principle is of inestimable value to the people. It should be indicated upon all proper occasions. While the reclamation of waste land is important, the preservation of the navigable waters of the state, as a matter of public policy, is of paramount importance . . . Generally speaking, a trustee can never rightfully destroy the subject of the trust.[179]

In a similar Shepard drainage case in Dane County, the court said that "rights of the public in a small body of water, navigable in fact and constituting a public highway, are as much entitled to protection as would be in a more pretentious watercourse."[180] The Trempealeau drainage case upheld the "rights of navigation and fishing" in trust for the public.[181]

In another test case, this time set up by Senator Paul Husting, who loved to hunt, he entered the so-called reserved waters of the Diana Shooting Club on Horicon Marsh in his hunting boat floating on the waters of Malzahn's Bay on the Rock River (Dodge County). The case which followed his arrest was significant in the fact that he was using a shallow draft boat in water about twelve inches deep and navigating for purpose of non-commercial navigation. The Court held that no trespass had been committed. The decision said that

> Navigable waters . . . should inure to the benefit of the public. They should be free to all for commerce, for travel, for recreation, and also for hunting and fishing . . . when it is confined strictly to such waters while they are in a navigable stage, and between the boundaries of ordinary high-water marks . . . It may be deep or shallow, clear or covered with aquatic vegetation.[182]

Other cases found that the title of Lake Michigan below the ordinary high-water mark was in the state;[183] a public street dedicated to the shoreline of a river gives the right to pass over submerged land between the shore and dock line;[184] even a state operated fish hatchery cannot legally block the normal flow of water in a stream;[185] and the 1915 Water Power Law was endorsed by maintaining that unquestionably it was intended to apply to all dams in the state, was "a general policy applicable to all the navigable water," and gave the Railroad Commission broad powers to control water levels and regulate these waters and obstructions "in the interest of public rights" or "to promote safety, and protect life, health and property."[186]

Of the many other conservation and navigable water relationships in this decade, the following are especially meaningful: the State Board of Forestry showed concern for scenic beauty by purchasing standing timber on the shores of Trout Lake (Vilas County) "to preserve the beauty of the shores"[187] and they also sent State Forester Griffith to the National Irrigation Conference in the State of Washington.[188] Very probably this was partly to assist President Van Hise, whose pioneering book on "The Conservation of Natural Resources" was published the following year. It contained a major part on water resources, predicted for the future greatly increased agricultural irrigation in the humid regions and efforts to change or modify the Riparian Doctrine of water use. Van Hise quoted a federal Supreme Court statement that

> Few public interests are more obvious, indisputable, and independent of particular theory than the interest of the public of a state to maintain the rivers that are wholly within it substantially undiminished . . . this public interest is omnipresent wherever there is a state, and grows more pressing as the population grows. It is fundamental, and we are of the opinion that the private property of riparian proprietors cannot be supposed to have deeper roots.[189]

The ecological approach to biological problems began to assume importance in scientific reports. Frank C. Baker used this method in his study of "The Molluscan Fauna of Tomahawk Lake, Wisconsin."[190] Several years later, in similar work on waters in the Lake Winnebago region, he called attention to the serious effect of municipal sewage pollution on these sensitive animals.[191] Also, Daniel Medd published "The Flow of Streams and the Factors that Modify It, with Special Reference to Wisconsin Conditions." Agricultural reports indicated that one million acres of Wisconsin had been reclaimed by tile drainage and "about 1,000,000 acres have been given an artificial outlet by deepening and straightening shallow, crooked creeks . . . . About 2,000,000 acres of swamp and marsh land still await the outlet drain."[192] The Railroad Commission reported in detail to the legislature on water powers of the state,[193] including their first "Gazetteer of Streams."[194] The Commissioner of Fisheries ordered that a fishway be placed in a Brule River (Douglas County) dam and considered the removal of old dams harmful to fish production in trout streams.[195]

IV. Prelude to the Conservation Act

From 1918 through 1927, the tempo of interest in preservation of public waters and other natural resources accelerated. A Conservation Commission report of the previous biennium complaining about the legislative act permitting a drainage operation which lowered the water level on Big Muskego Lake set off a spreading ripple of reaction. After the Supreme Court found this operation unconstitutional, the corporation failed and abandoned the project. A small dam at the outlet of the lake was repaired by the Commission under a law passed by the previous legislature, but the severe damage to the lake never was rectified.[196] They also commented on the "terrible destruction . . . pollution of streams is causing" from canning factories, paper and pulp mills, tanneries, sulphite mills and other industries. They said that "in company with an officer from the State Board of Health the members of this Commission called upon the owners of a number of large industries that were polluting streams and enabled them to realize the injustice that was being done . . ." A motion made and passed was to "notify the paper mills to make necessary improvements."[197]

Organization of the national Izaak Walton League of America in 1922, and the Wisconsin Division shortly thereafter, was a crest of the wave for protection of public rights in water. It is undoubtedly true that they helped inculcate the Railroad Commission's staff with the opinion that the enjoyment of scenic beauty should be a "public right" in waters similar to other rights. In a 1927 resolution opposing dams on the Wolf River, they stated their policy "to preserve to posterity all possible natural resources and beauty" and they viewed "with alarm this possible devastation of the Wolf River . . ."[198]

From the first, many civic leaders in the state joined forces with this group until they had over 100 chapters and thousands of members, with leaders such as Wm. J. P. Aberg, Frank Graass, Fred Luening, Aldo Leopold, Haskell Noyes, and Louis Radke. Almost immediately they pushed for pollution control legislation, and a great kill of fish in the Flambeau River below the Park Falls mill in 1925 dramatized the problem.[199] Fred Luening of *The Milwaukee Journal* told this group at their Green Bay meeting that ten tons of game fish had been killed: "It took ten men ten days to collect the ten tons of dead fish and bury them!" He also claimed the Wisconsin River was so polluted in the Wisconsin Rapids–Nekoosa area that the mills were piping water from springs and streams in the neighborhood because the river wasn't good enough to be used by them.[200]

Most important was a report by State Sanitary Engineer C. M. Baker, who produced facts and reasons for the fish kill and pictures of ten tons of dead bass, muskies and other fish. Baker said that so far as he knew, "no Wisconsin industry is voluntarily doing experimental work or even making a study of its waste disposal problem."[201] Although talking on the subject of forestry, Leopold made an impassioned plea for a conservation administration run by skilled men not subject to political pressures for their jobs.[202]

Horicon Marsh was another major battleground, with magazine articles telling of farmers interested in drainage who formed a "protective association," and conservationists describing "the ruin of forty thousand acres of Wisconsin beauty."[203] Pollution surveys on the Lower Fox, Wisconsin, Flambeau and Chippewa rivers were conducted by the State Board of Health and the following year they published their first report on "Stream Pollution in Wisconsin."[204] A year earlier even the Railroad Commission got into the act by issuing an opinion and decision on the Flambeau River problem at Park Falls.[205] Better roads and new popularity of the automobile justified state publicity of the recreation business. A 1927 constitutional amendment was ratified to permit special taxation of Forest Crop Lands and this eventually produced a County Forest program facilitating public rights in lakes and streams, as the lands were open to public access.[206] When the Conservation Act was passed that same year, setting up a six-man non-paid Conservation Commission, it was aimed at providing "a flexible system for the protection, development and use of forests, fish and game, lakes, streams, plant life, flowers and other outdoor resources."[207] Besides this legislative enactment, the creation of a "Committee on Stream Pollution" in 1925, which two years later was changed to the "State Committee on Water Pollution," was a significant development.[208] At this time the University of Wisconsin College of Agriculture Extension Division began surveying erosion control needs, with O .R. Zeasman as its project leader.[209]

For some reason, the Attorney General was quite prolific during this period, issuing a number of opinions in respect to public rights in water. He decided that the public had a right to fish in all navigable waters irrespective of ownership of the land under the waters;[210] that farmers owning land on both sides of a navigable stream had no right to put a fence across the stream;[211] that marl in a lake bed was held exclusively in trust for the public;[212] that the public was entitled to fish in lakes provided they could get to the water without trespassing on private land;[213] and that the state acquires proprietary title to land formerly part of the bed of a meandered navigable lake and may sell and convey it if so desired.[214]

Several court cases were important—and especially a federal case entitled "Economy Light v. United States." The United States brought suit against the company, asking an injunction to restrain them from building a dam in the Desplaines River without first securing the necessary federal and state approvals. This brought up the entire question of what was considered "navigable water" both on the federal and state levels. The highest court upheld the Circuit Court of Appeals, which repeated previous federal court decisions to the effect that when public rights of highway in navigable waters capable of bearing commerce from State to State was established, "it did not regulate internal affairs alone, and was no more capable of repeal by one of the States than any other regulation of interstate commerce enacted by Congress . . ." The court also found that

> Navigability, in the sense of the law, is not destroyed because the water course is interrupted by occasional natural obstructions or portages; nor need the navigation be open at all seasons of the year, or at all stages of the water.[215]

Several years later another somewhat similar case started by a Railroad Commission decision was decided by the Wisconsin state court on an evenly divided vote and upheld by the Supreme Court of the United States. It ruled that even though the Fox River Paper Company dam in question at Appleton was constructed in 1878, the company was required to comply with state regulations in order to maintain such obstruction. The riparian owners claimed their vested rights included "the right to use the water power and for that purpose to dam the river, subject only to the exercise by the State of its police power to regulate the use of navigable waters in the public interest, and to protect public health and safety . . ." The court found no denial of private property rights and stated that compliance with the state regulations was the price which must be paid to maintain the dam.[216] Of this case, Kanneberg asserted the constitutionality of the "recapture provision" was sustained by the United States Supreme Court, and that "the natural energy of the stream, since it can be developed only by such dam, is not a property right appurtenant to riparian lands, and that consequently it is either no man's property, as the winds that blow or it belongs to the state . . . ."[217]

Other Wisconsin court cases granted injunctive relief for protection of the public right of recreation in navigable waters;[218] declared the state was trustee of the navigable waters within its confines, not merely for the people of this state, but for the United States and that it was not within its power "to change navigable waters into agricultural fields, no matter how great the public benefits might be in favor of the latter;"[219] stated that "the state owns the beds of navigable lakes below low-water mark in its sovereign capacity in trust for the people, and not in a proprietary capacity;[220] found that the state had proprietary interest in minerals and other materials in the beds of navigable lakes;[221] and decided that the "trust reposed in the state is not a passive trust; it is governmental, active, and administrative."[222] This latter most critical decision might well be used for positive or negative results so far as public rights in navigable waters are concerned.

V. Effects of Drought on Water Policy

The decade of 1928–1937 was one in which administrative rules and orders promulgated by state agencies played a greater role in preservation of public rights in navigable waters—and the need was more acute due to an extended period of drought and economic depression. Lower water levels accentuated existing conditions of water pollution and brought fresh demands for protecting the flow of navigable waters from diversion. There was a sharp trend away from drainage and for better long-range planning on both poverty-stricken and tax delinquent lands. A Joint Resolution of the Legislature in 1931, asking for a report of the State Committee on Water Pollution, reflects the temper of the public through reference to a petition from almost 1,000 citizens of Lincoln County alleging "That persons operating paper mills near the Wisconsin River are causing to be discharged . . . . certain acids and refuse which are killing, blinding and otherwise maiming and injuring fish . . ." The resulting document refers to the $10,000 annual appropriation received from the Conservation Fund for this work and shows substantial gains in surveys and cooperative contacts with industries and municipalities. The report refers to an expenditure of almost one and a half million dollars spent by Wisconsin industries to that date for equipment and research to recover and treat wastes causing "objectionable pollution."[223]

The famous Horicon Marsh battle was fought in this decade. Authorized by the Public Service Commission to build a dam at the outlet of Horicon Marsh, the Conservation Commission was stopped by litigation. Circuit Court Judge C. M. Davidson reviewed the legal history of this great marsh and claimed that over the past forty years or so there had been, "as near as I can count, 11 cases in the Supreme Court of Wisconsin, between 40 and 60 in the Circuit Court and innumerable cases in Justice Court."[224] Louis Radke, in his "Horicon Marsh History," claimed that there was a "desperate organized effort to defeat the restoration program" and this was caused "by the drainage lawyers, promoters, and professional land owners, the majority of them living outside the state . . . ." Attempts to close the dam were met with "injunctions, controversy and delays for nearly four years . . ."[225]

Depression years brought federal aids for resettlement and the Civilian Conservation Corps (CCC) organization to work on erosion control and water management projects through the Federal Emergency Relief Administration (FERA) and Works Progress Administration (WPA). The Soil Conservation Service started its Coon Valley Project—one of the first in the nation—

and the University of Wisconsin College of Agriculture expanded its educational efforts in the recreational land use and soil erosion fields.[226]

In the 1930's, the University of Wisconsin published a "Science Inquiry" on the "Conservation of Wisconsin Waters" at the height of the drought period. It stated that "more than 300 truck and potato growers in this state have begun to irrigate their crops, some of them as much as 50 acres." Some found a source of water in deep wells, but "The larger projects have employed water taken from a river or lake, and this raises the question of water rights between the irrigator and owners of land farther downstream who are thus deprived of water." At another point they reported that sewage from over 600,000 urban dwellers still was being poured into the state's rivers and lakes, which "amounts to more than 60 million gallons daily, and carried a quantity of filth of such magnitude that 48 tons of pure oxygen would be needed to purify it." Further, "A recent survey of the Fox river valley showed nine times as much pollution from industrial organic wastes as from domestic sewage." They recognized the generous contribution of industry to the wealth of the state and urged that it be fostered "by every legitimate means." But, "Use of waters, with a wholesome respect for public rights, is both an opportunity and an obligation . . . . use, and not abuse . . . should be promoted . . ."[227]

John Gaus reviewed "Conservation in Wisconsin" in the 1933 Blue Book and called special attention to the Wisconsin Commercial Forestry Conference of 1928 which expressed new hope for forest industries, recreation and wise land use. He pointed out the relationships between forests and more constant water quality as well as the impact of the constitutional amendments of 1924 and 1927 making possible the forest crop law and an aggressive state forest policy. However, he also noted that the state forest reserve managed by the Conservation Commission contained about 165,000 acres less than it had before the ill-fated Supreme Court decision on forestry of 1915.[228] Probably even more important was the trend toward zoning and planning, through such new agencies as the Land Economic Inventory[229] and the Regional Planning Committee.[230] First reports of both made specific references regarding the fallacies of the earlier craze for drainage. In the planning committee report the first listing and map showing the location of existing drainage districts appeared. Publications on "Forest Land Use in Wisconsin," "Legislative Interim Committee Report on Forestry and Public Land" and the first study of "Recreation as a Land Use" by George S. Wehrwein and Kenneth H. Parsons reflected the concern of administrators for a shifting emphasis. County planning and zoning commissions were encouraged both by the legislature and College of Agriculture specialists such as Walter Rowlands.[231] Milwaukee County started its pioneering work in establishing parks along its waterway flood plains under the incentive of C. B. Whitnall.[232]

A strong land use conflict existed on the Central Wisconsin Conservation Area (CWCA) where the new Water Regulatory Board was supervising over 200 dams placed in drainage ditches to raise the water levels and help prevent fires. Much malicious damage to these small remote installations was caused when stop logs, locks and chains were destroyed or stolen, presumably by people favoring use of the ditch for drainage.[233] However, interest in building reservoirs continued, with legislative interim committees on water and electric power reporting in favor of the state building such flowages which might be "useful for flood control . . . or even for irrigation purposes under certain circumstances," besides the production of hydro power. Also, there was discussion of scenic beauty preservation.[234] A detailed federal report discouraged dams and reservoirs on the Wolf River and cited "increasing opposition from the interests rapidly developing the Post Lake region as an excellent summer resort."[235] *Milwaukee Journal* writer Fred Luening explained in his "Conservation Essays" that frequently power plants divert water through their turbines and artificial outlets so that "many waterfalls and picturesque rapids must be sacrificed." In fact, he suggested that "in districts having adequate power; where new plants mean rather profit for a few men than needed service for the community . . . beautiful waterfalls . . . probably will add more to the richness of human life than multiplied power plants."[236]

In keeping with this thinking, the Public Service Commission (name changed from Railroad Commission in 1931) issued several decisions and orders under its new authority,[237] including setting the level for Silver Lake near Portage in Columbia County to control removal of water by the railroad for their engines; requiring removal of a fence across Pollack Creek between two very small lakes in Langlade County because the water was navigable and public; ordering the Wisconsin–Michigan Power Company to operate its Weyauwega dam so as to conserve fish life in the stream below; and denying (in 1937) a dam permit requested by the Mellen Granite Company in the Potato River in Ashland and Iron Counties, on the grounds that it would destroy part of the beauty of a mile of stream containing waterfalls dropping 180 feet. This later significant decision was based on legislation secured in the 1929 legislature.[238] A decision by the Attorney General supported public rights to the effect that: 1) if a navigable stream is legally dammed, causing the water to flow over private land, the public has a right to enjoy privileges afforded by water overflowing such lands; 2) that it is a question of fact whether a certain stream is navigable and the test can be made by floating logs or a skiff; and 3) that licenses for private fur farms may not be issued covering any land submerged by a navigable lake or pond.[239]

The 1935 modification of the common law permitted diversion of so-called "surplus waters" for restoring lakes or streams in adjacent watersheds. The statutes stated:

> and water other than surplus may be diverted with the consent of riparian owners damaged thereby for the purpose of agriculture or irrigation but no water shall be so diverted to the injury of public rights in the stream or to the injury of any riparians located on the stream, unless such riparians shall consent thereto.

Surplus water was defined as "any water of a stream which is not being beneficially used," and the Public Service Commission was given the job of deciding what was "surplus water."[240] Much interesting history of this legislation cannot be detailed here, but several background facts are worthy of comment:

1) Agricultural irrigation had been experimentally carried on for several decades in Wisconsin and was not completely new even though water was taken without a permit either from wells or by common law riparian right from surface sources.[241]

2) The Cranberry Water Cooperative of Wood County had been diverting water to irrigate their crops from the Wisconsin River to their Cranmoor Reservoir and back to the Yellow and Wisconsin Rivers since 1933 under the "Cranberry Laws," and undoubtedly were the first to pay by-passed lower riparian hydro power interests for the non-surplus water used.[242]

3) While the Conservation Commission started promotion of the legislation for diverting *flood waters* (as the bill first read) for restoring lake and stream levels for aquatic life and recreation use during the prolonged drought (and they were to be responsible for its administration), this regulatory role was given to the Public Service Commission as a result of the legislative process. Substitute Amendment 1, A. to Bill 234, A. changed "flood waters" to "surplus waters" and "Conservation Commission" to "Public Service Commission" throughout.[243] Conservationists favored this legislation in spite of the change (no one appeared in opposition at two public hearings) and the Conservation Department Director appeared at the second public hearing for the bill.[244]

4) As indicated earlier, the Brazeau legal firm at Wisconsin Rapids represented both the water power and cranberry interests and this proposed legislation was submitted to them for review. The ideas of "surplus water" and "beneficial use" evidently were added on their recommendation. At that time there were known to be at least seventy-eight farmers irrigating about 1,400 acres of land.[245]

Although on the surface this apparent "weakening" of Wisconsin's water policy to permit some diversion of water may seem detrimental to public rights in streams and rivers, the test of time has shown it may rather have had a strengthening effect. Even though permits for agricultural irrigation were not issued under this law for many years, eventually it was so used quite effectively. With a permit system, it was possible to stop irrigation from small trout streams and to regulate the highly consumptive use of agricultural irrigation from most other waters when necessary. It should be recognized that the primary purpose of this law soon became secondary and only a few cases of diversion of surplus waters to restore other lakes and streams, such as by Sawyer County from the Chippewa River to Round Lake and by Washburn County from Clam River to Shell Lake, were approved.[246]

Interestingly, the Conservation Commission in 1936 issued an order requiring any person or agency "desiring to conduct lake and stream improvement projects in any manner materially affecting fish or fish life or their natural environment in or on any of the inland waters . . ." to apply for a permit to conduct such projects.[247] Another item of interest is a current thesis by University of Wisconsin hydraulic engineer Arno T. Lenz in which, with others, he proposed a water plan for Wisconsin's future including water use priorities with "Recreation and Wildlife Conservation" as No. 1 and "Water Power Development and Land Drainage" Nos. 7 and 8. Surprisingly, they did not assign any priority to Agricultural Irrigation.[248]

Of the many new laws or strengthened statutes in this decade, the following should be cited:

New legislation created the influential State Regional Planning Committee,[249] which M. W. Torkelson subsequently directed for many years, as well as the Water Regulatory Board,[250] which still exists. Pollution control received better definitions, effective organization, and power to control some sanitation aspects of plats along water courses.[251] The Public Service Commission was given orders to make a detailed study of floods on the Milwaukee River (with no funds to do the job),[252] plus greater control or powers for protection of scenic beauty in requests for dam permits,[253] the digging or filling of the beds of navigable waters,[254] and diversion of surplus waters,[255] while at least 25% of low flow was required as water to be passed through dams at all times.[256] The Conservation Commission was given new powers to start civil actions for fish killed by pollution or otherwise,[257] secured permission to build fish management structures on the Brule River (Douglas County)[258] and was required to determine on all its land sales that they were "no longer needed for conservation purposes."[259]

One authority points out that in spite of passage of the "scenic beauty" bill, the Water Power Law at that time (1929) was only amended to require "that a dam permit was not to be granted if public rights in the stream were violated."[260] The revised "surplus water diversion" law of 1935 included reference to water use "for the purpose of irrigation," but it also stated, "No water shall be diverted to the injury of public rights in the stream."[261] A vitally important section added to the fish propagation statutes in 1925 favored public fishing rights in navigable waters as follows: ". . . the state conservation commission, or its agents and employes, shall not furnish fish or fry from state hatcheries to private ponds, private clubs, corporations or preserves, and shall not plant them in waters where the general public is not allowed the rights and privileges enjoyed by any individual."[262]

There were a number of court decisions which strengthened the state's policy of preserving public rights for future generations. Even the final bitter ruling that Horicon Marsh (State v. Adelmeyer) had to be purchased from the landowners might be considered one of these for the several good results of the battle. One decision especially referred to the status of the state as trustee and its right to complain against an invasion of its rights as trustee when there is an intrusion by a third person upon the bed of a navigable water held in trust by it—and this technique for action probably should be used more often.[263]

The court decided in other cases that the state alone may object to plans for changing the waterlevels or course of a stream even if all riparian owners agree;[264] authority cannot be given for invasion of the bed of a navigable stream which would preclude the state from removing such structures when necessary in aid to navigation;[265] unsurveyed islands in unmeandered lakes are not part of the lake bed no matter their size;[266] the public gains prescriptive right to enjoy artificial waters after members of the public have used it for twenty-seven years (Blass Lake) regardless of whether the stream was navigable or the bed remains in private ownership;[267] two Langlade County lakes of 5.24 and 2.35 acres (deepest points twenty-five feet and eighteen feet respectively) connected by a channel twenty-two feet long, ten feet wide and two feet deep are navigable (even though entirely surrounded by private land) and the channel cannot be fenced to prevent access;[268] and such subjects of statewide concern as the conservation of fish and game (also part of the public trust and often dependent on water habitat) cannot be considered merely of "local" interest.[269]

One 1930 case deserves special consideration here. The Railroad Commission had denied the Nekoosa–Edwards Paper Company a permit or license to maintain a dam on Four Mile Creek, a small Wood County stream flowing into the Wisconsin River, partly because application was made under the Milldam Act applying to streams "not navigable for any purpose." The Commission maintained the stream was navigable and that the dam had to be authorized under the Water Power statutes. In upholding the Commission, Mr. Justice Crownhart, speaking for the Court, declared.

> Navigable waters, in contrast to non-navigable waters, is but one way of expressing the idea of public waters, in contrast with private waters. Boating for pleasure is considered navigation as well as boating for pecuniary profit . . . As population increases, these waters are used by the people for sailing, rowing. canoeing, boating, fishing, hunting, skating, and other public purposes. While the public right may have originated in the older use or capacity of the waters for navigation, such public right having once accrued . . . is not lost . . .

He also pointed out that the state's fish stocking program had kept the small streams of the state as fishing waters "that the public may more fully enjoy the sport and recreation of fishing . . . so long as they do not trespass on the private property along the banks."[270]

VI. Preface to the Namekagon Case

The next fourteen years might be considered a preview to the Namekagon Case, which is *the* high water mark of all decisions to date, so far as preserving public rights in Wisconsin navigable waters is concerned. The period began with Adolph Kanneberg's 1938 article, "A General Survey of the Water Power Law," in which he commented,

> . . . state policy is that no dam shall be built for any purpose whatsoever which is capable of developing 50 theoretical horsepower or more for 50 per cent of the time unless provision is made whereby the state may acquire the project after 30 years from the date of the permit.[271]

This statement also reviewed the many responsibilities of the Public Service Commission, background history, and cited decisions in a number of cases during this period involving public rights. To name a few, one required a larger opening in the "narrows" of Plum Lake, Vilas County; another ordered a riparian to fill in a ditch he had dug affecting a lake and outlet stream; and a third declared in favor of public use of a beach on Upper Genesse Lake in Waukesha County abutting a highway.[272] Reasons were detailed for refusal to issue a permit to the Central Wisconsin Power Company for a dam on the Wolf River because the Company had first secured a license for the dam from the Federal Power Commission. The conflict arose over a federal recapture clause which would interfere with a similar requirement in the state statutes.[273]

The Conservation Commission showed interest in current problems by establishing a continuing "Rivers Survey" project with an annual budget of about $25,000 at their February 1948 meeting.[274] Reflecting the developing strength of the Commission was their endorsement of a Watershed Management Program at the February 1950 meeting with an annual budget of $228,000.[275]

Also, the state's interest was evident when Assistant Attorney General Roy G. Tulane is quoted on the subjects of the public trust in surface water and riparian rights at the half-century mark:

> The state owns the water in trust for all public purposes and this includes navigation, fishing, hunting and pleasure. Currently the basic state law is that property owners with riparian rights are entitled to a reasonable use but cannot substantially reduce the flow to other riparian owners, or cause damage to the state . . . There hardly is a free flowing river in all Wisconsin except the Brule. Only the Wisconsin and Mississippi rivers are big enough to stand much diversion and still have rivers left.[276]

Miscellaneous developments of special interest at this time included federal (Pittman–Robertson) aids to help acquire Horicon Marsh, and the beginning of the Conservation Commission's land acquisition program for wildlife management (Deansville Marsh); establishment of two land and water management projects—the Central Wisconsin Conservation Area (1940) and Necedah National Wildlife Refuge (1939); formation of the Sulphite Pulp Manufacturer's Research League;[277] holding of the first public hearings on Lower Fox River pollution (1948–49) with subsequent clean-up orders;[278] publication of three comprehensive "Reports to the People" by the Conservation Department, including one on watersheds and water management;[279] presentation of a "Consolidated Report on Wisconsin's Water Conservation Program and Policy" (assembled and prepared by M. W. Torkelson) to the President's Water Policy Commission;[280] and also publication of Aldo Leopold's articles on "The Flambeau," making a plea for its preservation as a "wild river,"[281] and "The Ecological Conscience," with this critical comment on "The Flambeau Raid":

> The good soil which enabled the Flambeau to grow the best cork pine for Paul Bunyan, likewise enabled Rusk County, during recent decades, to sprout a dairy industry. These dairy farmers wanted cheaper electric power than that offered by local power companies. Hence they organized a cooperative REA and applied for a power dam which, when built, will clip off the lower reaches of canoe-water which the Conservation Commission wanted to keep for recreational use. There was a bitter political fight, in the course of which the Commission not only withdrew its opposition to the REA dam, but the legislature, by statute, repealed the authority of the Public Service Commission and made County Commissioners the ultimate arbiters of conflict between power values and recreational values. I think I need not dwell on the irony of this statute. It seals the fate of all wild rivers remaining in the state, including the Flambeau. It says, in effect, that in deciding the use of rivers, the local economic interest shall have blanket priority over statewide recreational interests, with County Commissioners as the umpire.

Attorney General's opinions during these years stated that the legislature had no power to make a grant of the bed of a navigable lake for a private purpose;[282] that diversion of water from a lake which reduces flow of the outlet stream is the same as a diversion from the stream;[283] that dumping ashes in a navigable lake is in violation of the property rights of the state, and also of other state laws if deleterious to fish life;[284] that the Conservation Department has no authority to issue private fish hatchery licenses on a "natural" lake;[285] and that in enforcement of the law prohibiting throwing of debris into public waters, the proof of putting any such things in the water is proof of violation.[286]

An effort to establish a "protected stream list" for the prevention of any future dams (on 3,300 miles of "Priority I Waters") was the substance of a recommendation considered by the Conservation Commission and later submitted (Bill 113, S.) in revised form (and in vain) to the legislature for action.[287] Other legislation in this period stopped the use of one-half the income of state swamp land sales for drainage purposes;[288] established the Wolf River Reservoir Company, including power to condemn state lands;[289] repealed and revised the 1907 Wisconsin Valley Reservoir Act, but retained a recapture clause;[290] strengthened the statutes to require the Public Service Commission to "regulate and control the level and flow of water in all navigable waters" to better safeguard the public's rights and also to have them set levels on lakes used for agricultural irrigation purposes;[291] approved the important County Forest law[292] and established two new state coordinating agencies—the Natural Resources Committee[293] and the State Board for Preservation of Scientific Areas.[294] The former was a compromise from a proposed bill to create a "Water Use Council."

The infamous "County Board Law"[295] passed by the legislature in 1947 to favor a Flambeau River Dam being promoted by the Dairyland Power Cooperative was not struck down until the Court ruled in the Namekagon Case. After this, the legislature passed a revised and weakened "County Board Law."[296] An explanation of this plan by A. Allen Schmid is good background for understanding the importance of the battle for preserving public rights in navigable waters:

> The amendment provided that the economic need of electric power for the full development of agriculture and industry was to be considered along with other public rights. It further required the Public Service Commission to weigh the recreational use and scenic beauty of the artificial reservoir against that of the natural river. Another part of the amendment provided that a dam permit could not be denied on the ground that the proposed dam would violate public rights in fishing and scenic beauty if the local county board approved the dam by a two-thirds vote. It was a provision which favored the hydro-electric interests, since local people, feeling that a dam would contribute to their community's economic growth, usually were in favor of it, even though some public uses were lost.[297]

Besides the court decisions to be discussed later, the most important new development was the rapid increase in the consumptive use of water for agricultural irrigation. While some other states may have had less reason for concern, many of Wisconsin's finest trout streams were located in the same areas as the agricultural regions being irrigated on sand-type soils. At the close of World War II aluminum production was at a peak and in surplus and new lightweight pipe was available and strongly promoted for spray-type irrigation. There were several state and federal bulletins and numerous articles in agriculture journals encouraging "Humid Region Irrigation."

Despite the fact that the 1935 legislature added Section 31.14 to the Statutes[298] providing for issuance of permits to divert surplus water from streams, only one permit had been issued (to the State Department of Public Welfare) by early 1950.[299] The United States Census of 1934 had reported seventy-eight farmers irrigating 1,438 acres in Wisconsin while in 1949 the figure was 354 farmers irrigating 9,781 acres.[300] Most of this was from wells, pits, and landlocked lakes, all of which did not require a permit, but many also were irrigating from other surface waters where a permit was required.

As early as February 1948, Lewis C. French of the *Milwaukee Journal* staff publicized the fact "one Langlade County potato grower has more than five miles of this pipe and pumps capable of pulling out 1,000 gallons of water a minute."[301] Late in 1949, Professor F. W. Duffee, Chairman of the University of Wisconsin's Agricultural Irrigation Committee, was explaining publicly that within twenty-five to fifty years possibly 300,000 acres of Central Wisconsin lands would be under irrigation agriculture and that irrigation would triple in Wisconsin in the next three years. Similar statements were made by Professor O. I. Berge of the College of Agriculture, who said, "What we need is to regulate withdrawal of water and put on the books legal recognition of irrigation, establishing what the farmer can use, how much and when."[302] An even earlier 1947 United States Department of Agriculture report reviewed the increasing use of irrigation in producing Wisconsin potato crops.[303]

In the fall of 1949 the *Milwaukee Sentinel* carried the following story:

> There's a battle brewing over water use that is making enemies among leaders of our billion dollar agriculture and our 300 million dollar a year recreation industry. For proof, residents in the north central counties in Wisconsin whisper furtively about costly pumping engines ruined by sand poured into them at night.[304]

Early the next year, Virgil J. Muench, President of the Izaak Walton League of America, criticized professors of the University of Wisconsin for "promoting irrigation projects" and inferred that they "seem to fail to understand that all the people of the state have a vital interest in our public waterways."[305] About this same time civil suits were filed against three Langlade County potato growers with large acreage on the Antigo flats for building barriers to impound waters of Spring Creek for irrigation use without a permit. The state ordered them to stop drawing off the creek water and they then resorted to the use of easily available ground water.[306]

Two University of Wisconsin Law School students have given detailed explanations as to why the Public Service Commission had not required agricultural irrigators to secure permits when the statute evidently required them.[307] In brief, the Commission's replies to requests for information generally were worded so as to discourage the possible applicant. By March 1950, only one such permit had been granted to another state agency. On December 12, 1950 the Public Service Commission received a reply to a series of questions asked on this subject from the Attorney General as follows:

> These statutes clearly require that application of water for agricultural irrigation should be considered and disposed of under section 31.14, Stats . . . it would appear that the public service commission could not properly determine that water was surplus if its diversion would injure public rights. . . . Such a permit may be withdrawn or amended by the commission at any time . . . The pumping of water from a lake which results in reducing the flow of its outlet stream does constitute a diversion from the outlet stream.

This decision also indicated that those riparians involved were any located "downstream from the diversion to the junction of the next stream" and the common law applied because the Munninghoff case in the Wisconsin Supreme Court had ruled specifically "that non-riparians did not have a right to the use of water other than for navigation and its incidents."[308]

Schmid reported that the Public Service Commission did not require all irrigators to have a permit until 1956 and gives this explanation:

> In March 1951, James R. Durfee, a lawyer from Antigo, was appointed to the Commission. Prior to his appointment he was legal counsel for the Wisconsin Potato Growers Association. Durfee was chairman of the Commission from 1954 to 1956 and while a member of the Commission it continued to hold permit hearings only upon complaint.[309]

The Conservation Commission's policy in regard to these rapidly increasing supplemental irrigation practices was developed through experience gained by the Conservation Department. In response to a request from the Northwest Area for advice, Assistant Director H. T. J. Cramer made the following reply (in part):

> The policy of the Wisconsin Conservation Department in the matter of water diversion is to recognize the multiplicity of rights to the use of the water. It recognizes the riparian's right under common law to a reasonable use of the water, considering such defined or authorized diversions reasonable which are not detrimental to fish, wildlife, vegetation, and scenic beauty, or the pursuit of these values. In theory then, finding that a particular diversion is detrimental to these values, is sufficient to enable the Public Service Commission to make the necessary corrective ruling under Chapter 31 of the statutes (31.02 and 31.14) to protect these recognized public rights. Under existing statutes our policy is adequate—if we can determine that public rights, particularly the rights we are charged with, are injured—and if we can *demonstrate* that such injury will or is likely to occur . . . .
>
> The complete absence of observations on flow in most of the waters likely to be diverted or suitable for diversion, let alone *low* flow observations, makes the problem of demonstrating deleterious effects most difficult . . . Until far more information is available on low stream flow conditions Rivers Survey has established a policy of questioning permitting non-surplus diversion in streams where flow is less than 10 c.f.s.

and opposing any diversion where low flow is less than 5 c.f.s. in waters inhabited by game fish. It has no minimum standards for low flow effects on game or cover.[310]

The Public Service Commission now was in the business of regulating diversion of surface waters for supplemental irrigation and the Conservation Commission of attempting to preserve the public trust as well as the wildlife and outdoor heritage. It is of no little import that the second application for such water diversion for supplemental irrigation which was received by the Public Service Commission, on the Little Wolf River in Marathon County, was denied because a lower riparian testified he had purchased his property primarily for its trout fishing values and any diversion would injure his type of "beneficial use."[311] A talk by Attorney G. R. Coates to the 1950 University of Wisconsin Farm and Home Week on "Water and the Wisconsin Farmer," fired the first shot of severe criticism against the state's water policy in a pitched battle for water rights which was to last more than another decade.[312]

Several other items of interest in this period included an Attorney General's opinion to the effect that the state could build a dam only as an improvement of a public park (or similar project) and that the Conservation Commission could build one only when express statutory authorization also was received.[313] Chief Engineer George P. Steinmetz wrote a memorandum to members of the Public Service Commission in 1948 calling attention to the problems of agricultural irrigation and a request from the Conservation Department for a conference on the subject in conjunction with the University of Wisconsin College of Agriculture. He referred to a memorandum on the subject from Sam Bryan dated February 26, 1926, with the comment that such irrigation had been carried on to some extent for many years under the "common law" rights of riparians. Steinmetz even related surface water levels to pumping from high capacity wells for this purpose and urged consideration of that problem in cooperation with the State Board of Health, which supervised ground water use.[314] The Legislative Council in 1950 prepared a report on the state's Water Resources,[315] and Coates, in his January speech, urged farmers to use whatever surface waters they wished on any of their land and thereby force others being damaged to prove that the use was not "reasonable" or the water not "surplus."[316]

Shortly thereafter, the Public Service Commission set up criteria for consumptive use of surface waters in the Stanislawski Case (1951), putting the burden of proof on the applicant, as follows:

> The record must therefore establish the following:
>
> 1. That the proposed diversion of water other than surplus water will not be to the injury of public rights in the stream.
> 2. That all injured riparian owners, if any, have consent thereto.
>
> (1) The burden is upon the applicant to produce evidence sufficient to prove these facts. Failure to substantiate either element must result in denial.
>
> (2) The failure of a riparian owner to appear at a hearing in response to a direct or published notice does not establish that he will not be injured by the proposed diversion or that he consents thereto, if he is injured thereby. Some more specific evidence is essential. Just what

> form such proof should take or how extensive it should be cannot be here set forth, since circumstances may differ widely.
>
> It is possible that in certain cases the amount of water to be taken from the stream will be so small in comparison with the entire volume of flow that it may be inferred therefrom that no riparian would be injured. . . .[317]

Shortly thereafter, the Public Service Commission limited any permit for diversion for purposes of irrigation to land which was riparian to the stream from which water was to be taken, using the "source of title" definition of riparian lands as "consisting of the smallest legal subdivision which is in contact with water or of a larger assembly of legal subdivisions, some portion of which is in contact with water, and which have come down to present ownership in an uninterrupted chain of title from the original government patent."[318] Significantly, in 1953 a pioneering "Statement of Watershed Development Cooperation" (An Interagency Agreement) was signed by the United States Soil Conservation Service and three state agencies: Soil Conservation Committee, Agricultural Extension Service and Wisconsin Conservation Department. It has been expanded and revised several times since and still proves to be a useful tool for coordination and cooperation.[319]

Several court actions in this period were important. In Winnebago County Circuit Court, a Public Service Commission decision requiring the Cook and Brown Lime Company to restore fill removed from the bed of Lake Butte des Morts without a permit was upheld even though the restoration involved considerable expense.[320] Also, a Chippewa County case of stream pollution by the City of Stanley is interesting because it involved serious wastes from local cannery operations and a farmer named Abner Krogan won an award for damages. Moreover, the canneries subsequently closed some of their plants in the area—possibly in part for this reason.[321]

A policy-setting Federal Circuit Court action brought by the Wisconsin Public Service Corporation in which they were joined by the state, asked review of a Federal Power Commission decision requiring a federal license on the company's Tomahawk dam built in 1887. The printed transcript of testimony, showing navigation difficulties in the Wisconsin River prior to the dams, contains 637 pages and the Corporation's "brief" another 100 pages.[322] In the end, the federal court upheld the Federal Power Commission's decision that all of the Wisconsin River was "navigable water of the United States" and under their jurisdiction so far as this type of obstruction was concerned.[323]

A state court case in 1943 dealt with the 25% of natural flow required to pass through dams and was brought by the Northern States Power Company. Limitations of this law were discussed and it was pointed out that its principal purpose was ". . . to protect rights of riparian owners to a reasonable natural adequate flowage of the stream against upper owners cutting off that flowage."[324] However, public rights also are present in these minimum flows and certainly are covered by the court's decision. The 1949 Munninghoff Case decision was negative in that it eliminated trapping as one of the public's rights in navigable water, but it did result in some benefit and supported such recreational activities as boating, canoeing, bathing, fishing, hunting and recreation, "until the heart of the public is content."[325] In this case, the brief of Thomas E. Fairchild and Roy G. Tulane for the Wisconsin Conservation Commission was a masterpiece of completeness in explaining the state's viewpoint and stated in part:

> If meaning is to be accorded to the phrase "FOREVER FREE", consistent with the legitimate restrictions that have been put upon it, it can only mean that the navigable waters are common property which all the people have a right to go upon, to navigate, and to the incidents of navigation and it is owned by the state in trust for the preservation of such rights. If the navigable waters are common property or public property and *required to be preserved as such by the Constitution*, then obviously no man can be given a special privilege therein for a private purpose. If any portion of our navigable waters can be surrendered to private control and the public excluded therefrom then all portions could be likewise transferred to private control and the public rights defeated *in toto*.[326]

VII. The Namekagon Case

The Namekagon Case[326a] was instigated by the Wisconsin Division of the Izaak Walton League of America in the name of their President, Attorney Virgil J. Muench of Green Bay, and with the counsel of Attorney Alfred Sutherland of Fond du Lac. It was supported by the Wisconsin Conservation Commission and the Attorney General's office. The Public Service Commission invited this case by refusing to make a finding on the scenic values involved on an application for a dam on the Namekagon River in Washburn County. Many serious questions of Wisconsin water policy were laid to rest by the outstanding decision handed down for the Court by Mr. Justice Currie in 1952, reversing an earlier decision in the Dane County Circuit Court. The earlier judgment in favor of the Public Service Commission's grant of permit not only was reversed, but the case was sent back to them for further proceedings in accordance with the high court's opinion. Most important was the finding that the "County Board Law" section of the statutes was unconstitutional, as follows:

> The delegation of power attempted in the "county board law" permits the "public right to the enjoyment of fishing, hunting, or natural scenic beauty" in a navigable stream to be seriously impaired or destroyed through action of a county board and the Public Service Commission action is rendered powerless thereby to intervene to protect these public rights. Such an attempted delegation of power by the legislature, involving as it does a complete abdication of the trust, is therefore void.[327]

However, the decision involved many other findings, including:

1) The Public Service Commission decisions are reviewable in the courts.

2) Attorney Muench was declared a person "aggrieved" and "directly affected" even though he was not a riparian owner and lived many miles away from Washburn County.

3) The Attorney General has a right to intervene and it is the duty of the state through its Wisconsin Conservation Commission to appear in be-

half of the public in proceedings pending before the Public Service Commission in their judicial capacity as was done in this case.

4) The Public Service Commission will be required to make findings "as to whether public rights for the recreational enjoyment of this stream in its present natural condition outweigh the benefits to the public which would result in the construction of the dam."

The Court defined Wisconsin's water policy trend by observing that it was the purpose

> in development of the law of navigable waters in this state to extend the rights of the general public to the recreational use of the waters of this state, and to protect the public in the enjoyment of such rights . . . The right of the citizens of the state to enjoy our navigable streams for recreational purposes, including the enjoyment of scenic beauty, is a legal right that is entitled to all the protection which is given to financial rights.[328]

The sequel to the Namekagon Case was even sweeter than this excellent decision. Namekagon Hydro Company had requested a federal license from the Federal Power Commission simultaneously with their litigation in Wisconsin. Before the Public Service Commission made a new decision in accordance with directions from the Court, their problem was solved by the Federal Circuit Court of Appeals (Seventh District) which supported the Federal Power Commission's refusal of a license. In a strongly worded endorsement of the Wisconsin Supreme Court's earlier decision, Chief Judge Duffy declared for this Court that the free-flowing "wild river" qualities of this twenty-two mile stretch of the Namekagon River in Washburn County were to be preserved for the future. Their decision pointed out that eighty-five other lakes in a ten mile radius offered recreation similar to that offered by another flowage, and "that there would be nothing unusual or unique about a body of water thus formed." The Court endorsed the Federal Power Commission decision

> that the unique recreational features of the river were of greater public benefit than the use of the river for water-power development . . . and which the Commission has determined that it was bound to protect in the public interest. No modification of the project short of its prohibition would serve the public interest.[329]

This federal decision has made a tremendous difference in preservation of public rights in Wisconsin's navigable waters, especially in the present decade. Of late years there has been an unprecedented trend toward the use of public waters in many ways unfavorable to their future life, such as by pollution, diversion, encroachment, obstruction, enlargement and many other forms of manipulation for private interest or profit.

VIII. Conclusion—The Pendulum Swings

Wisconsin's water policy has evolved gradually over the past century and there have been many battles over the decisions—political, legislative and judicial, and involving many administrative agencies and private interest groups. This latter category includes the large number of conservation and sportsmen's organizations which have so much to lose if public rights in navigable waters of the state are weakened in any manner. The latest decade, when agricultural interests clashed most appressively with the conservationists over the use of surface waters, already has been reviewed in detail elsewhere and therefore was not included here.[330] Also, the smoke has not completely cleared as yet from that encounter and it is difficult to see it in historical perspective.

As stated earlier, the pendulum swings from some weakening decision to another with strengthening qualities for preservation of the public trust. However, it is evident that any losses from the original heritage of this trust are very difficult to regain and much already is gone. In this paper the strengthening decisions have been stressed but reference has been made to the concerted effort being made by some to point out the decisions which have had a weakening effect. The presumption seems to be that if this can be done for one special interest, such as the consumptive use of water in agricultural irrigation, there is no reason why it cannot also be done for others. In this respect, Richard Harnsberger, in his thesis on "The Present and Future Status of Public and Private Rights in Wisconsin's Waters," claimed that the first modification of our "Riparian Doctrine" incorporating a feature of the "Western Prior Appropriation Doctrine," was the Milldam Act of 1840 when Wisconsin was a Territory.[331] Likewise, A. Allan Schmid writes: "There is no provision in the statutes permitting the communal benefits of irrigation to be weighed against any losses in other public rights, as was the case in legislation affecting dams."[332]

There always has been a close relationship between the state and federal Supreme Courts so far as their decisions are concerned and in this there is hope for the future. A typical example of this was in the federal case of Holyoke Water Power v. Lyman in which Mr. Justice Clifford delivered the opinion of the Court as follows (in part):

> Rivers, though not navigable even for boats or rafts, and even smaller streams of water, may be and often are regarded as public rights, subject to legislative control, as the means for creating power for operating mills and machinery, or as the source for furnishing a valuable supply of fish, suitable for food and sustenance. Such water-power is everywhere regarded as a public right, and fisheries of the kind, even in waters not navigable, are also so far public rights that the legislature of the State may ordain and establish regulations to prevent obstructions to the passage of the fish, and to promote the usual and uninterrupted enjoyment of the right by the riparian owners.[333]

This case subsequently was quoted by the Wisconsin Court in the case of State v. Nergaard, in which it was stated:

> We believe it has never been seriously denied (and it is now certainly too late to deny) that the state has the right, in the exercise of its police power, to make all reasonable regulations for the preservation of fish and game within its limits.[334]

Since one of the major controversies so far as use of the public waters in lakes and streams is concerned always will be in respect to fish and fishing, the definition of a Wisconsin navigable stream as "one in which a trout can swim on its side" is of interest. Possibly the closest reference to this statement ever being made by an authority on the state's water law was found in the text of a radio talk presented by Adolph Kanneberg in 1940, and that may be where the story started. Commenting on the 1911 amendments (Chapter 652) to the Wisconsin water laws, he said that it

> was intended to enlarge the definition of a navigable stream by including streams of lesser capacity than that required to float saw logs to mill or market. Perhaps the legislature intended to include streams of a capacity to float pulpwood, as is practiced, we are informed, in New York State and Canada. If this interpretation is correct, then most any stream capable of supporting game fish is navigable and public.[335]

That the future still is questionable is quite obvious. Even though public rights in water may be better protected—including both non-navigable streams and ground waters—the constantly increasing pressure of man's developments on the land and use of these waters will tend to diminish the value of this public trust. Gradual impairment over the years will make remaining unspoiled water resources even more precious, inspiring interested citizens to fight even harder for their legacy.

Professor J. H. Beuscher has referred to the public rights in Wisconsin's navigable waters as a "burden" on the abutting riparian land but has added that "the public rights will, when the chips are down, prevail." He then goes on to indicate, however, that there is latitude for adjustment in specific situations "which will permit the private owner to accomplish his desires without *substantially* impairing the public's rights."[336] (Underlining is mine). It is this "annoying and wearing away" of the public waters that continues to reduce the quality, quantity and value of this sacred trust.

In a recent paper, Harold H. Ellis of the University of Wisconsin Law School reported on "Water Rights and Legislation in the Eastern States," with some interesting observations in his summary. He recognizes the importance of the question "how to define and safeguard the public interest" and the arguments which have arisen over the use of "some type of maximum-net-benefits principle . . . as a primary general goal of a water-rights system." However, he then points out the fact that "more detailed areas of concern may include such questions as the feasibility or method of making and utilizing *monetary evaluations* of alternative uses of water and how to ascertain and what to do about so-called spill-over or external costs or benefits."[337] (Underlining is mine).

Possibly Luna Leopold, Chief Hydraulic Engineer of the United States Geological Survey, gave the best analysis of this suggestion in his talk before the Izaak Walton League in Colorado several years ago when he said:

> . . . We as a people must recognize that certain esthetic and ethical values are important—values sufficiently important, in fact, to be preserved whether or not they are compatible with the greatest monetary return from our resources. In the field of water we must face the fact that to preserve any stream from pollution, to preserve any piece of wilderness, we must make this decision before the pressures for exploitation become too great. Not all places can be preserved the way we

> would like to have them; not all streams can be free of pollution. In this civilized society rivers must continue to serve the important purposes of dilution and transportation of wastes. But if we judge values only in economic terms, eventually no piece of country will remain untouched and no stream unpolluted.[338]

So for Wisconsin, there shall be a continuing controversy—and many battles—between "Economic Development and Natural Resource Conservation."[339] The hopes for the future lie partly in the several state agencies charged with various responsibilities for protection of public rights in the state's water resources, primarily the Public Service Commission, Conservation Commission, State Committee on Water Pollution and Board of Health.[340] Many others have vitally important duties such as comprehensive planning, zoning and platting controls (Department of Resource Development), scenic beauty preservation along waterways (Highway Commission) and natural areas preservation (State Board of Preservation of Scientific Areas).

The future also will bring additional decisions by the Attorney General, the Legislature, and the state and federal Supreme Courts. For Wisconsin, the 1959 court decisions in Nekoosa–Edwards Paper Co. v. Public Service Commission again was a "high water mark" for public rights although the battle largely involved private riparian rights as related to agricultural irrigation under the 1935 permit law. The Court rightly pointed out that Section 31.14 included "rights of the public, sportsmen . . and those people interested in recreation, conservation and the enjoyment of natural scenic beauty" as well as other private and public utility water users and they "all are a part of the water problem."[341]

Whether the increased legislative power of urban communities through the "one person-one vote" decision will help or hinder the cause of public rights protection in the state's water resources remains to be seen. It can be said that rural agricultural irrigation from sources affecting navigable surface waters and other rural-based activities such as taconite mining and flowage developments may expect to receive critical evaluation and even opposition from urban citizens in some cases. However, the justification of any opposition depends upon understanding of these problems by the public and accentuates the great need for more research on water resource problems as well as better communication of such facts to the people.

Citizens of Wisconsin must be given credit for their alert and militant action in many cases when they joined together for preservation of some principle or choice water area which they considered worthy of preservation. Credit also should go to a conscientious Supreme Court, capable statesmen, outstanding educators and public administrators. Still, it must be remembered that it was Wisconsin's unusually fine natural heritage which made these waters worth fighting about, even by private riparians—that made a large part of the difference.

But history reveals the erosion of quality in public waters due to continual small changes which individually have not challenged the public's conscience or which did not seem important enough for a fight. Even worse, some major battles were lost in spite of the efforts of state agencies as the

Conservation Commission, as chronicled by Aldo Leopold as he reflected and "healed the wounds" he had received in the conflict:

> We lost the Flambeau as a logical consequence of the fallacy that conservation can be achieved easily. It cannot. Parts of every well-rounded conservation program entail sacrifice, usually local, but none-the-less real. The farmers' raid on our last wild river is just like any other raid on any other public wealth; the only defense is a widespread public awareness of the values at stake. There was none.

He then went on to his oft-quoted and classic observation:

> The practice of conservation must spring from a conviction of what is ethically and esthetically right, as well as what is economically expedient. A thing is right only when it tends to preserve the integrity, stability, and beauty of the community, and the community includes the soil, waters, fauna, and flora, as well as people.[342]

In 1931 Justice Oliver Wendell Holmes stated that "a river is more than an amenity, it is a treasure . . . It offers a necessity of life that must be rationed among those who have power over it."[343] His comments apply as well to lakes, ponds and springs—and to the ground waters which continually feed the flowing surface waters. It must be clearly recognized that "those who have power over it" refers to *the public* as well as to private riparian owners and that *public rights* are paramount to private rights. Although those who make the decisions for rationing these waters need the wisdom of Solomon, their decisions will be wiser when based upon *facts* resulting from adequate research. Each water resource problem will contain different factors from the others and as conditions change frequently, searching for these truths requires a never-ending process. Actually, it will become more urgent and important in proportion to increasing population pressure on the water resource.

This year Harold E. Alexander of Arkansas reported to the North American Wildlife and Natural Resources Conference that

> Wisconsin has the most positive program to preserve some of its fine streams. They have prepared positive conservation policies, explored legal avenues, conducted surveys and encouraged public groups in efforts to establish a state system of wild rivers.[344]

May the state of Wisconsin ever continue its efforts to protect and preserve public rights in its water resources!

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Abbreviations

Explanations for some abbreviations used appear below:

FC	—Commissioners of Fisheries (or Fish Commission)
IWLA	—Izaak Walton League of America
LRB	—Legislative Reference Bureau
OAG	—Opinions of Wisconsin Attorney General

PSC	—Public Service Commission
RRC	—Railroad Commission
RS	—Revised Statutes
SBH	—State Board of Health
SCWP	—State Committee on Water Pollution
SHSW	—State Historical Society of Wisconsin
UW	—University of Wisconsin
WASAL	—Wisconsin Academy of Sciences, Arts and Letters
WCD	—Wisconsin Conservation Department
WGNHS	—Wisconsin Geological and Natural History Survey

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