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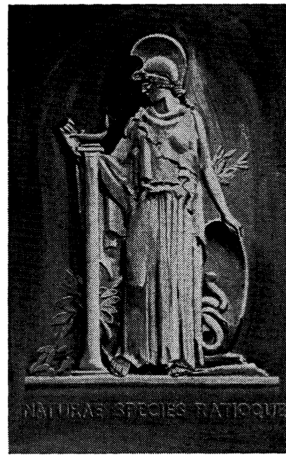

LIII — 1964

Editor

GOODWIN F. BERQUIST, JR.

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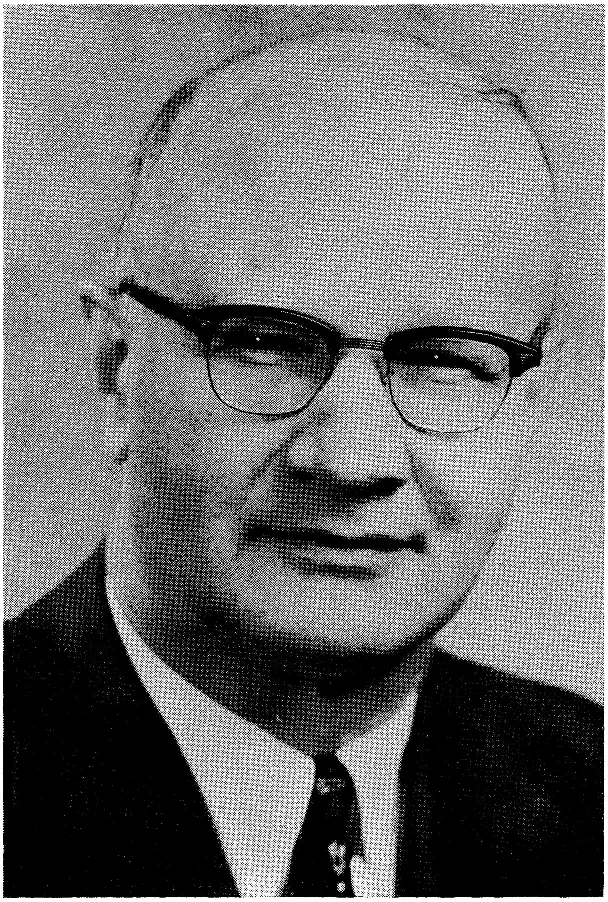
DR. AARON J. IHDE



43rd President of the

WISCONSIN ACADEMY OF SCIENCES, ARTS AND LETTERS

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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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

[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

[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-

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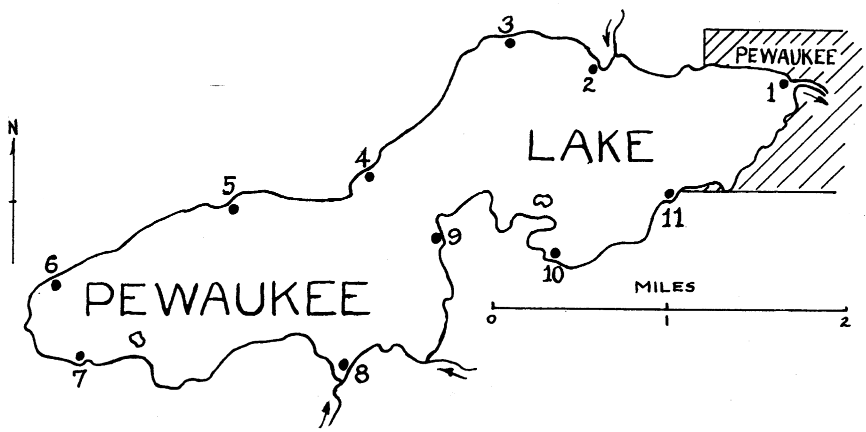
Figure 1
Sampling Stations



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

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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

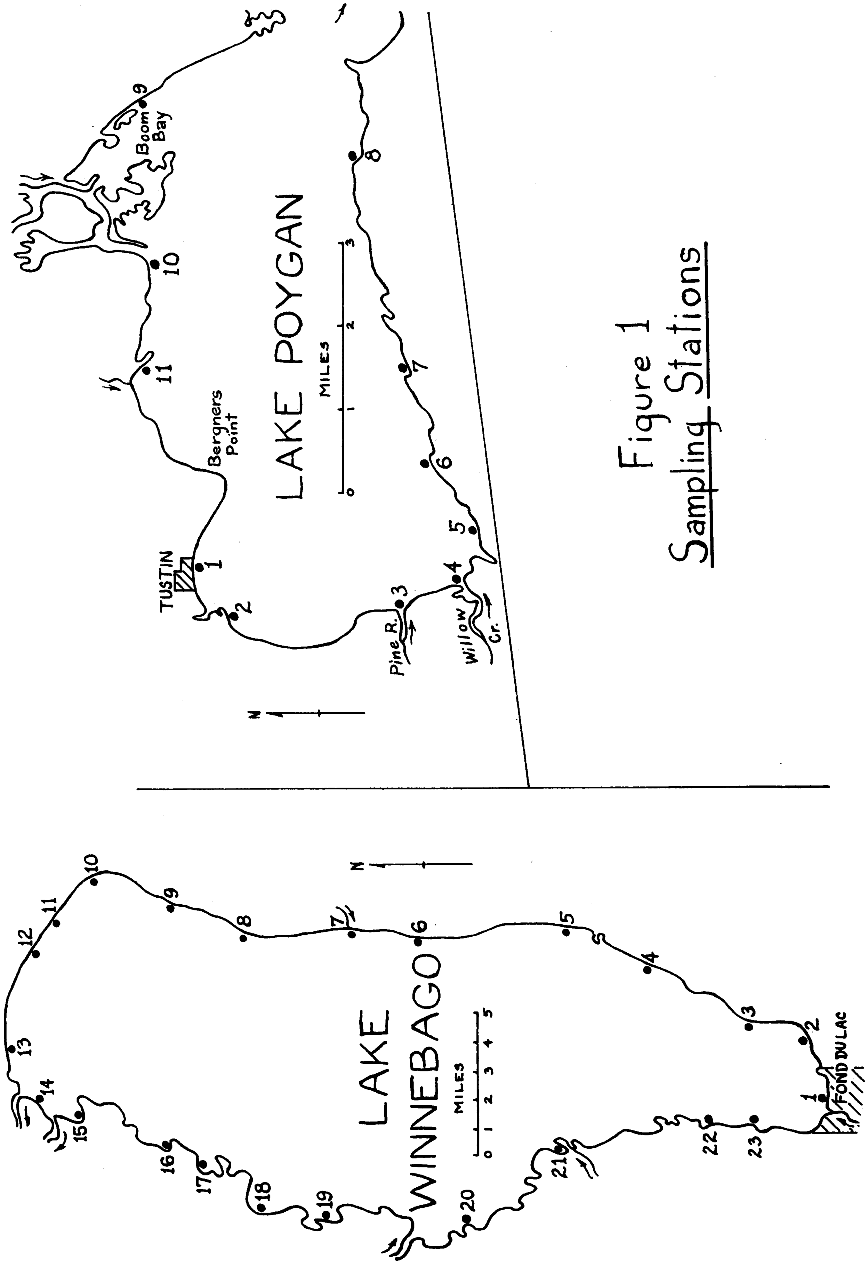

Figure 1
Sampling Stations

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
Lellow 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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[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

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[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

[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

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[1] This study was conducted in cooperation with the Wisconsin Conservation Department and was financed in part with Federal Aid to Wildlife Restoration funds under Pittman–Robertson Project Number W-79-R.

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

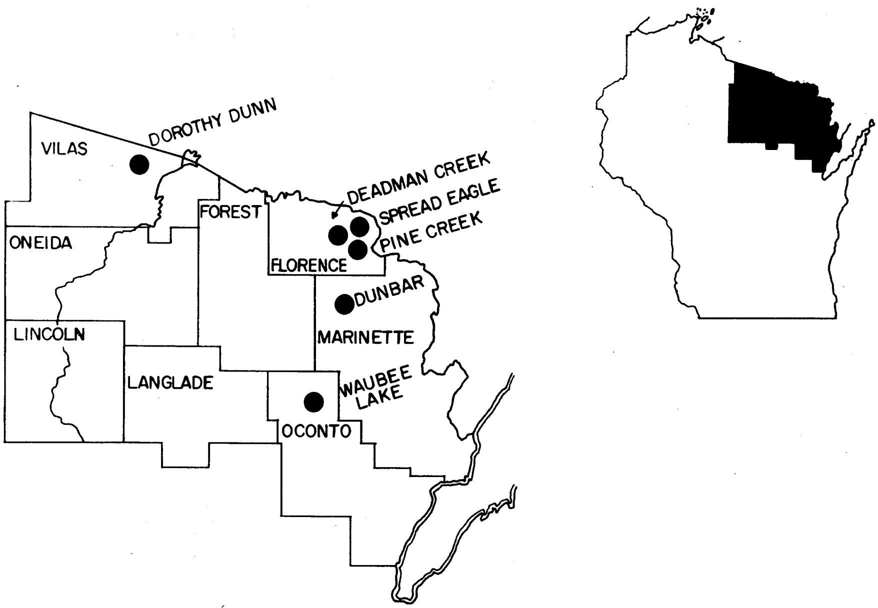

FIGURE 1. The six Conservation Wildlife Areas selected for study of bracken-grasslands in northeastern Wisconsin.

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 sharp-tailed 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 sharp-tails 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.

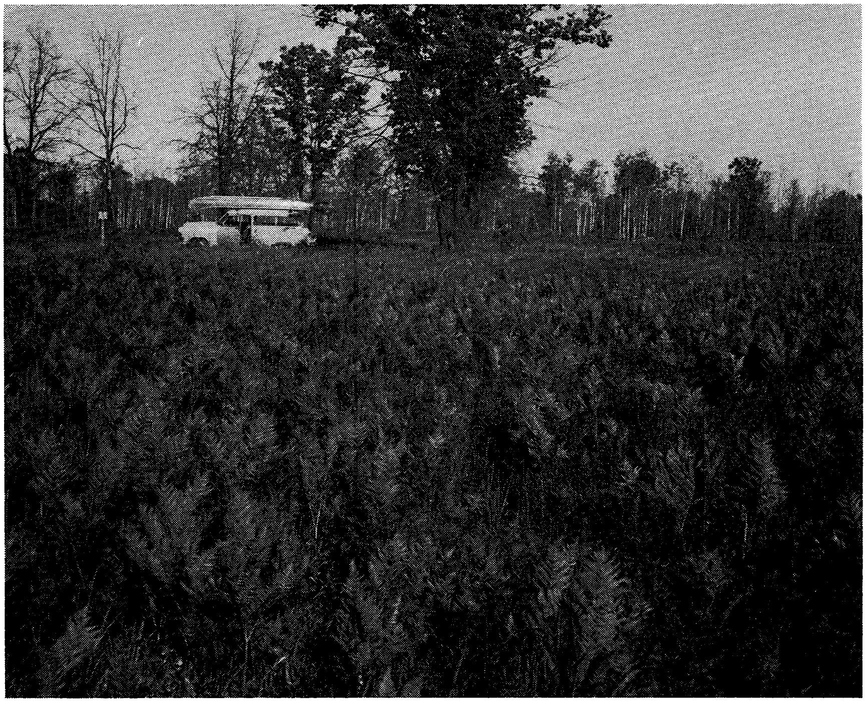

FIGURE 2. A burned bracken-grassland dominated by bracken fern.

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*

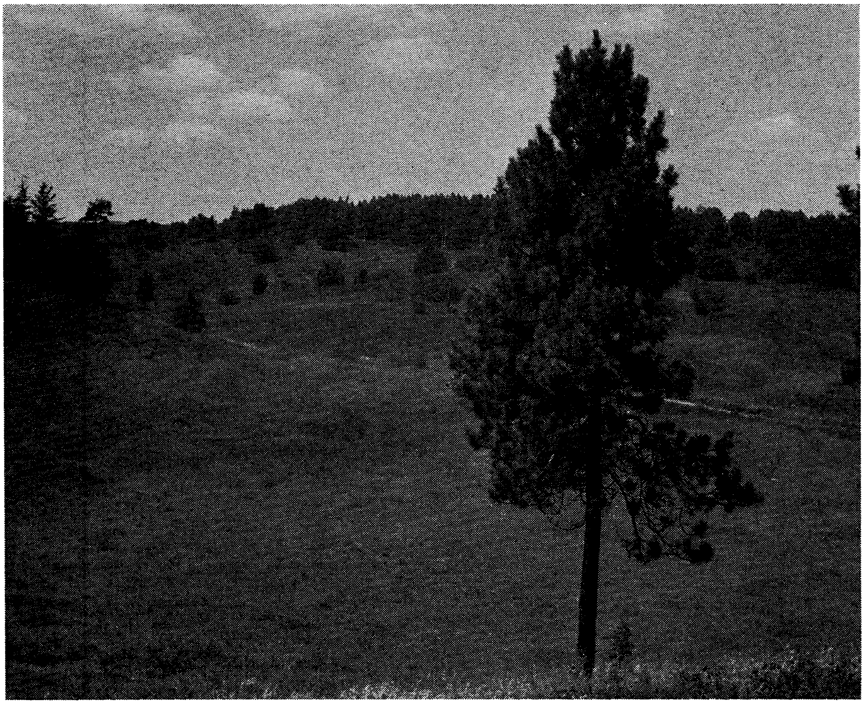

FIGURE 3. Spread Eagle Wildlife Area, composed of a series of open, upland basins. Bracken fern covers the ridges along with red pine, jack pine, and white birch.

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 low-lying 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

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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-

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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	Per-cent	Diving Ducks	Number	Per-cent
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 statewide 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,

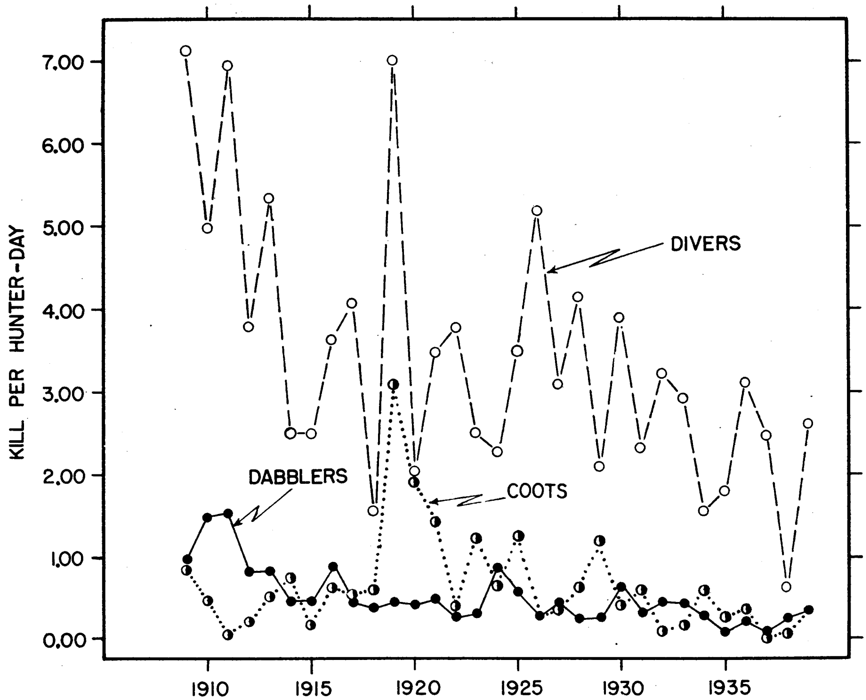

FIGURE 1. Average kill per hunter-day of diving ducks, dabbling ducks, and coots (excluding unidentified species) on Lake Winnebago, 1909–39.

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

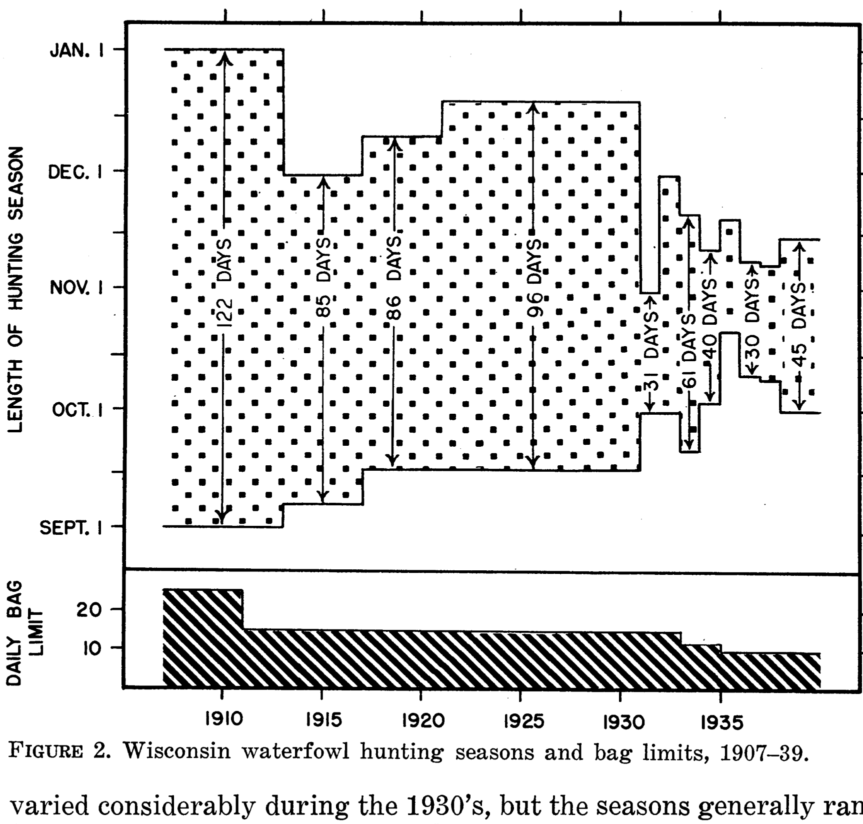

FIGURE 2. Wisconsin waterfowl hunting seasons and bag limits, 1907–39.

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

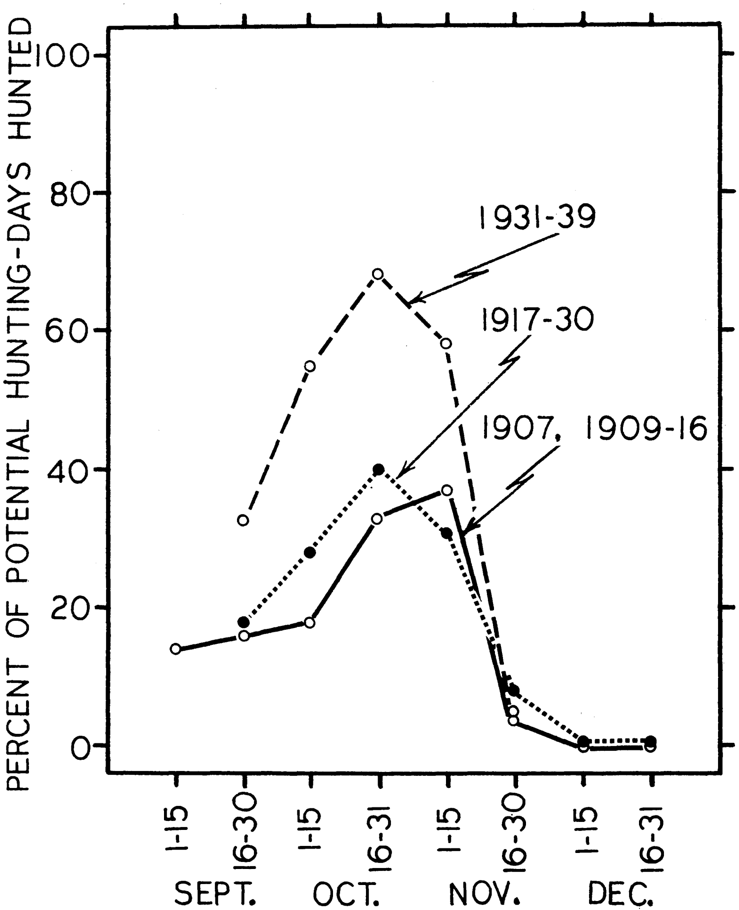

FIGURE 3. Distribution of hunter-activity by the percentage of potential hunting days that were actually hunted for three periods having different season's length and/or dates of opening and closing.

(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

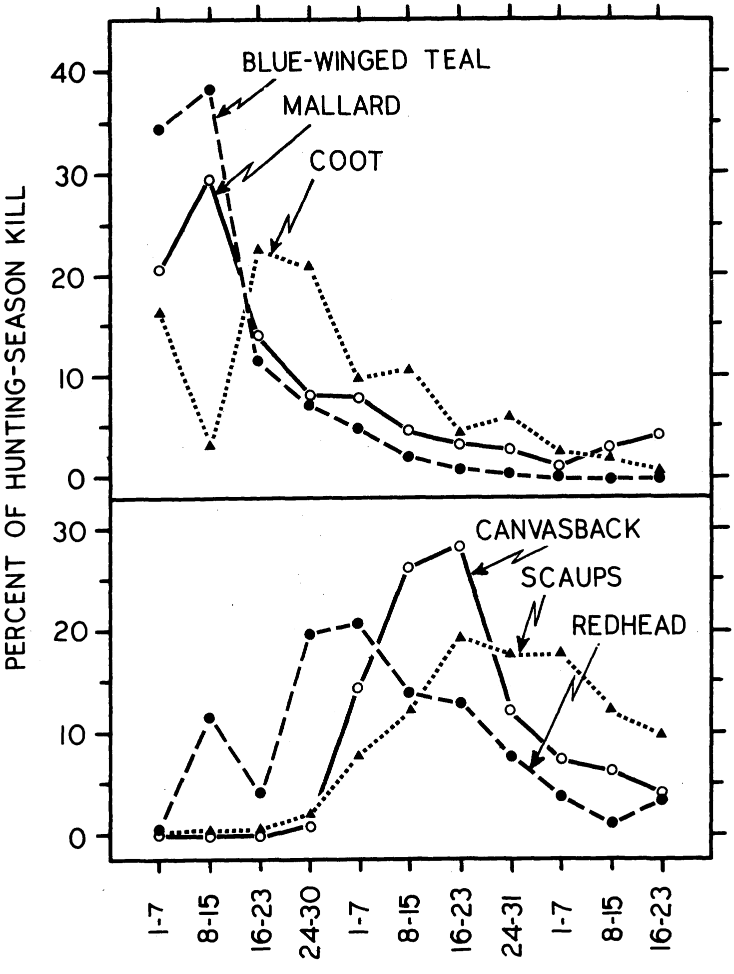

FIGURE 4. Seasonal distribution of six species of waterfowl bagged on Lake Winnebago, 1907 and 1909–39.

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 WATER-FOWL 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

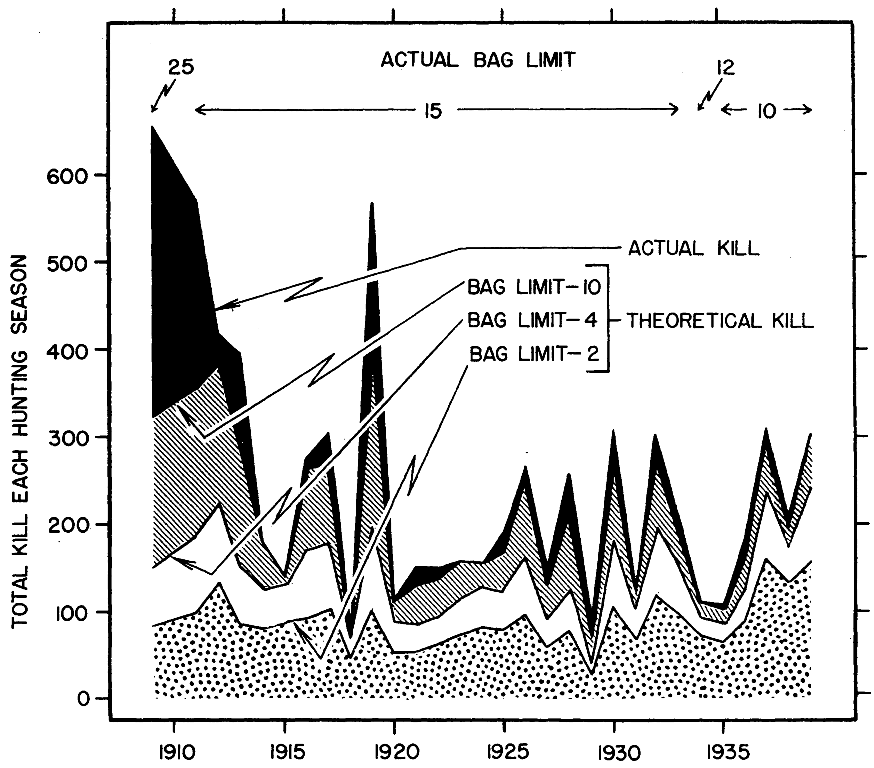

FIGURE 5. Total duck kill for each hunting season and theoretical harvests when hypothetical bag limits of 10, 4, and 2 birds per day were assumed, 1909–39.

(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

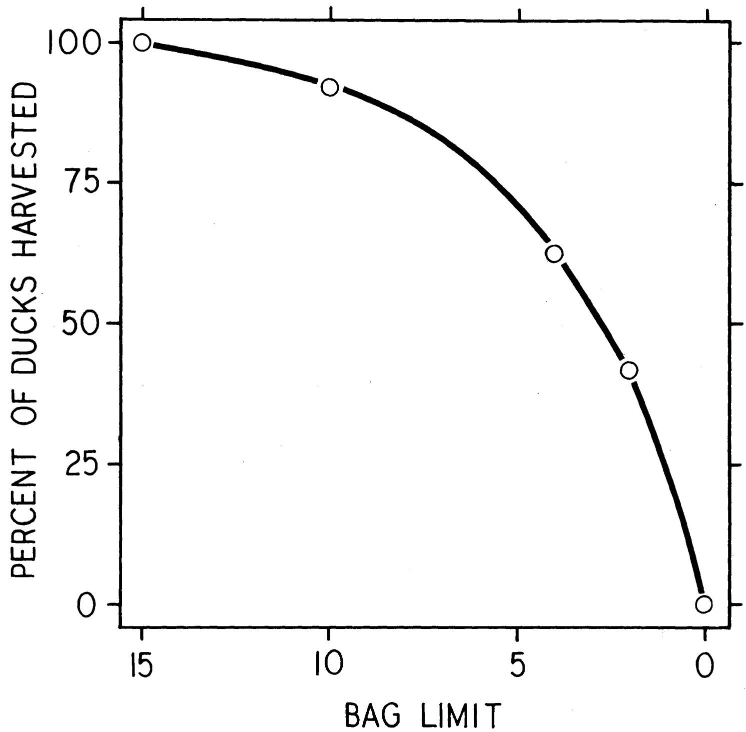

FIGURE 6. Effects of theoretical bag limits on the duck harvest when actual bag limits were 15 birds (1911–32).

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-

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[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.

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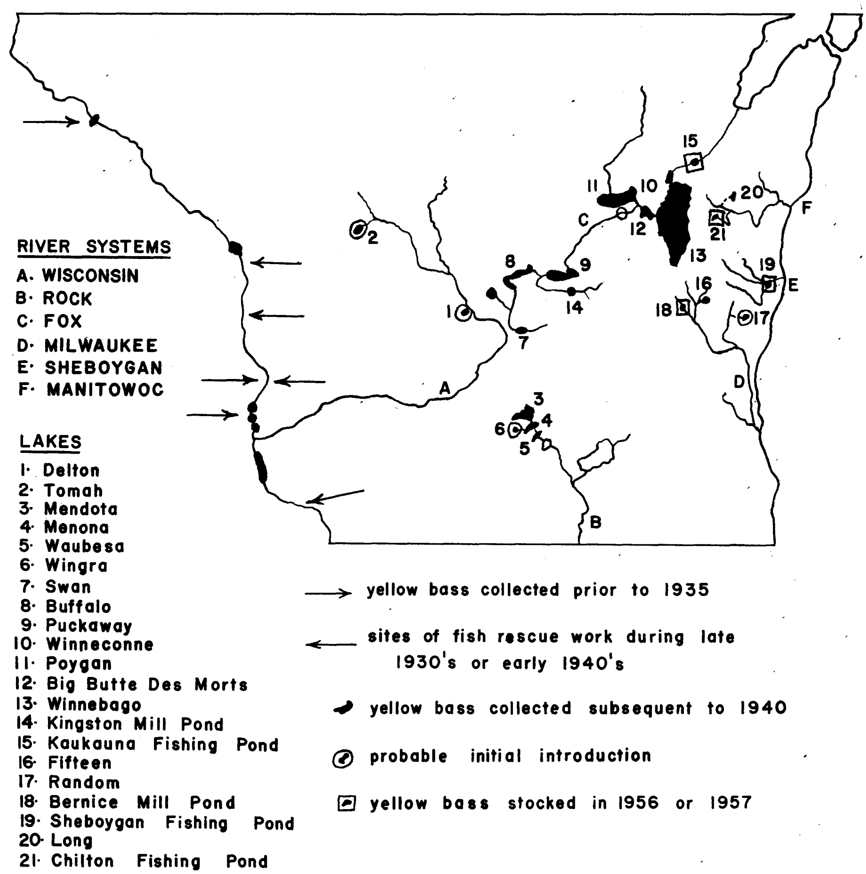
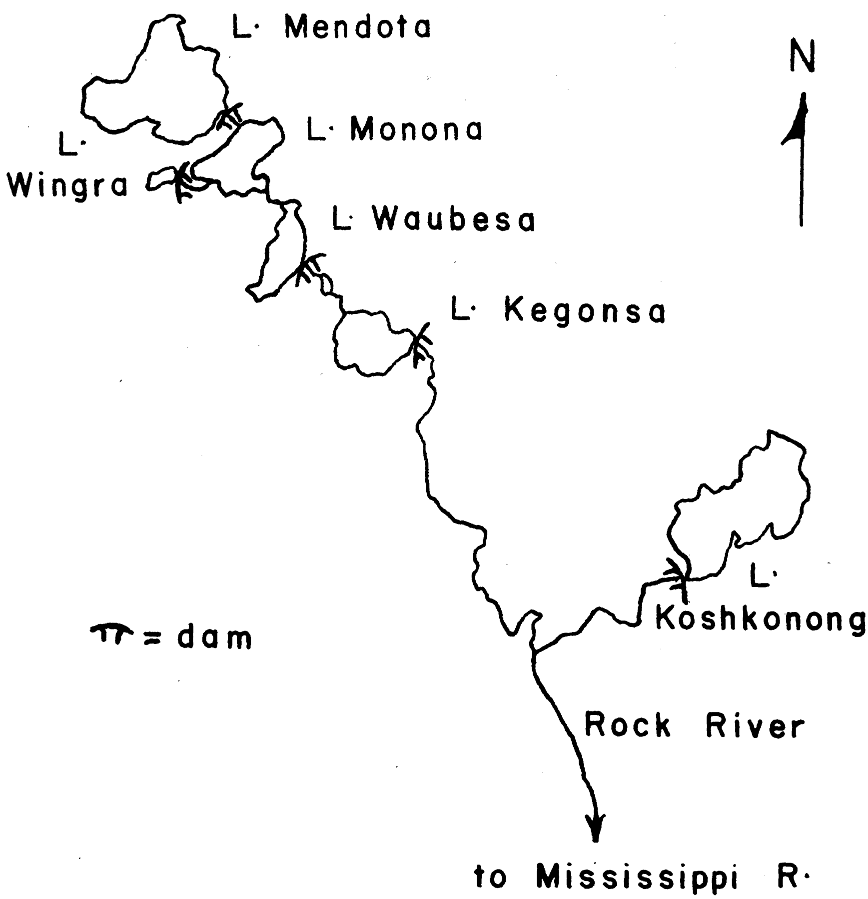
partment, similar departments of other states bordering the Mississippi River, and the Federal Government undertook extensive "fish rescue" work in the late 1930's and early 1940's. This involved the salvage of fish stranded in shallow sloughs when the Mississippi River receded, and the subsequent release 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.

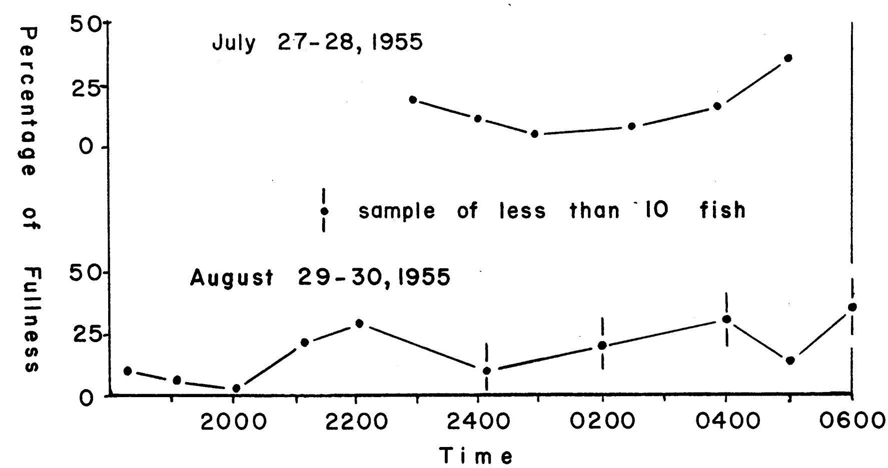
Table 3. Number of Food Categories Represented in the Stomachs of Yellow Bass Collected from Lake Wingra by Various Methods

	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.

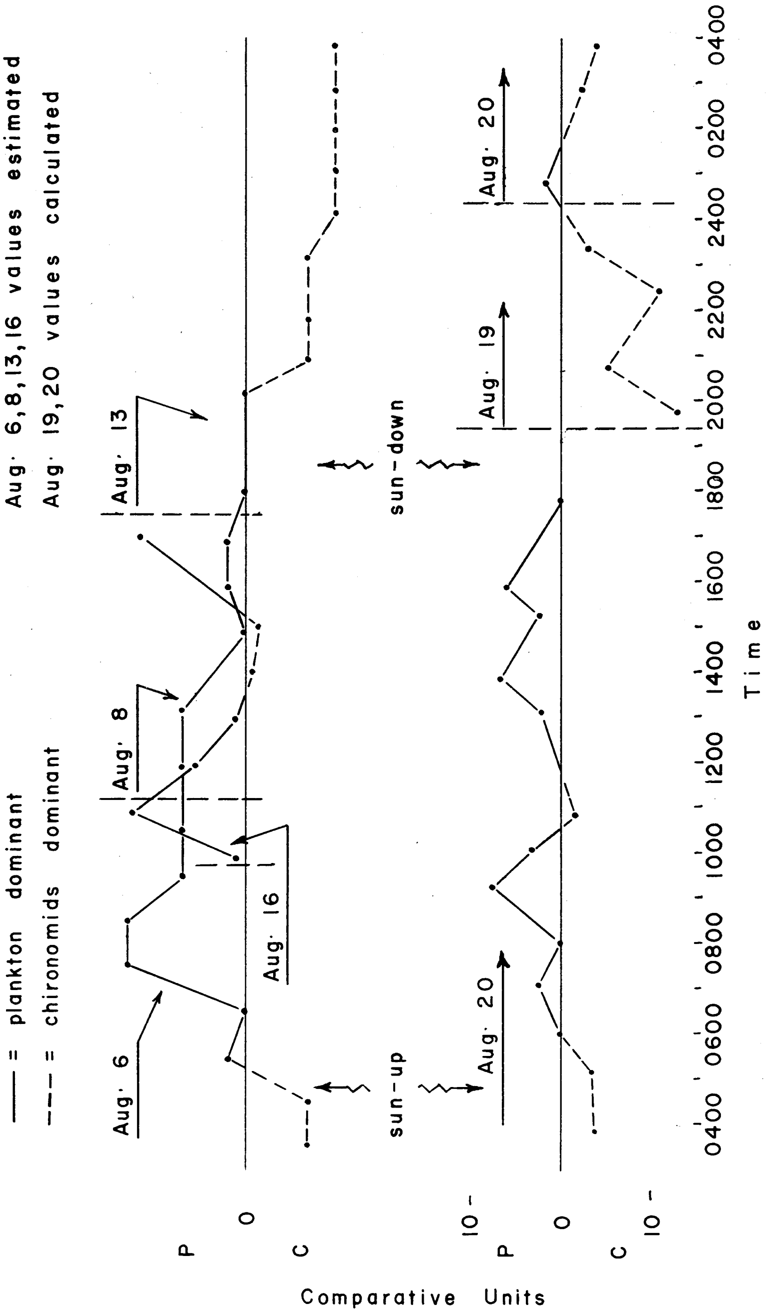
As soon as possible after collection, usually within a few minutes, the entire stomach and intestine were removed from the fish and preserved in 70% alcohol. Stomachs were opened in the laboratory and all the food was removed. The actual volume of material present was estimated as percent of fullness 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
0400
0600
0800
1000
1200
1400
1600
1800
2000
2200
2400
0200
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Time
P
0
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10
P
0
C
10
Comparative Units

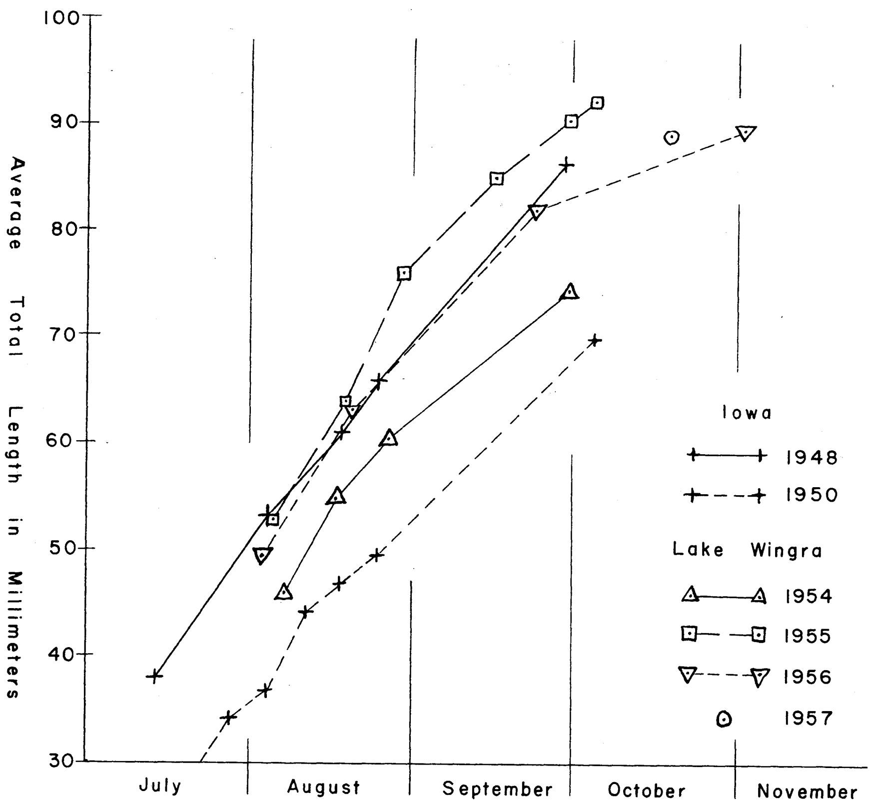
gories represented did not change. Either chironomid larvae or plankton crustaceans were the dominant organisms in most stomachs. A plankton-chironomid (P/C) ratio was calculated for each collection of fish. This ratio was determined by assigning a value to either P or C, whichever was the dominant organism 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.

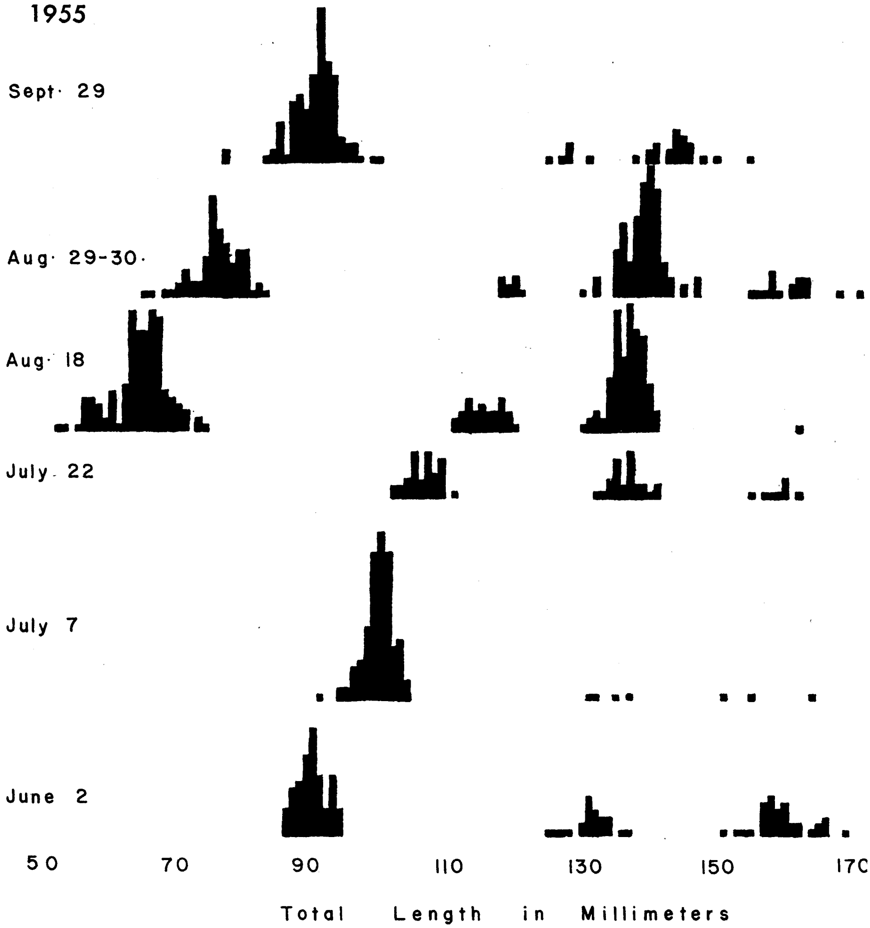
Examination of scale samples collected during 1954 revealed that only a small fraction of the yellow bass had laid down an annulus that year. Collections had been made at such short intervals in 1954 and 1955 that the growth of yellow bass throughout summer could be plotted, and age-groups could be identified 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.



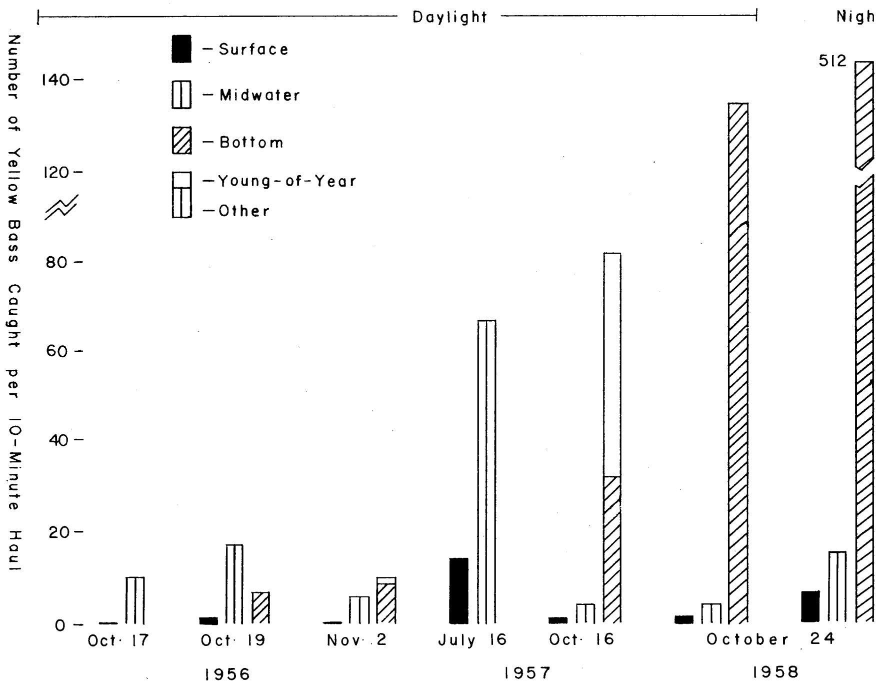
Part of the yellow bass population moved into shallow water at dusk but did not travel laterally to any extent. Seining and removal of fish from an area at 1-hour intervals during the night produced moderate numbers of fish the first few hauls, but very few thereafter. Single collections at various times 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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[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

[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

[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

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[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

[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.

[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

[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.

[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
	Agricultural Extension				
India 4	Mathematics/Science Teaching	June 14–Aug. 30, 1963	11	39	6
	Home Economics Education				
	Nursing Education				
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
	Auto Mechanics				
Peru 12	School Lunch Programs	Jan. 3–Mar. 19, 1964	11	53	13
	Community Development				
Brazil RCA	Community Development	Mar. 20–June 11, 1964	12	53	16
	Public Health				
Brazil 12	Community Development	June 17–Sept. 9, 1964	12	79	24
	Public Health				
India 8	Mathematics/Science Teaching	June 19–Sept. 9, 1964	12	70	12
	Teaching English				
Kenya	Rural Community Development	Sept. 25–Dec. 17, 1964	12	39	2
	Ag. Extension and Cooperatives				
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.

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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

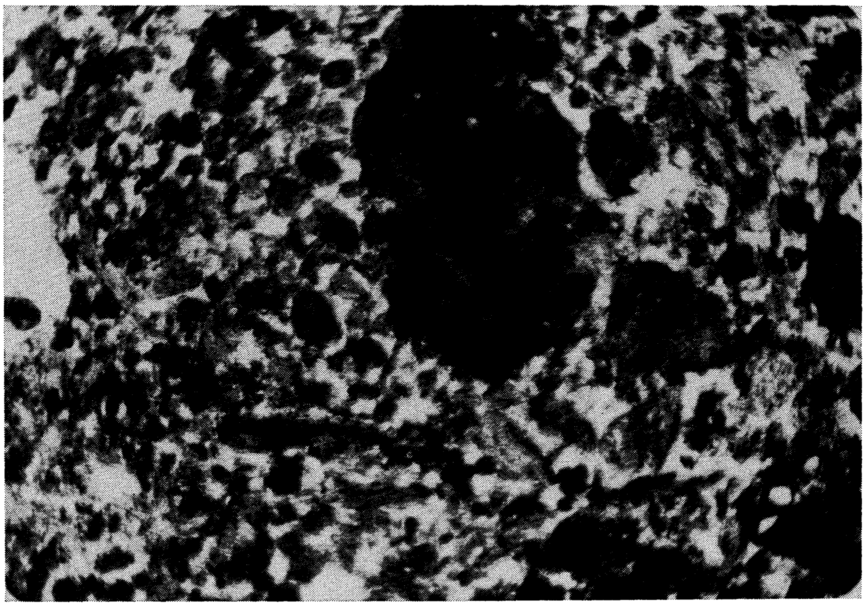

FIGURE 1. Small and larger moder, and a single mull aggregate in surface horizon of University Marsh soil (X100).

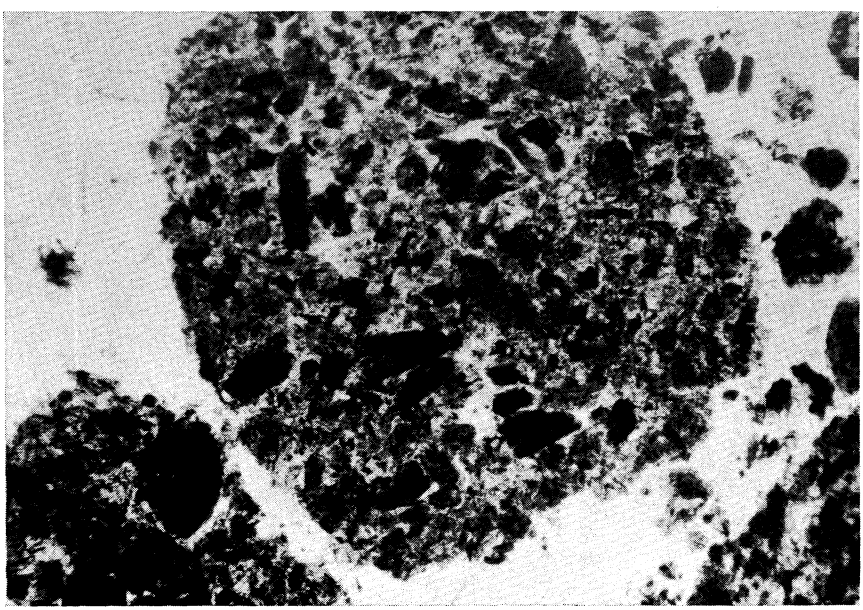

FIGURE 2. Mull-like moder aggregates in subsurface (buried) horizon of Eldorado Marsh soil (X100).

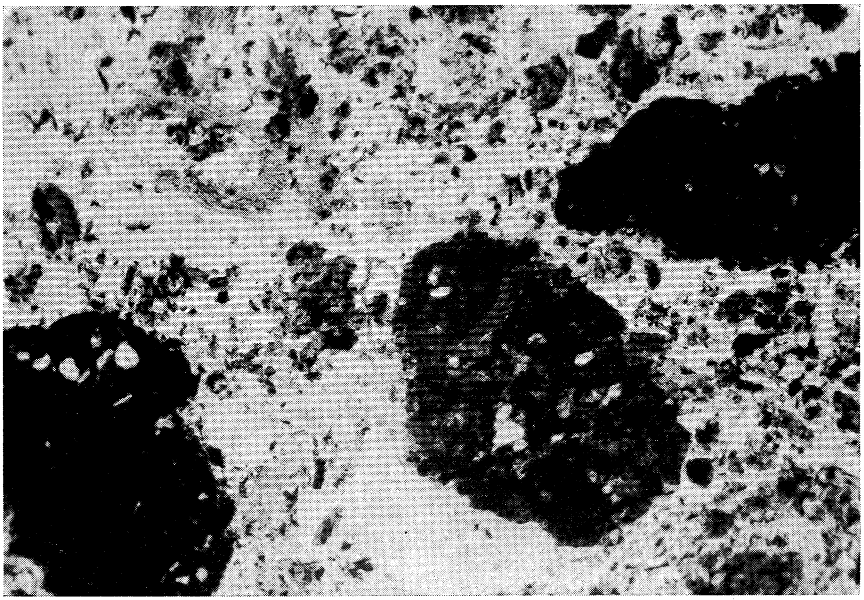

FIGURE 3. Mull and a few moder aggregates in subsurface (buried) horizon of Cherokee Marsh soil (X100).

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.

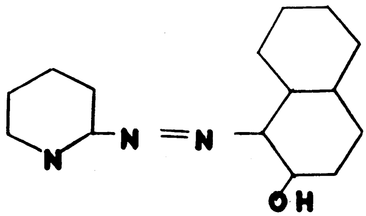
Holzbecher[5] reported a large number of aromatic compounds which formed fluorescent complexes exclusively with the aluminum ion. He observed that each of these reagents had a phenolic hydroxyl group either ortho or para to its aluminum complexing group. As seen in figure 1, PAN possesses a phenolic 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

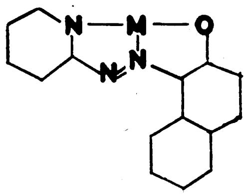
TABLE 1. COLORS OF METAL-PAN COMPLEXES UNDER ULTRA-VIOLET LIGHT

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

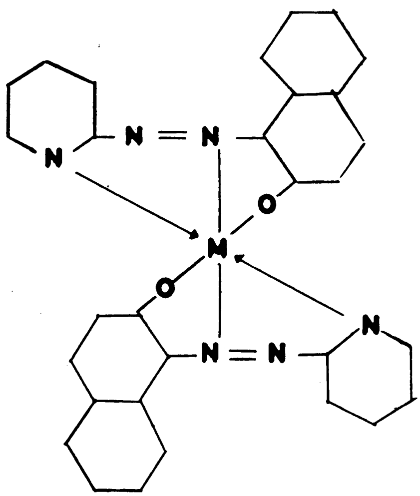
B = Blue BR = Brown P = Pink PU = Purple O = Orange L = Lavender R = Red G = Green Y = Yellow



PAN

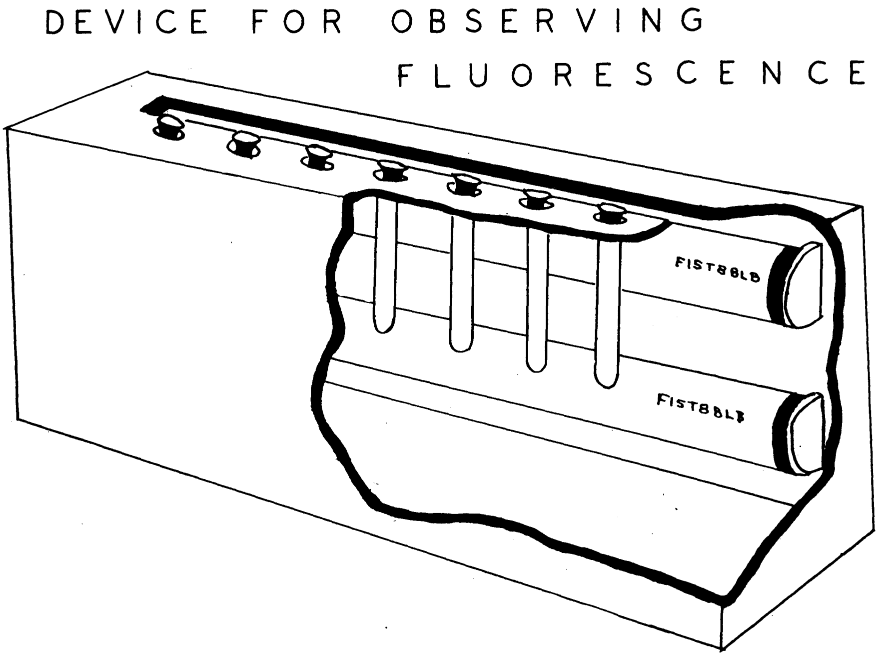


M II-PAN



M III-PAN

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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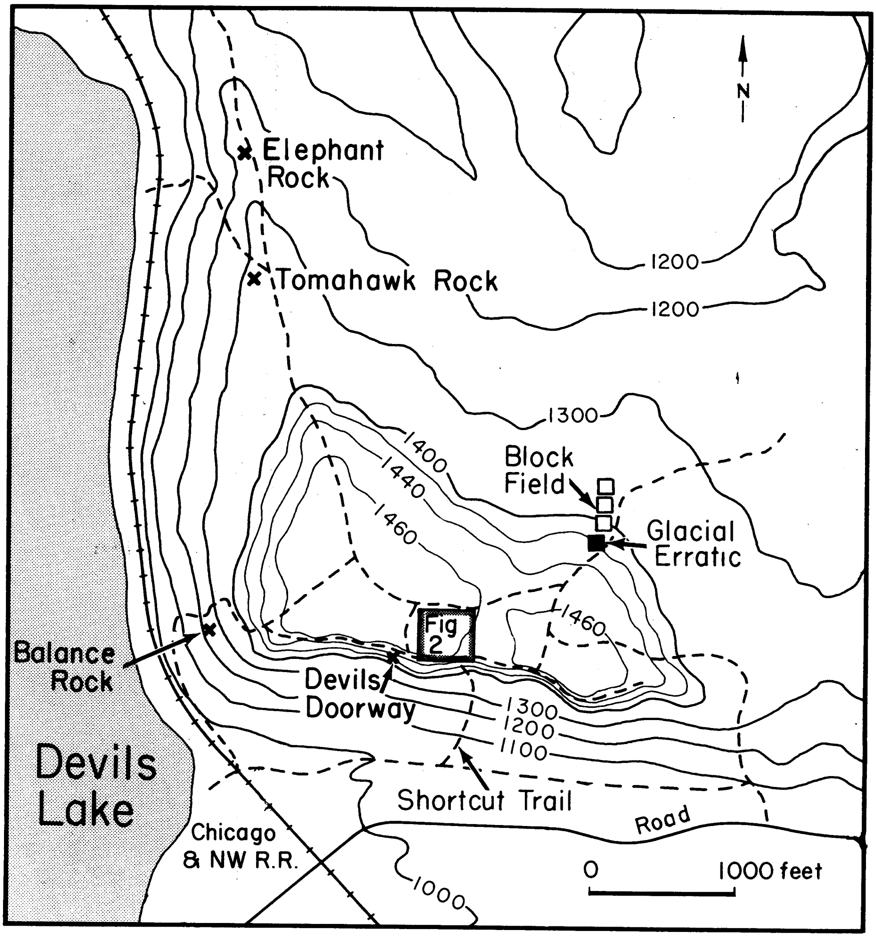

FIGURE 1. Generalized topographic map of East Bluff, Devils Lake State Park. Modified from U. S. Geological Survey Baraboo Quadrangle. Trails in part diagrammatic.

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

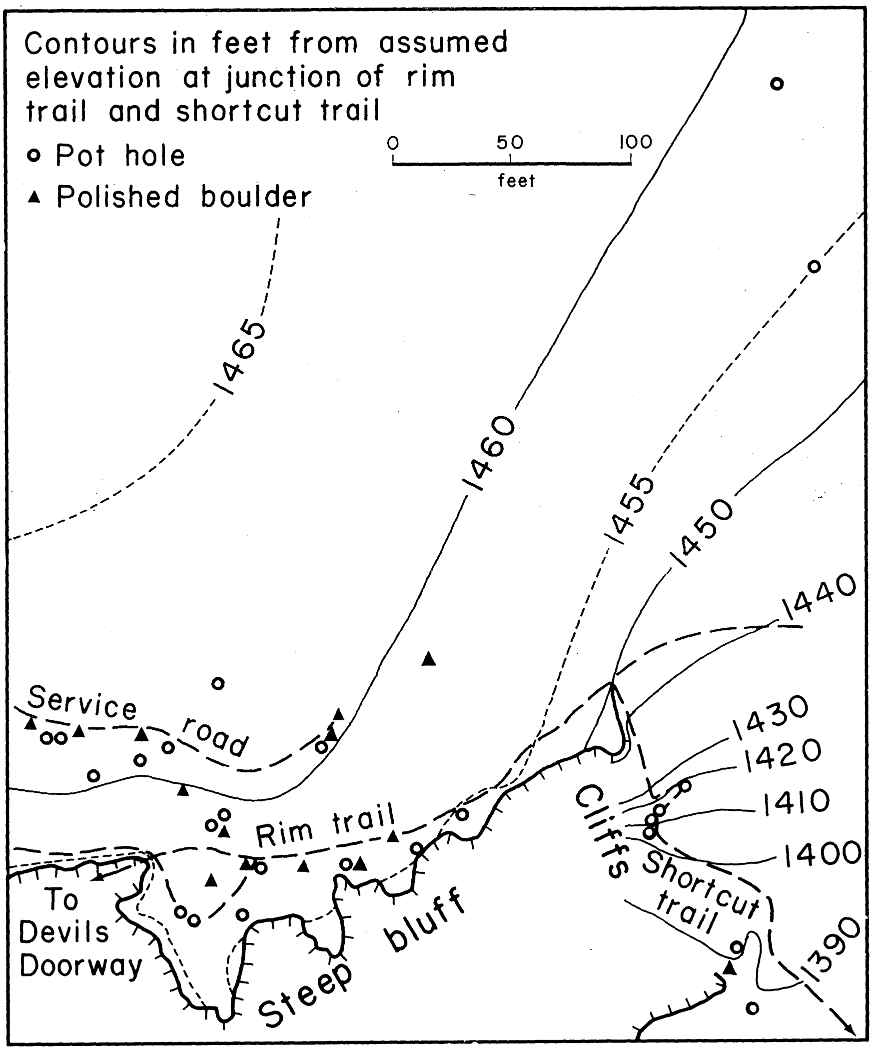

FIGURE 2. Sketch of pothole area, East Bluff, Devils Lake State Park.

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,

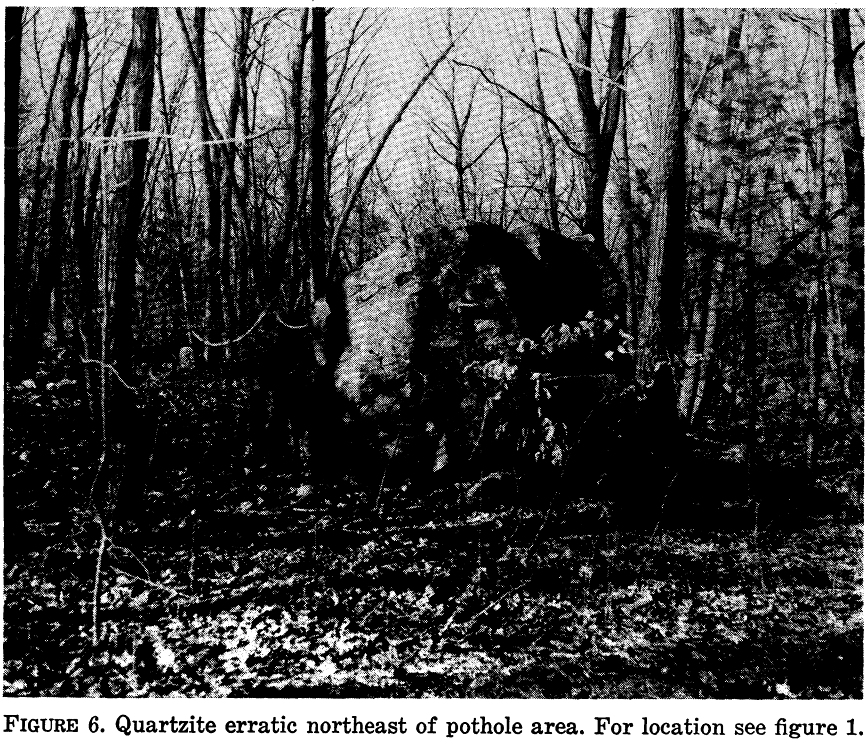

FIGURE 6. Quartzite erratic northeast of pothole area. For location see figure 1.

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

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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

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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 artemisicola* 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 ordinarly 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, pallidobrunneis, marginibus angustis, fuscis; pycnidiis in seriebus, fuscobrunneis, 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 *

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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

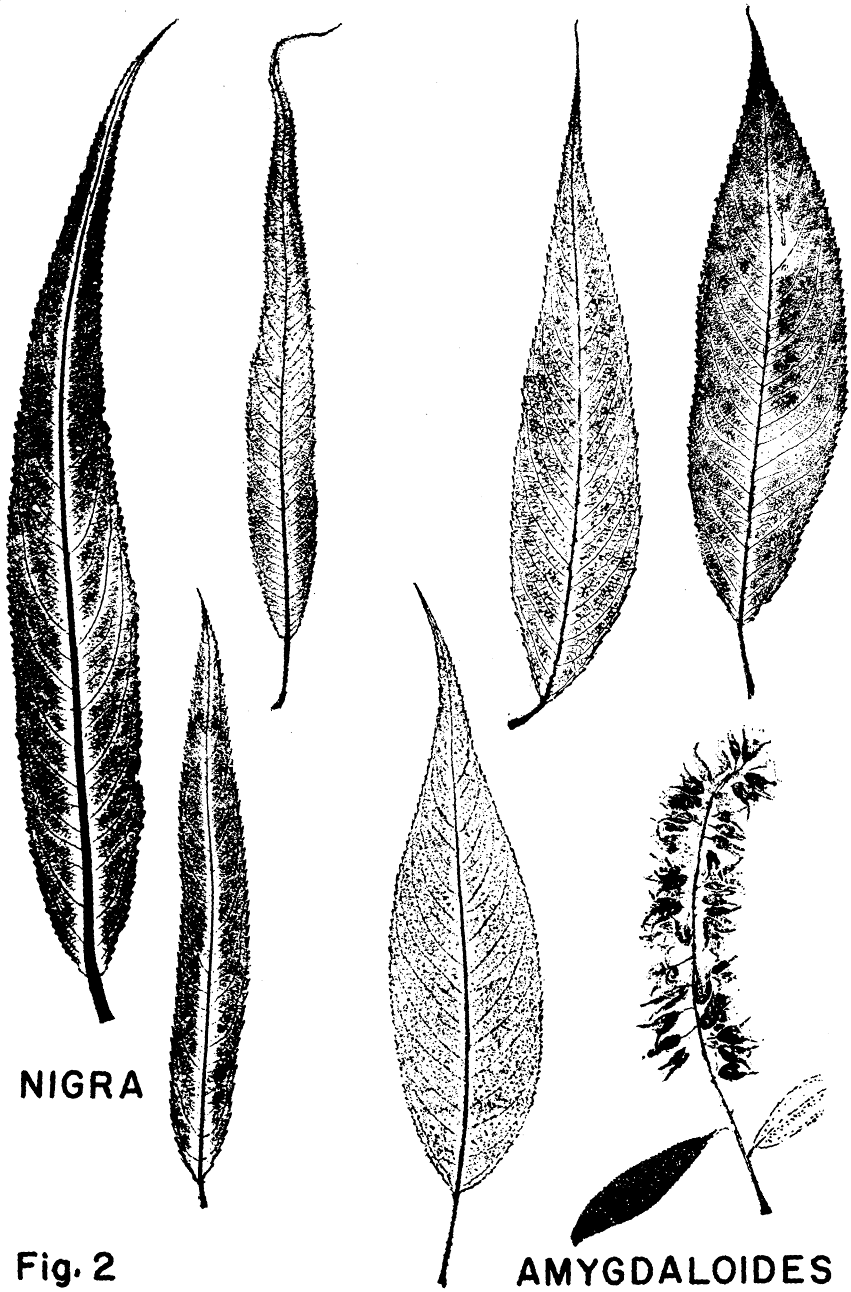


FIGURE 2. Leaves of *S. nigra* and *S. amygdaloides*. Pistillate anent of *S. amygdaloides* in fruit.

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.

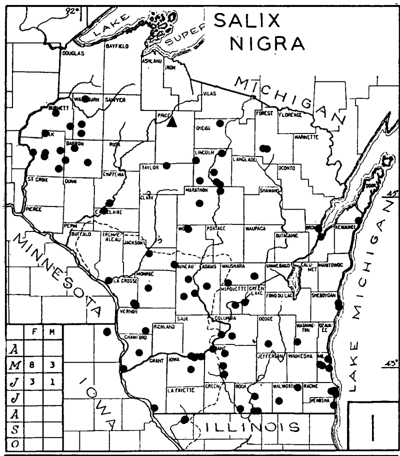
Shrubs or small trees 4–6 m tall; branchlets reddish brown or yellowish, glabrous and highly glossy, immature branchlets sometimes pubescent (remaining so in var. *intonsa*). Leaf blade lanceolate, broadly lanceolate to sometimes elliptic-ovate, 4–14 cm long (excluding apex), 1.4–3.3(–4.5) cm wide, length/width (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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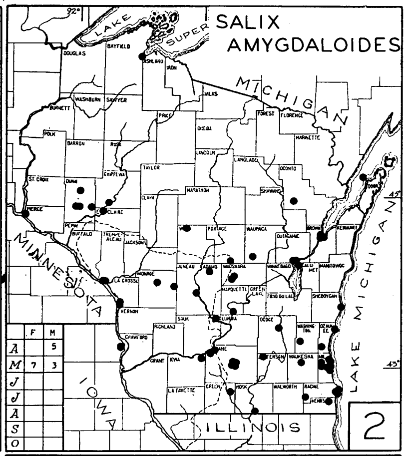
ILLINOIS
LAKE MICHIGAN
1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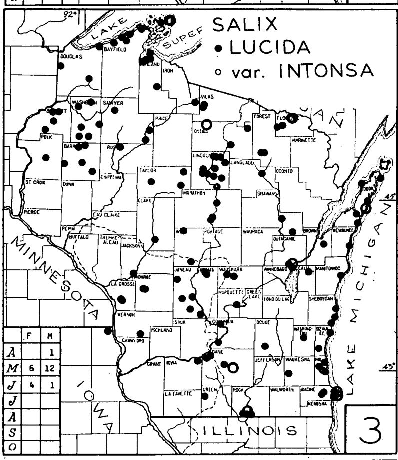
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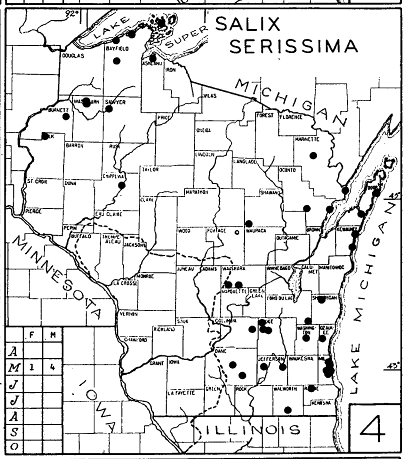
3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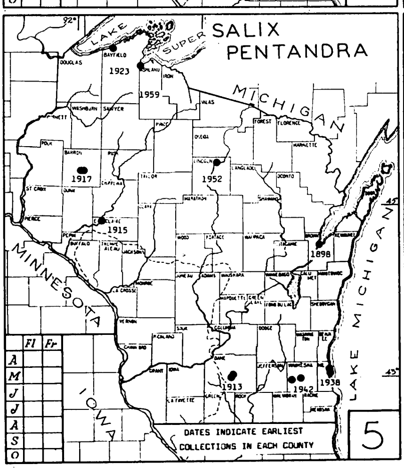
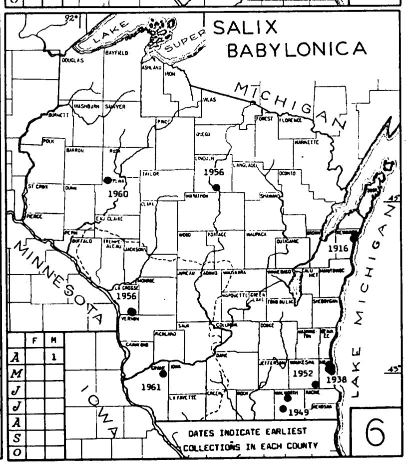
ILLINOIS
LAKE MICHIGAN
4


SALIX
PENTANDRA
MICHIGAN
MINNESOTA
IOWA
LAKE MICHIGAN
1923
1959
1917
1952
1915
1898
1913
1942
1938
DATES INDICATE EARLIEST
COLLECTIONS IN EACH COUNTY
5


SALIX
BABYLONICA
MICHIGAN
MINNESOTA
IOWA
LAKE MICHIGAN
1956
1960
1916
1956
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-

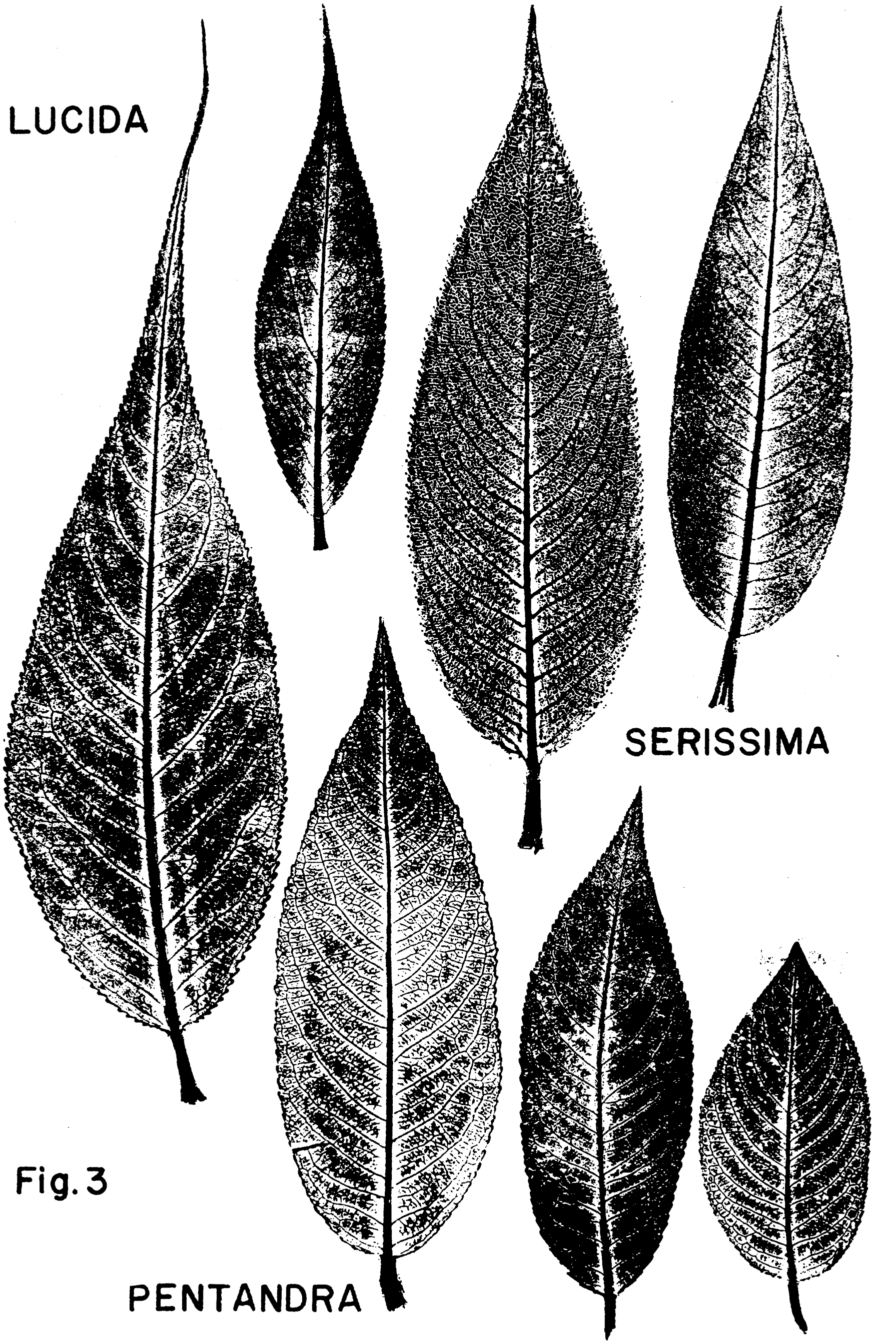


FIGURE 3. Leaves of *S. lucida*, *S.. serissima*, and *S. pentandra*.

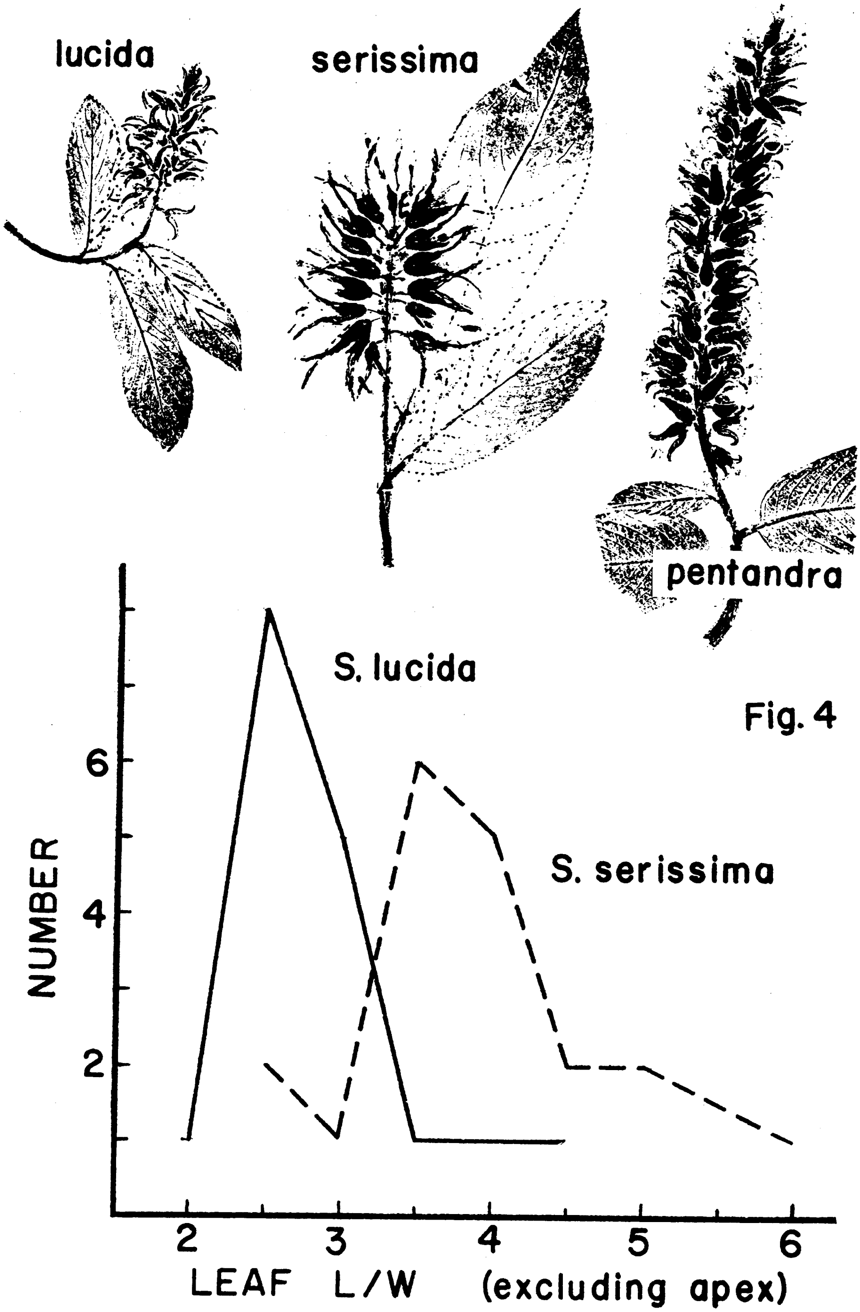


FIGURE 4. (Top) Pistillate eaments of *S. lucida*, *S. serissima* and *S. pentandra* in fruit. (Bottom) A comparison of the shape of the leaf blades (length-width ratio, excluding apex) of *S. lucida* and *S. serissima*.

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*

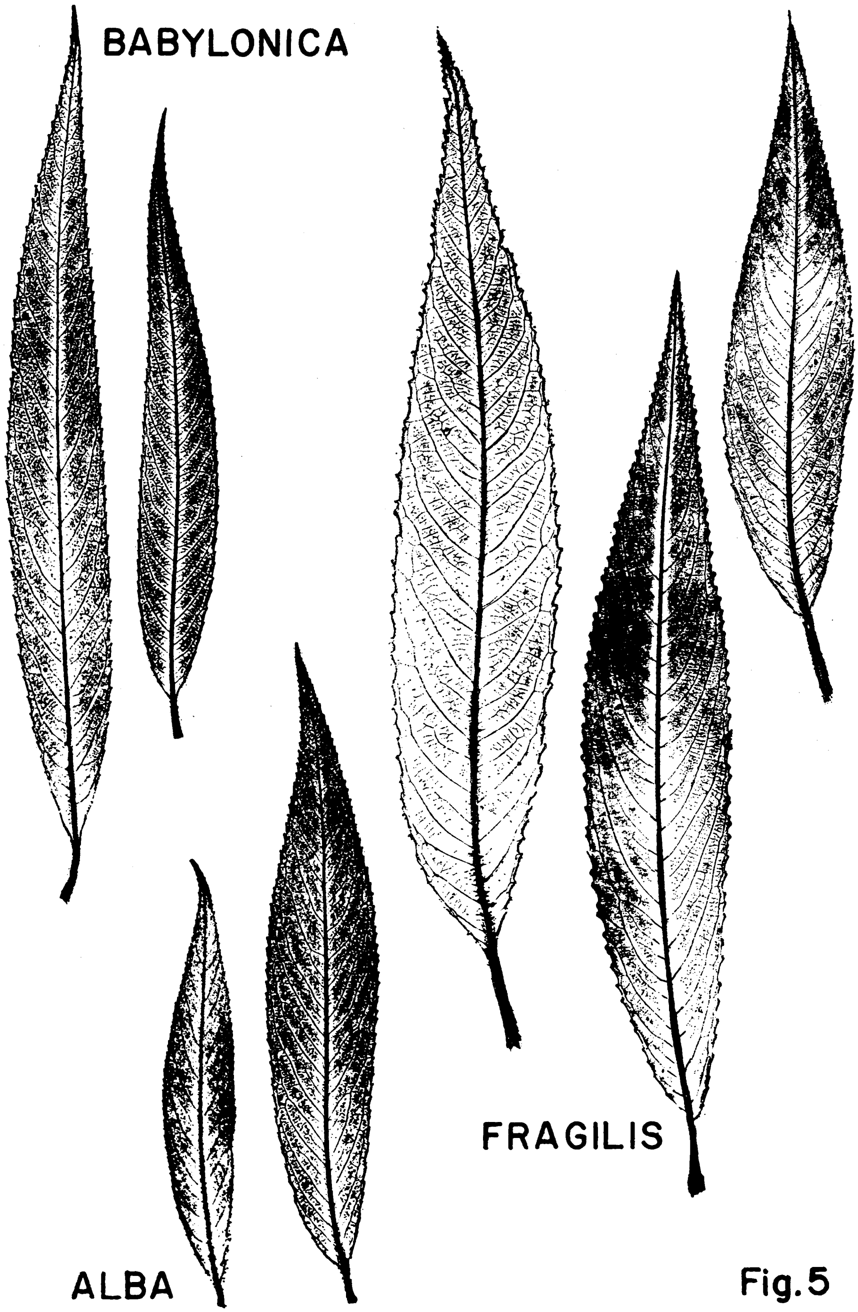


FIGURE 5. Leaves of *S. babylonica, S. fragilis,* and *S. alba.*

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.

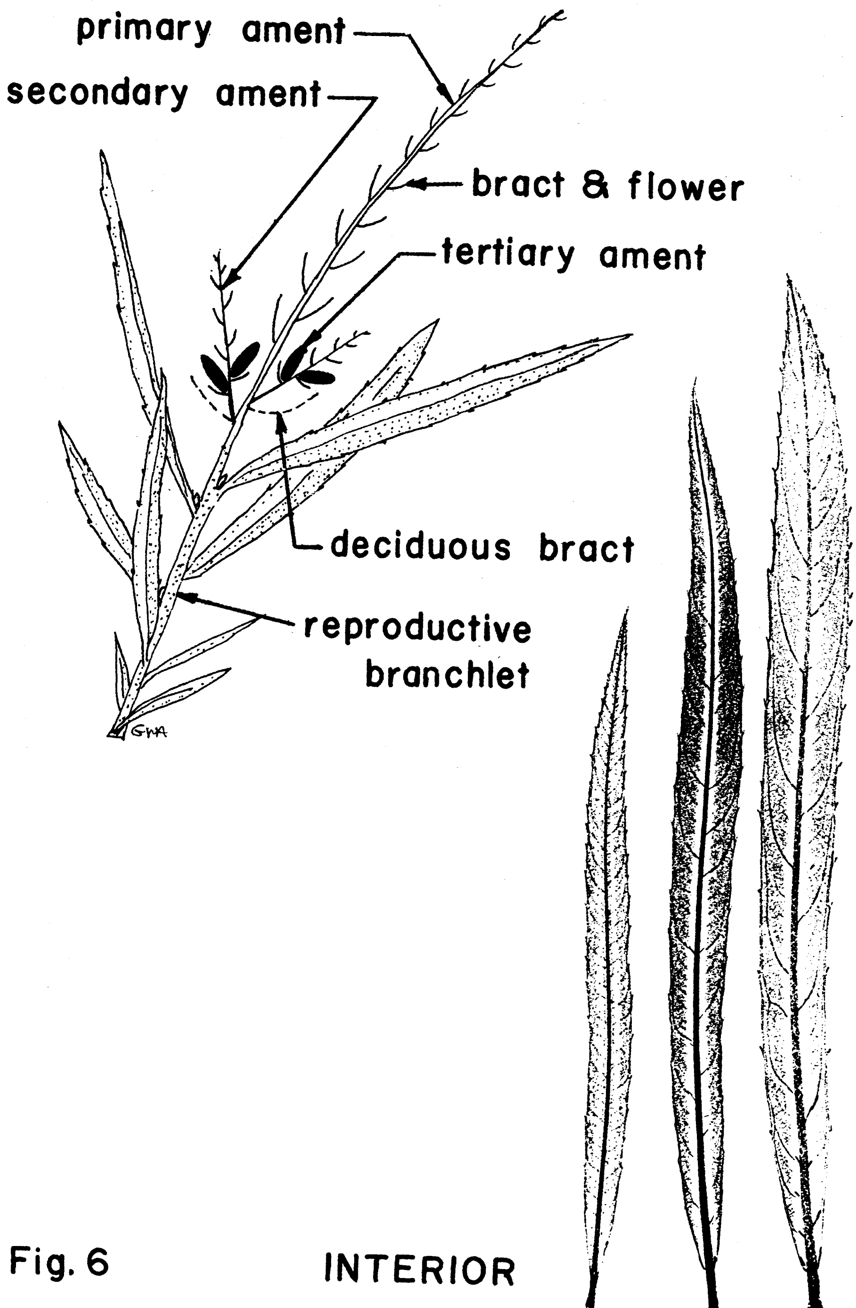
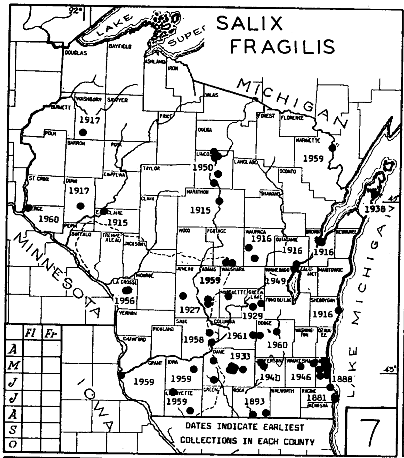


FIGURE 6. (Top) A generalized diagram of an ament (♂ or ♀) of *S. interior* illustrating the mode of branching (cf. text for discussion). (Bottom, right) Leaves of *S. interior.*

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


SALIX
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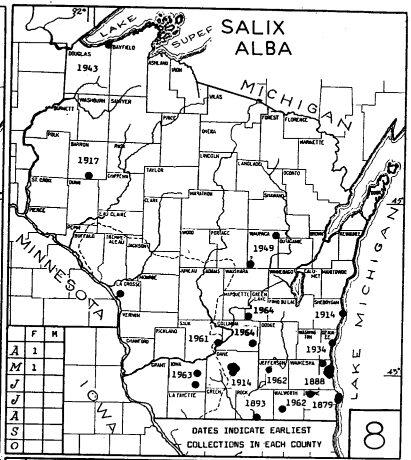
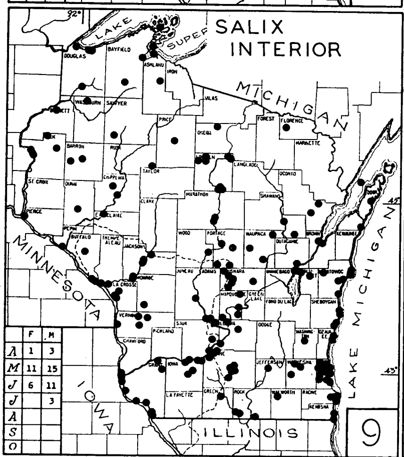
COLLECTIONS IN EACH COUNTY
7


SALIX
ALBA
DATES INDICATE EARLIEST
COLLECTIONS IN EACH COUNTY
8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INTERIOR
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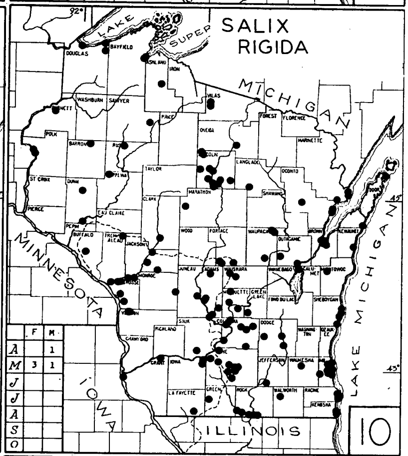
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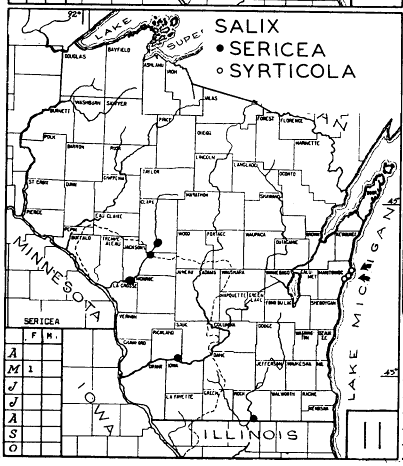
SALIX
• SERICEA
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SERICEA
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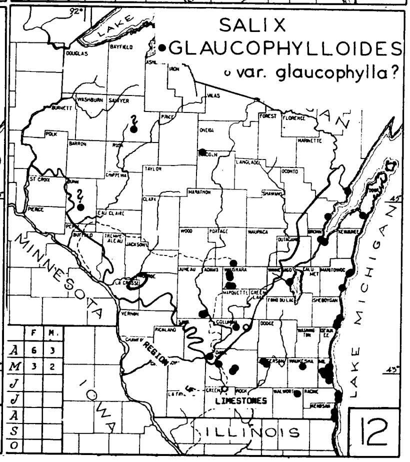

SALIX
• GLAUCOPHYLLOIDES
∘ var. glaucophylla?
LIMESTONES
12

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

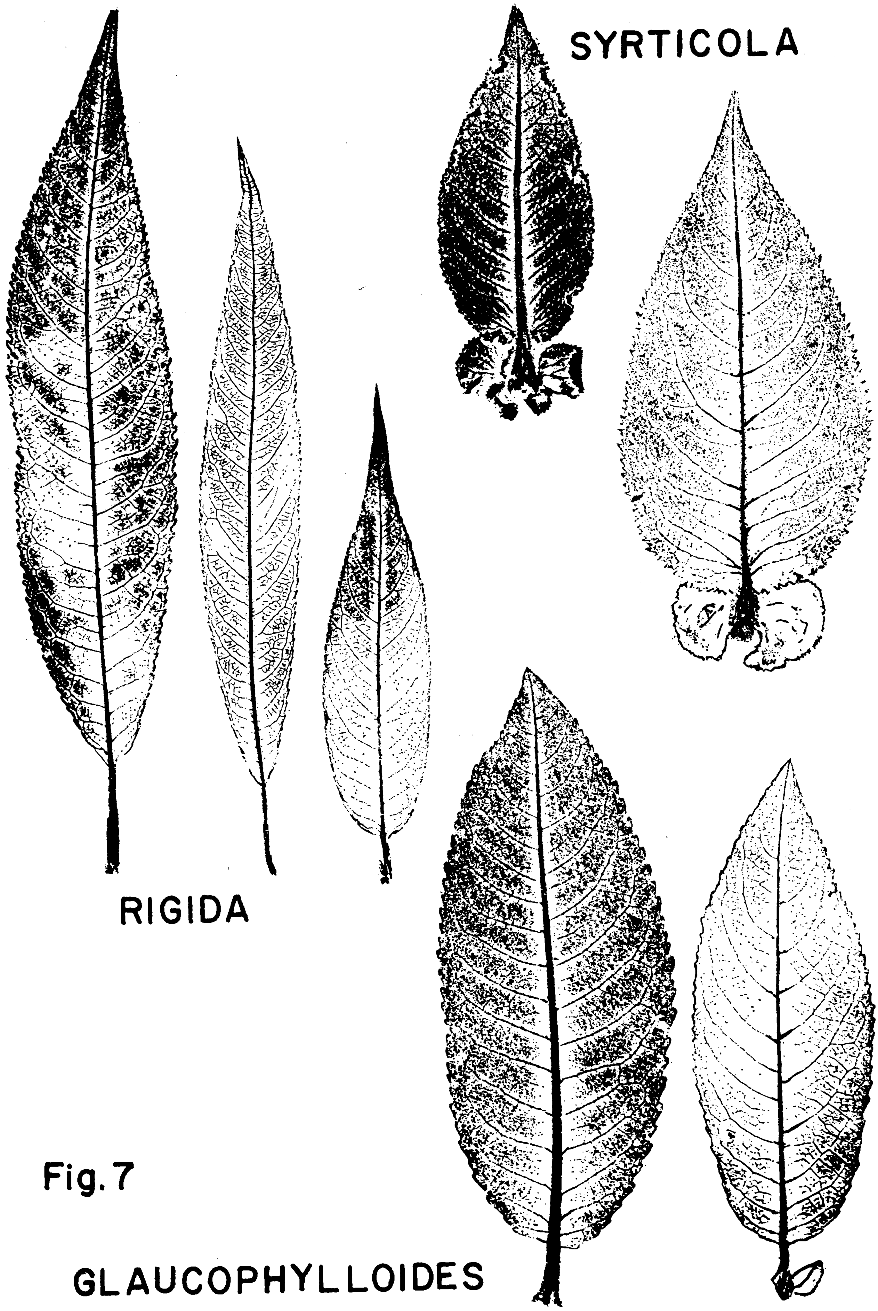


FIGURE 7. Leaves of *S. rigida*, *S. syrticola* (including stipules), *and S. glaucophylloides*.

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

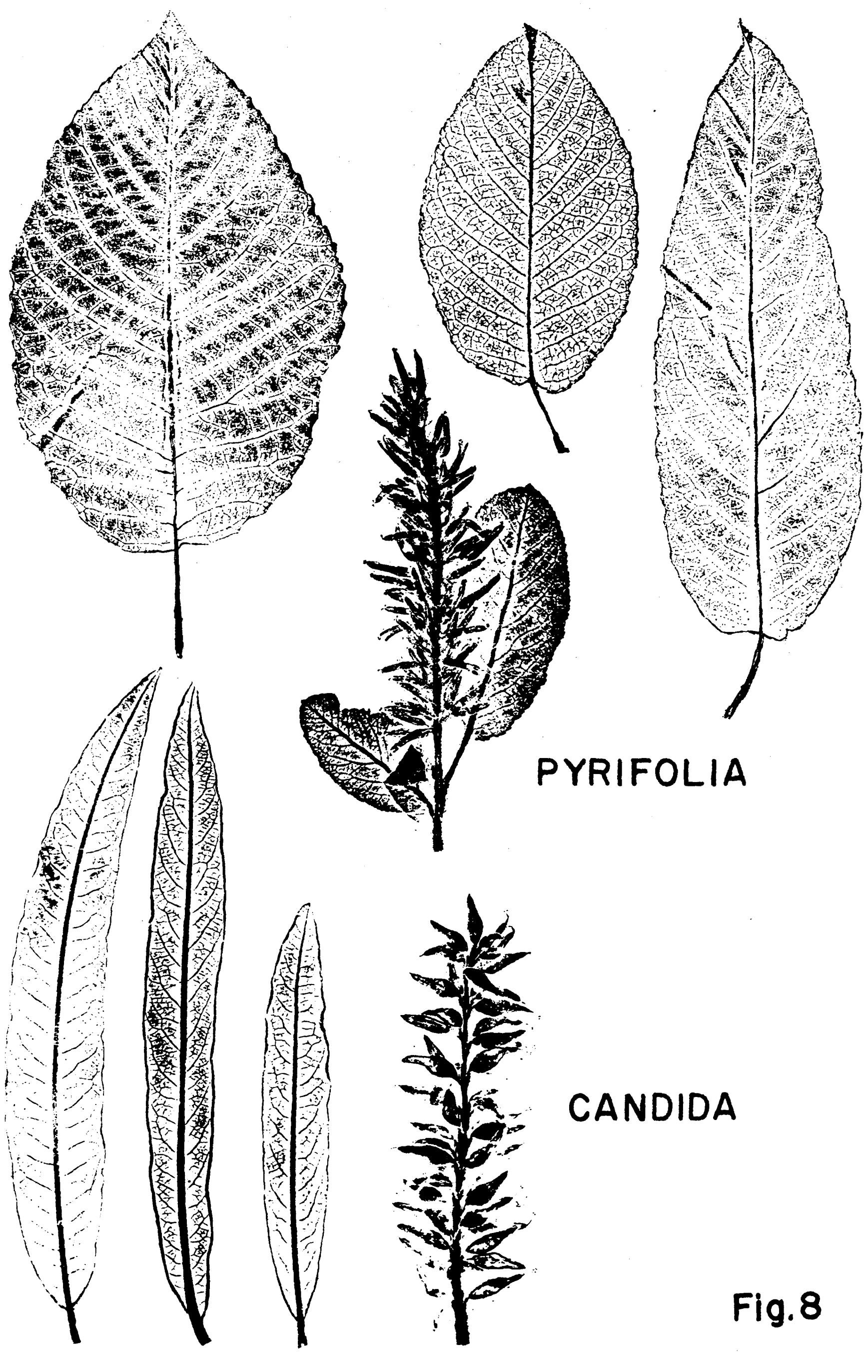


FIGURE 8. Leaves and pistillate aments (in early fruit) of *S. pyrifolia* and *S. candida.*

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).

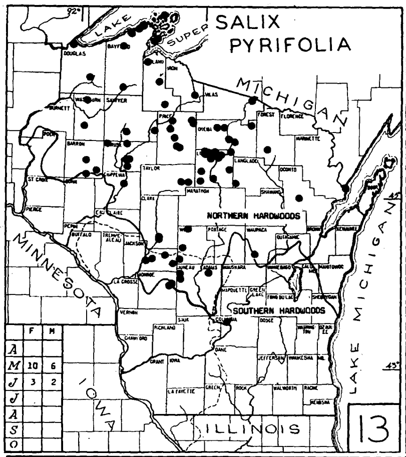
A glabrate variant of this characteristically tomentose species has been named *Salix candida* f. *denudata* (Anderss.) Rouleau (Nat. Canada. 71:266. 1944). Two specimens of this variant from Wisconsin have been seen (*A. M. Fuller 2371,* Cedarburg swamp, Ozaukee Co., Wis., 9 June 1928 (MIL) ; *H. Iltis 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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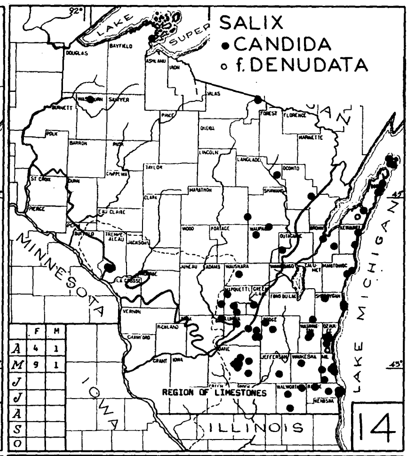
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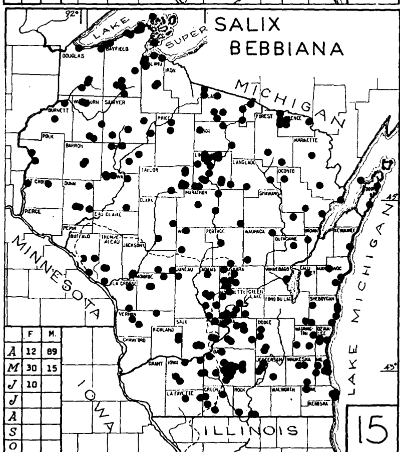
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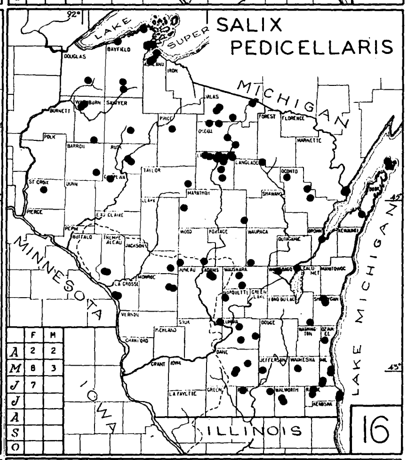
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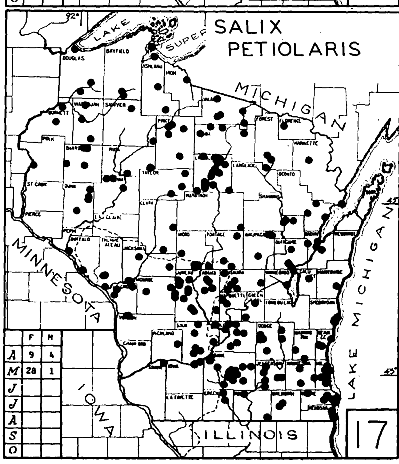
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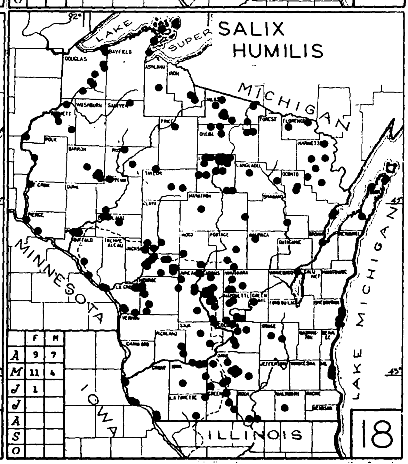
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long, pubescent; stipules small, usually less than 2 mm long, deciduous. Aments coetaneous or subprecocious, borne on reproductive branchlets. Staminate aments 1.5–2.5 cm long; reproductive branchlets 3–6 mm long; stamens 2, filaments pilose at base, 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.

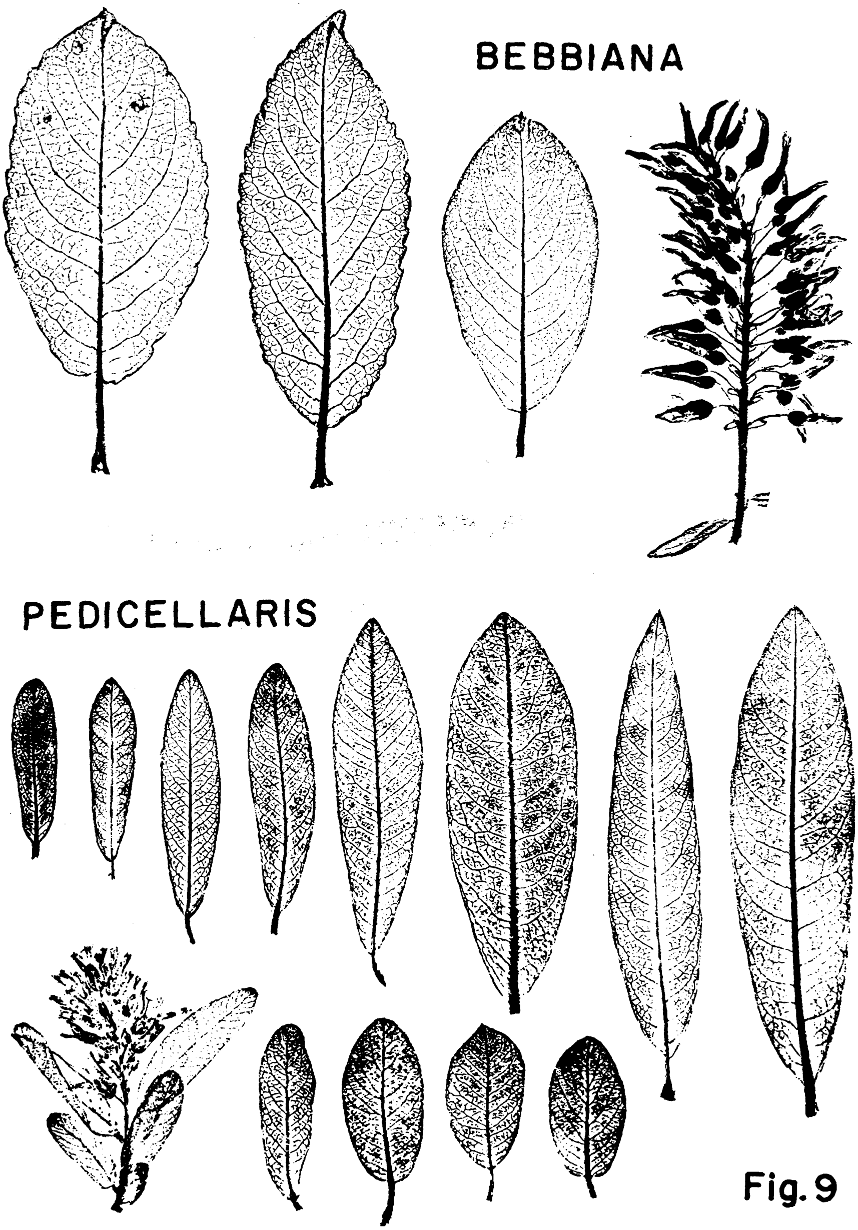


FIGURE 9. Leaves and pistillate aments (in fruit) of *S. bebbiana* and *S. pedicellaris.*

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-

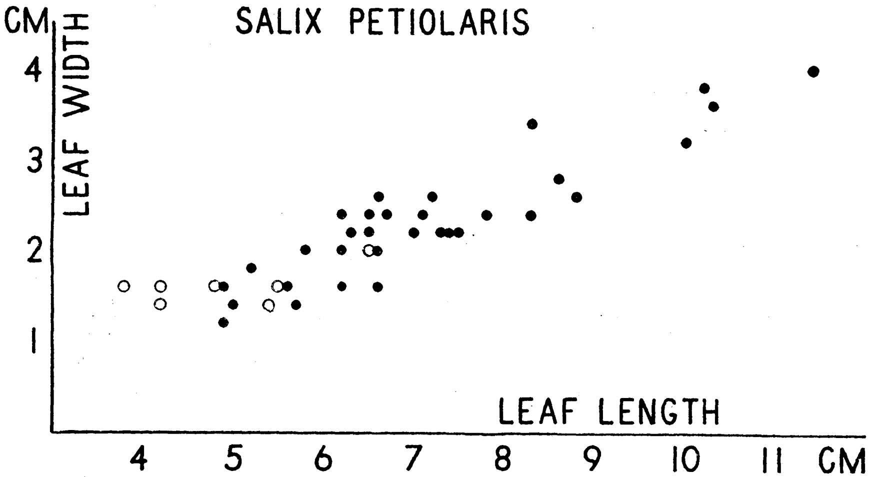


FIGURE 12. Leaf length and width of *Salix petiolaris* in Wisconsin. The scatter diagram compares leaf length and leaf width of fruiting (open circles) and vegetative (closed circles) specimens. See text for discussion.

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.

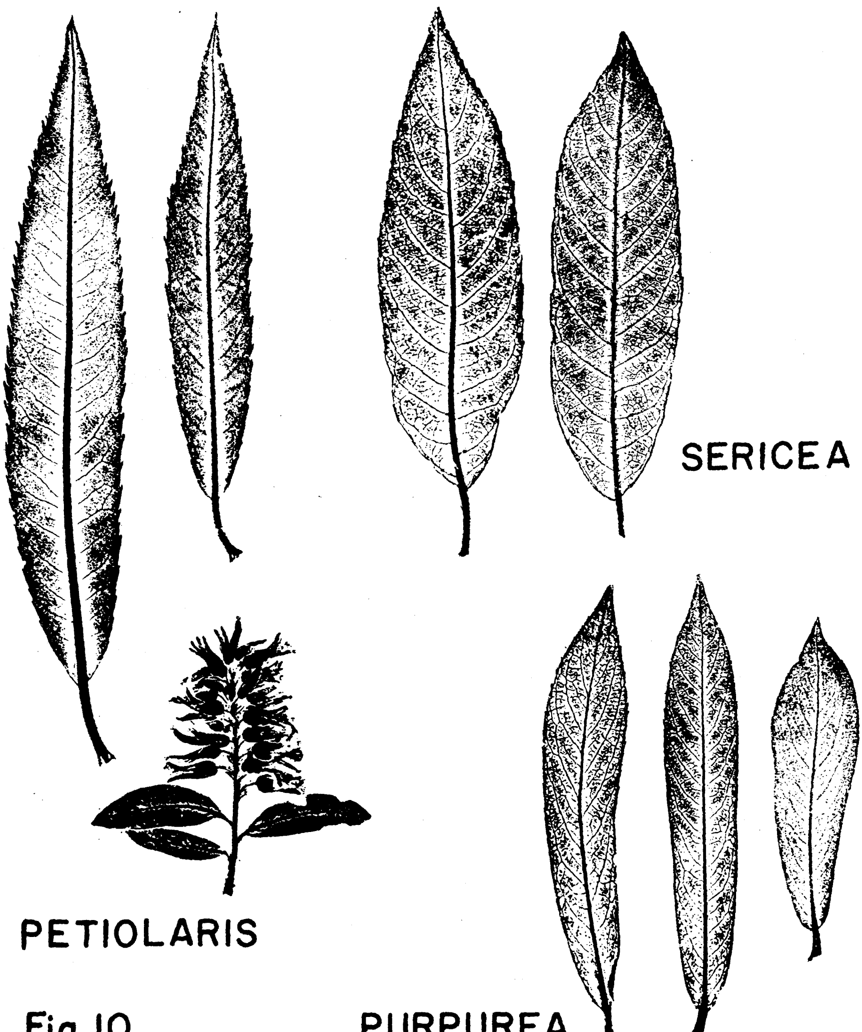


FIGURE 10. Leaves of *S. petiolaris*, *S. sericea*, and *S. purpurea*. Pistillate ament of *S. petiolaris* in fruit.

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-

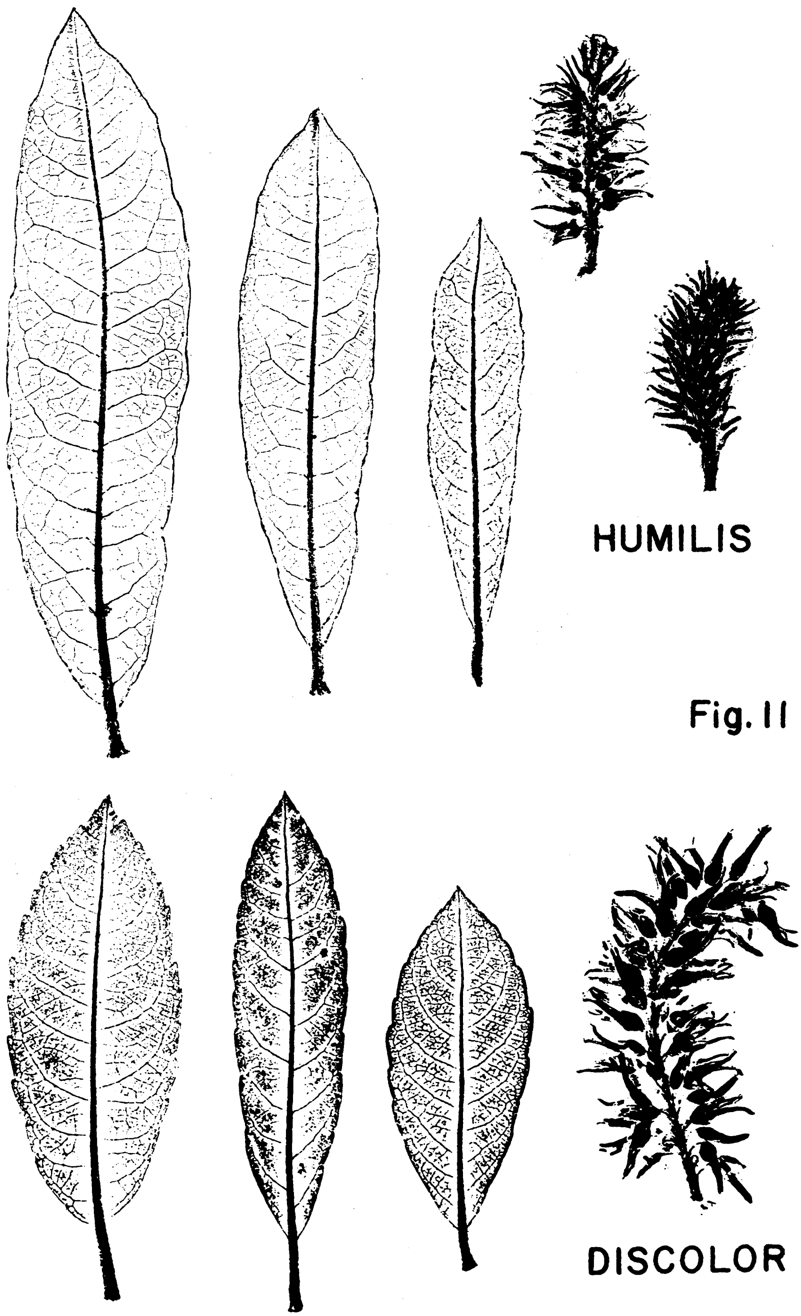


FIGURE 11. Leaves of *S. humilis* and *S. discolor.* Pistillate aments of *S. humilis* (upper in fruit, lower in flower) and *S. discolor* (in fruit).

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.

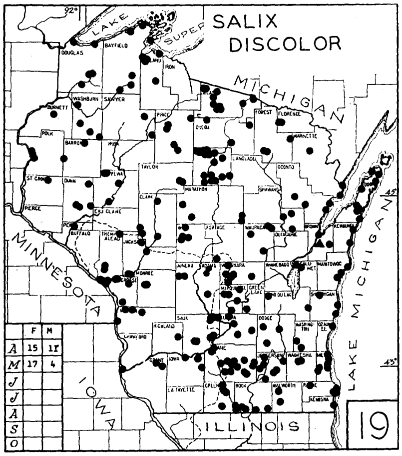
A diminutive form of *Salix humilis* which occurs in Wisconsin has been named *S. tristis* Ait., or *S. humilis* var. *microphylla* Fern. It is distinguished from the species on the basis of the small size of all its organs and may represent a prairie ecotoype or perhaps an ecophene (a reversible ecological modification). Whether or not this is so remains to be studied.

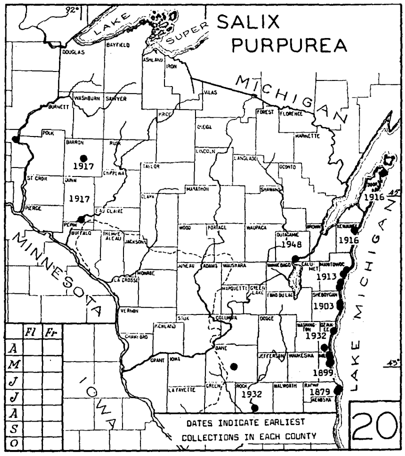
None of the forementioned varieties have been distinguished in this study.

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]

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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.

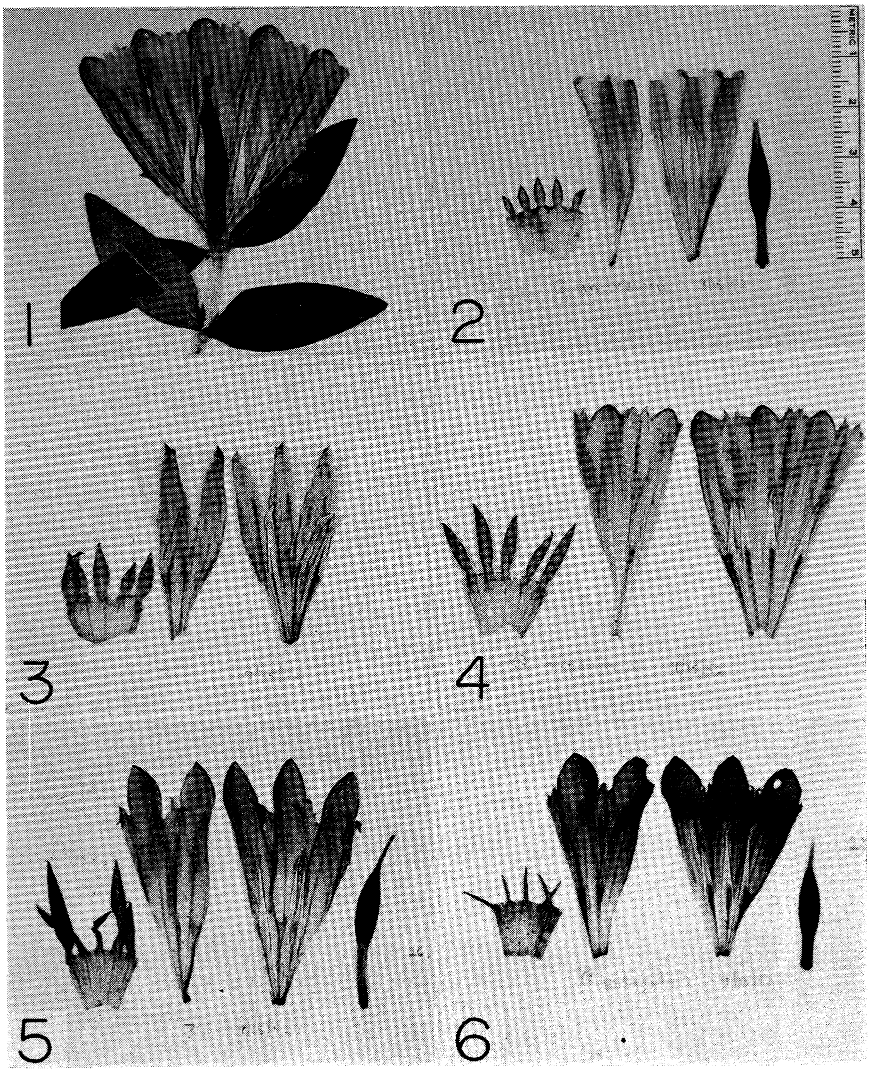
Wisconsin: Columbia Co.: prairie at Hwys SS and P, Town of Springvale, *Curtis s.n.*, 13 Sept. 1953 (WIS).

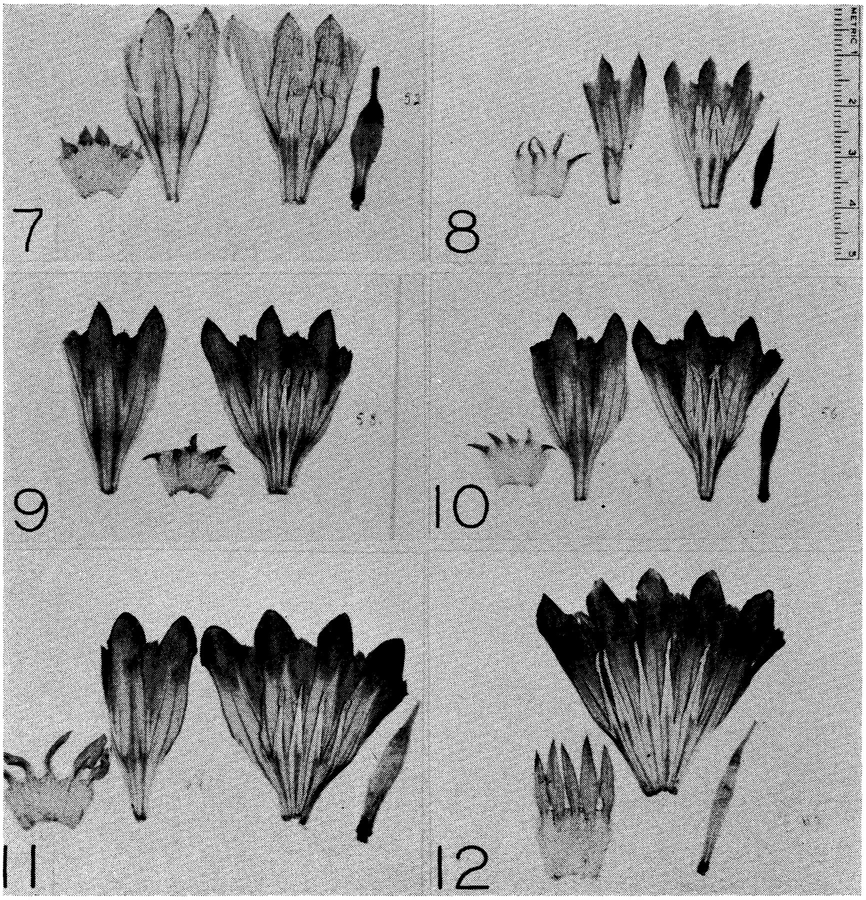
Green Co.: "Milwaukee" RR w of Brodhead at Park Road, *Fell 58–825*, 3 Sept. 1958 (WIS); *ibid., Fell 58–889, 58–891*, 27 Sept. 1958 (WIS); s of Belleville between County Road CC and rr track, *Mason 1387*, 17 Sept. 1950 (WIS); along rr track, Exeter, S 32, R8E, T4N, *Mason 1393*, 17 Sept. 1950 (WIS); 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, $\times$ ⅔. FIGURE 1. An experimental F_1, *G. puberula* $\times$ *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 collected 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.

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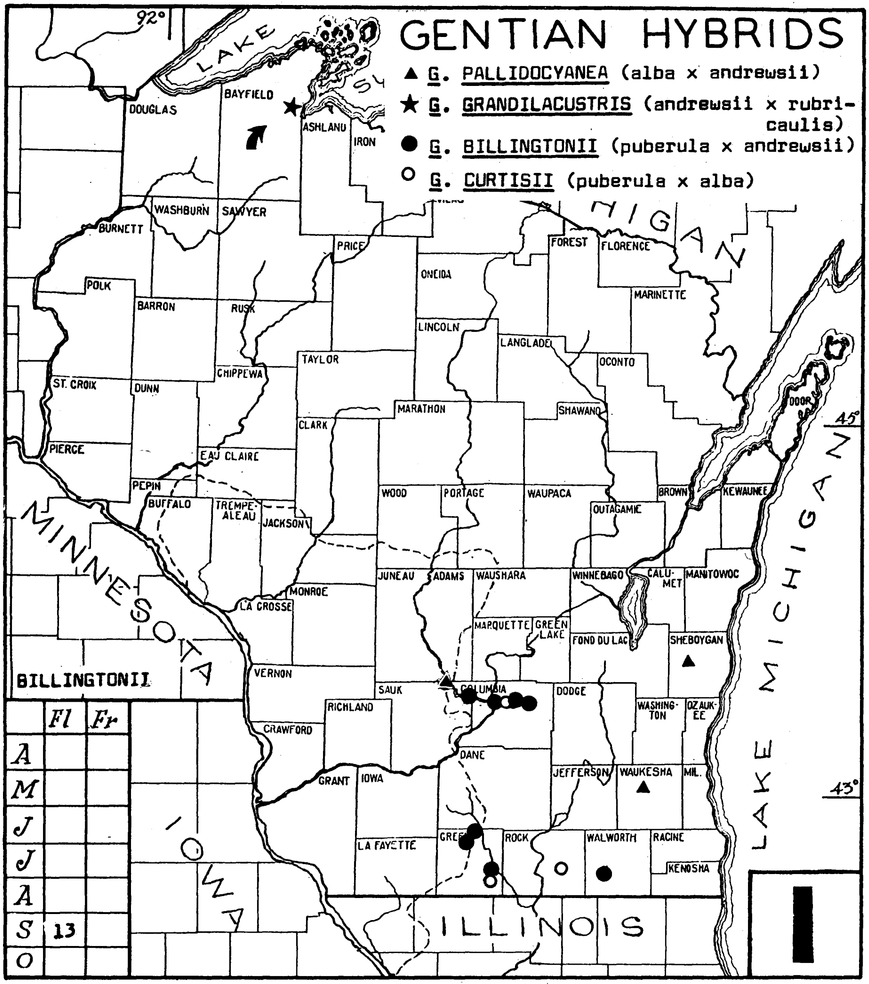
[3] **Gentiana** x **pallidocyanea** Pringle, **hyb. nov.,** inter *G. andrewsii Griseb.* et *G. alba* Muhl. Caules glabri. Foliae ovatae acuminatae. Lobae calycium ovatae, plus minusve carinatae. Corollae pallido-cyaneae appendicibus saepe albis. Lobae corollarum triangulae parvae, appendicies aegre superantes. Appendicies corollarum paulae, irregulare erosae.

Typus: Between Hartland and Pewaukee, along R.R., SE ¼, 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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