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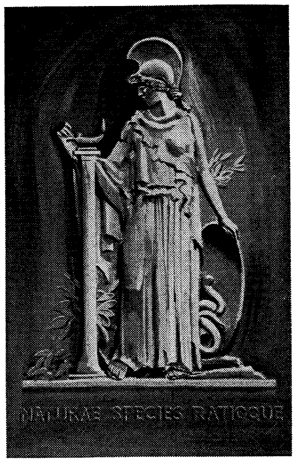

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GOODWIN F. BERQUIST, JR.
Editor

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HENRY JAMES AND SCIENCE: *THE WINGS OF THE DOVE*

Harry Hayden Clark

"The critic's first duty in the presence of an author's collective works," Henry James says in discussing George Eliot, "is to seek some key to his method, some utterance of his literary conviction, some indication of his ruling theory."[1] There are dozens of such comments in James's work which declare his central interest in philosophical and ethical attitudes—an area which recent criticism of James has neglected in its concern with formal technique rather than content. But it seems only logical to turn more fully to content in order to learn more about that area of James, the writer, which he as a critic centered on in other writers— an ethical sense. For, as James wrote in *French Poets and Novelists,* "Be the morality false or true, the writer's deference to it greets us as a kind of essential perfume."[2] In view of the weight James placed on moral questions and motivation, then, let us consider *The Wings of the Dove,* 1902, the culmination of some thirty-six years of thoughtful fiction and criticism, in terms of its philosophical and ethical attitudes.

James was, as is well recognized, especially concerned in general with the distinction between surface appearance and inner or psychological reality. But, holding that the novel "should begin with a picture and end with an idea," he was just as concerned with ways in which he could flesh out his characters' distinctively psychological conflicts. In fact, the quest of such ways, such images, seemed to James the very "essence of poetry." Hence, the critical interpreter has the problem of finding what James himself called "the figure in the carpet" represented in the configurations of images in a given story, assisted by what he said in non-fictional work about his general ideas.

Such an approach to *The Wings of the Dove* suggests that here James is ultimately concerned with a struggle for existence which

* Grateful acknowledgement is made of the fact that I have been much aided in getting this study into its present form through several versions by Mr. Clinton Burhans and Mrs. Carol Scotton, Research Assistants generously provided by The Graduate School of the University of Wisconsin. They deserve much credit.

[1] *Views and Reviews* (Boston, 1908), p. 1.

[2] *French Poets and Novelists* (London, 1878), p. 114.

is economic at center, though it is a struggle in which Milly Theale excels because of superior moral force. Further, the terms in which James describes this struggle—his images—suggest that Social Darwinism influenced his conception of the novel.

That James had such a view of the world is apparent from his other writings. "James saw [the world] a place of torment," his personal secretary Theodora Bosanquet wrote, "where creatures of prey perpetually thrust their claws into the quivering flesh of the doomed, defenseless children of light . . . He . . . saw fineness sacrificed to grossness, beauty to avarice, truth to a bold front. . . . He hated the tyranny of persons over each other."[3] And in his non-fictional *English Hours* James makes clear he saw society in general as well as business in terms of "the steady rumble of that deep keynote of English manners, over-scored so often, and with such sweet beguilement, by finer harmonies, but never extinguished—the economic struggle for existence."[4] As James sees meaning in society beneath its smooth surface, we should look for significance in *The Wings of the Dove* beneath all its surface "sweet beguilement."

One related consideration is important, and that is the novel's reflection of Jame's lifelong concern as an expatriate writer with the theme of international contrasts. For the struggle for existence is embodied in terms of these contrasts in *The Wings of the Dove.* This theme of international contrasts is considered not only because of James' travels and his conscious attempt to play the observant "cosmopolite,"[5] but because of his interest in the theme of "the great and admirable Taine" (on whom he wrote five essays) that a given book is determined by a writer's time, place, and race or nationality.[6] Along this line, Professor Christoff Wegelin in *The Image of Europe in Henry James* argues that in *The Wings of the Dove* the two contrasting heroines, "Milly and Kate are representative of the civilizations which formed them."[7] And Mr. R. P. Blackmur says that Milly Theale, with Maggie Verver of *The Golden Bowl,* "although victimized by Europe, triumph over it, and convert the Europeans who victimized them, by the positive strength of character and perceptive ability which their experience of treachery only brings out . . . By these means, in the figure of the American girl, candor, innocence, and loyalty become char-

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[3] *Henry James at Work* (London, 1924), p. 32.

[4] *English Hours* (Boston, 1905), p. 71. (First edition, 1875.)

[5] *Portraits of Places* (New York, 1948), p. 115.

[6] I have elaborated on these matters in "The Influence of Science on American Literary Criticism, 1860–1910, Including the Vogue of Taine," in *Transactions of the Wisconsin Academy* (XXXIV, 1955), 109–164.

[7] Christoff Wegelin, *The Image of Europe in Henry James* (Dallas, 1958), p. 117.

acteristic through not exclusive American virtues which redress the deep damage done by a blackened Europe."[8]

As we explicate *The Wings of the Dove,* then, let us watch for reflections of the influence of the current scientific determinism (whose teachings in general James had access to in hundreds of contacts) and the influence of Taine's thesis of the author being a spokesman of his time and place. By approaching this book in the light of ideas associated with science—an approach hitherto unexplored in depth—I do not claim that James was directly influenced by Darwinism. My point is only that in *The Wings of the Dove* James sees his characters' psychological conflicts and the essential conflict of the novel in terms of images of destruction, counterpointed at the end by an ethical renunciation associated with what Emerson called "the internal check." These images reflect current scientific ideas which make plausible in 1902 his interpretation of the socialite life of that time.

There is in Milly Theale's situation in *The Wings of the Dove* more than a suggestion of the evolutionary concept of the survival of the fittest in a struggle for existence. James, characteristically, is not interested primarily in the struggle in a life and death sense; he is concerned chiefly with the struggle of Milly, the wealthy young American who is dying of an incurable disease, to achieve at all costs life's fullest potentialities. As such, her struggle and quest is a matter of sensitivity and realization, not of breath and blood; its arena is not the jungle of fang and muscle but rather of drawing-rooms and galleries, of intellectual conversations and social graces. And it is here that Milly encounters the forces—members of London society who view her in economic terms—forces which would inhibit her quest.

James turns to upper-middle class English society because it has the conditions he considers necessary for the realization of life's highest potentialities. And, though this arena has its beguiling social aspects, it is a psychological jungle and James is as concerned with the moral and ethical problems of its conflicts as are those who deal with more obvious and basic jungles.

The essentially savage nature of English society is revealed by Kate Croy in her description of it to Milly Theale. For Kate speaks in terms of a "monster," to which one must be introduced and enabled to "walk all round . . . whether for the consequent exaggerated ecstasy or for the still more . . . disproportionate shock."[9] Milly's immediate social success in London is discussed one evening in similar bestial terms at a dinner party from which she is absent.

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[8] R. P. Blackmur, in *Literary History of the U.S.,* ed. R. E. Spiller et al. (New York, 1949), pp. 1056–7.

[9] Henry James, *The Wings of the Dove* (New York, 1930), Modern Library Edition, I, 302. All subsequent references will be to this edition.

Milly's friend and companion, Mrs. Stringham, is pictured as observing the discussion "very much as some spectator in an old-time circus might have watched the oddity of a Christian maiden, in the arena, mildly, caressingly martyred. It was the nosing and fumbling not of lions and tigers but of domestic animals let loose as for the joke" (II, 46).[10] And for Merton Densher at the same party, Milly's success is best described with similar animal images. He sees the situation in terms of competition within nature: "The huddled herd had drifted to her blindly—it might as blindly have drifted away. There had been of course a signal, but the great reason was probably the absence at the moment of a larger lion. The bigger beast would come and the smaller would then incontinently vanish. It was at all events characteristic . . ." (II, 47). James thus describes English society as an arena in which a struggle for existence akin to that in primeval nature is constantly going on.

Nearly everyone of English society in the novel is engaged in this struggle; more important, almost all are selfishly and unscrupulously using their personal relationships to advance their material and social interests. Kate's despicable father is a prime example, for he hopes to gain wealth and position through Kate's relationship with her wealthy aunt, Mrs. Lowder. Kate is ready to give up Mrs. Lowder because her aunt has offered her a home only on the condition that Kate have nothing further to do with her father and sister. But her father, insensitive to the insult and very greedy for money, refuses such a plan: "One doesn't give up the use of a spoon because one's reduced to living on broth. And your spoon, that is your aunt, please consider is partly mine as well" (I, 17).

Mrs. Lowder also sees in Kate a means of achieving her goals —in this case, attracting guests to enable her to outdo other competitors for social prominence. She feels that her money combined with Kate's charm and beauty will produce a marriage with the highest social connections. In the most economic of terms, Mrs. Lowder explains to Merton Densher her "feeling" for Kate: "I've watched [Kate's presence] long; I've been saving it up and letting it, as you say of investments, appreciate, and you may judge whether, now it has begun to pay so, I'm likely to consent to treat for it with any but a high bidder. I can do the best with her, and I've my idea of the best" (I, 92).

Kate, whom we shall see has had her sordid family background to teach her the meaning of a struggle for existence, realizes she

[10] In a non-fictional essay on "London," 1888 James remarks, "A sudden horror of the whole place came over me, like a tiger-pounce of home-sickness . . . London was hideous, vicious, cruel, and above all over-whelming; whether or not she was 'careful of the type' (as in Tennyson's view of evolution), she was as indifferent as Nature herself to the single life." (James's *Art of Travel* (New York, 1958), pp. 176–77.) On p. 189 he envisages London as an "ogress devouring the poor."

has "been marked from far back" (I, 32) for Mrs. Lowder's predatory purposes. She goes to live with her aunt, but secludes herself in her room as much as possible where she thinks of herself as "a trembling kid, kept apart a day or two till her turn should come, but sure sooner or later to be introduced into the cage of [Mrs. Lowder] the lioness" (I, 32–33). While Kate ponders her fate, James makes his most telling comment on the savage character of the situation: "Yet what were the dangers, after all, but just the dangers of life and of London? Mrs. Lowder *was* London, *was* life —the roar of the siege and the thick of the fray" (I, 35).

Yet Kate, too, is involved in the struggle as selfishly and unscrupulously as the next. She is in love with Merton Densher, the penniless but cultivated and charming journalist; but she refuses to marry him until her Aunt is reconciled to the marriage, for she doesn't want to lose the material affluence which life with Mrs. Lowder means. In a conversation between Kate and Densher on this subject, James seems clearly to indicate the basic nature of the struggle for existence which characterizes the society he is describing:

> " 'I don't see,' [Kate remarks,] 'why you don't make out a little more that if we avoid stupidity we may do *all*. We may keep her.'
> He stared. 'Make her pension us?'
> 'Well, wait at least till we've seen.'
> He thought. 'Seen what can be got out of her?'
> Kate for a moment said nothing. 'After all I never asked her; never, when our troubles were at the worst, appealed to her nor went near her. She fixed upon me herself, settled on me with her wonderful gilded claws.'
> 'You speak,' Densher observed, 'as if she were a vulture.'
> 'Call it an eagle—with a gilded beak as well, and with wings for great flights.' " (I, 82–3)

It is into this unscrupulous social struggle for existence that the American Milly Theale steps upon her arrival in England. She is innocent, not as one who is unaware of the art of living, but as one who is uncorrupted. And, suffering from an incurable disease, she is herself engaged in a struggle for existence far more importunate than that which she enters. In his preface James indicates explicitly—as does finally the entire novel—that his concept of a social struggle for existence is not the simple one between life and death; the struggle is rather to live up to life's fullest potentialities. "The idea," writes James in the preface, "reduced to its essence, is that of a young person conscious of a great capacity for life, but early stricken and doomed . . . while also enamored with the world; aware moreover of the condemnation and passionately desiring to 'put in' before extinction as many of the finer vibrations as possible, and so achieve, however briefly and brokenly, the sense of having lived" (v).[11]

It is essentially in the struggle of life and not in the fact of death that James is interested. Of the artist and his characters James says, "It is still by the act of living that they appeal to him, and appeal the more as the conditions plot against them and prescribe the battle. The process of life gives way fighting, and often many so shine out on the lost ground as in no other connexion" (vii). James, then, meant his tale in no way to be "the record predominately of a collapse" (viii) but rather the portrayal, of an ethical triumph. Thus, in the novel "powers conspiring to a sinister end" are yet "in such straits really to *stifle* the sacred spark" that Milly as "a creature so animated, an adversary so subtle, couldn't but be felt worthy, under whatever weaknesses, of the foreground and the limelight" (viii-ix).

When Milly arrives in England, she immediately is seized upon as all things to all people—all in an economic context in the struggle for existence. In Milly, Mrs. Lowder, who was Mrs. Stringham's classmate in girlhood, sees the person who will marry Densher and thus eliminate him as a threat to her plans for Kate's marriage to a man of social prominence. When Kate learns that Milly is dying and that her physician, Sir Luke Strett, feels that only happiness can prolong her life, she tries to arrange a marriage between Milly and Densher. Such a marriage, Kate feels—though she is secretly engaged to Densher—will bring Milly happiness and bring Densher, after Milly's death, the wealth which will make them independent of Mrs. Lowder. Milly and Mrs. Stringham leave London for Venice and Milly rents an ancient palace which becomes the scene of action. They are joined there by Mrs. Lowder, Kate, and Densher. Densher has agreed to Kate's plans, if in deference to his conscience he is a passive rather than an active participant. But Lord Mark, a penniless aristocrat whom Mrs. Lowder wants Kate to marry and who had met Milly in London, comes to Venice to ask Milly to marry him. As much involved as anyone in the economic struggle for existence, Lord Mark too is after Milly's money. Milly refuses him and he realizes that she loves Densher. Lord Mark then returns to London to ask Kate to marry him, but she also refuses. Now he discovers the scheme which she and Densher have to obtain Milly's money and he returns to Venice (motivated by animal-like jealousy and frustrated greed) to tell Milly

[11] Leon Edel in *Henry James: The Untried Years* (Philadelphia, 1953), pp. 226–38 and 323–33, discusses James's youthful devotion to Mary Temple, and the extent to which she served as an inspiration to his creation of Milly and others. Mr. Edel's many studies of James and his editing have placed all who study James deeply in debt to his expert knowledge and rich insights.

of their secret engagement, and hence of Densher's duplicity. This is the greatest of blows for Milly and she turns "her face to the wall" (II, 294).

At this point Mrs. Stringham goes to Densher and describes Milly's struggle to live:

> " 'She's more than quiet, She's grim. It's what she has never been. So you see—all these days. I can't tell you—but it's better so. It would kill me if she *were* to tell me.'
>
> 'To tell you?' He was still at a loss.
>
> 'How she fells. How she clings. How she doesn't want' " to die (II, 299).

But Densher can't tell a direct lie by going to Milly and denying Lord Mark's accusation, as Mrs. Stringham asks. A few weeks later Milly dies. But her physician, Sir Luke, had convinced her that Densher meant well in trying to prolong her diseased life, and Milly had seen him before her death. She sends him home in order that he might not see her die.

Densher's relation to Milly has been a very subtle one; he has been a passive participant in Kate's plan, but he has become involved with Milly on their own terms to the exclusion of other considerations. And he finally realizes he is in love with her memory. He refuses to marry Kate ("I won't touch the money") unless she joins him in renouncing the money. She replies she will if he can deny he is in love with Milly's memory. But this he cannot do, and they both realize there is too much between them—Milly's wings, the wings of the dove—to permit their marriage.

Both in the English society he describes, then, and in the character of Milly Theale, James seems to reflect the influence of the evolutionary concept of the survival of the fittest in the struggle for existence.

The fact that James's characters are clearly products of hereditary and environmental factors also reflects the influence of evolutionary science in *The Wings of the Dove*. Kate Croy's family background is one in which personal attachments are weighed in terms of financial value. To her father and her destitute sister, Marian, as Kate so clearly recognizes, "My position's a value, a great value, for them both. It's *the* value—the only one they have" (I, 80). In the light of such conditioning, Kate's actions in this pattern toward Milly Theale are easily understood. And Kate heavily feels the burden of her heredity, her natural affinity for family and its unhapy consequences: "Her haunting harassing father, her meanacing aunt, her portionless little nephews and nieces," writes James, "were figures that caused the chord of natural piety superabundantly to vibrate. Her manner of putting it to herself—but more especially in respect to Marian—was that she saw what you might be brought to by the cultivation of consanguinity" (I, 36).

In his preface James leaves little doubt of his intention with Kate as the product of corrupted heredity and environment. He explains her thus: "The image of her so compromised and compromising father was all effectively to have pervaded her life, was in a certain particular way to have tampered with her spring . . ." (xviii). And in a conversation between Kate and Densher, James again indicates the fruits of heredity, for to Kate her father's dishonor has become a part of her, and she concludes, "How can such a thing as that not be the great thing in one's life?" (I, 77)[12] Kate "sleeps" with Densher to encourage him to continue to make love to Milly!

Quite ironically, Milly Theale sees Kate as the "wondrous London girl" (I, 190), the particular product of the London environment of whom she had read. But as the two girls become close friends, Milly perceives more than Kate's turns of head and tones of voice; she sees the Kate who is straining in an earnest competition. Significantly, James describes this element in Kate in terms that reflect both his conception of a social struggle for existence and his concern with environmental determinism. "Wasn't it," he writes, "that the handsome girl was, with twenty other splendid qualities, the least bit brutal too, and didn't she suggest, as no one yet had ever done for her new friend, that there might be a wild beauty in that, and even a strange grace?" (I, 201). And, as James continues, Milly soon saw the reason for such a bold approach to life, for "There were more dangers clearly roundabout Lancaster Gate [Mrs. Lowder's ostentatious home] than one suspected in New York or could dream of in Boston" (I, 201).

In the case of Merton Densher, James depicts an individual in whom the qualities have yet to be shaped by his environment into a final character. And of course in the novel it is Kate's plan and Milly's splendid fortitude, coupled with his renunciation of Milly's money, that determine the final form of his character.

It is significant that the two characters in the novel who see the final circumstances of Milly's death as a sort of ethical triumph are those two who are not distinctly products of any one environ-

[12] J. A. Ward (*The Imagination of Disaster* (Lincoln, Neb., 1961), p. 130) in his analysis of *The Wings of the Dove* scarcely mentions its reflections of evolutionism but he does call attention to "hereditary predestination." "Both Milly and Kate, we are told, are destined to suffer for the sins of their ancestors, Milly by dying early and Kate by committing a great sin. Milly's family has been plagued by a long history of early deaths and widespread disaster. Kate also partakes mysteriously in the failure and disaster that have visited all her relatives and ancestors. Early in the story, Kate thinks of her family: "Why should a set of people have been put in motion, on such a scale and with such an air of being equipped for a profitable journey, only to break down without an accident, to stretch themselves in the wayside dust without a reason?' " (N.Y. ed., XIX, 4).

ment, that is, Densher and Susan Stringham. These characters also are the ones who, with Milly, spiritually gain something from the total experience encompassed in the novel. Thus, Densher, who had lived abroad, is delineated as "but half a Briton" (I, 101). Mrs. Lowder notices his "want of the right marks, his foreign accidents, his queer antecedents," (I, 101), and Kate discovers "how many more foreign things were in Merton Densher than he had hitherto taken the trouble to catalogue . . ." (I, 103). Densher himself insists he had come back "to being a Briton," but James observes, indicating clearly his partial belief in environmental determinism, "Brave enough though his descent to English earth, he had passed, by the way, through zones of air that had left their ruffle on his wings . . . . Something had happened to him that could never be undone" (I, 104). Densher's final renunciation of Milly's money is also explained in part by the fact that his father was a clergyman whose idealism the son inherited.

Mrs. Lowder and Mrs. Stringham are as much products of their backgrounds as the other characters, but background has fixed the London society matron into a rigid pattern of behavior and has left the New Englander all the more flexible for her experience. In renewing her childhood friendship with Mrs. Lowder when they were classmates in Switzerland, Mrs. Stringham notes the differences between her London friend and herself. To the questing New England companion of Milly, Mrs. Lowder appears now as concerned only with the fundamental "business" of life. Mrs. Stringham sees it thus: "The joy, for her, was to know *why* she acted—the reason was half the business; whereas with Mrs. Lowder there might have been no reason: 'why' was the trivial seasoning-substance, the vanilla or the nutmeg, omittable from the nutritive pudding wihout spoiling it" (I, 187–8).

Mrs. Susan Stringham is the perfect companion for Milly, whom she worships as a princess, because her character's development is determined throughout the story by the demands of the new environment, as was noted of Densher's character. Like Densher, she had spent part of her life in foreign lands; her mother had given her daughters five years abroad which was "to stamp the younger in especial—Susan was the younger—with a character [which] . . . made all the difference" (I, 133). Coming equipped with the simplicity and directness of a New England background and the perspective of travel, Mrs. Stringham does develop—under the demands of a new environment—a character subtle enough to perceive by the end of the story the involved but untold relationships between Merton, Kate, and Milly. "She has seen for herself," Merton tells Kate. "I've told her nothing. She's a person who does see" (II, 358).

James makes it clear in his preface what he intends of heredity and environment for Milly. "She should be the last fine flower,—blooming alone, for the fullest attestation of her freedom—of an "old' New York stem . . ." (x). Going with this, James sees a peculiar American background, for he speaks of "a strong and special implication of liberty, liberty of action, of choice, of appreciation, of contact—proceeding from sources that provide better for large independence, I think, than any other conditions in the world" (x).

When Susan Stringham visits Milly in New York, it is Milly's New York background which impresses, a background which is an "imense, extravagent, unregulated cluster, with free-living ancestors, handsome dead cousins, lurid uncles, beautiful vanished aunts, persons all busts and curls, perserved, though so exposed, in the marble of famous French chisels . . ." (I, 124). Milly *is* upper class New York to Mrs. Stringham, is undeniably the product of her environment. And what Milly represents is "all on a scale and with a sweep that had required the greater stage; it was a New York legend of affecting, of romantic isolation . . ." (I, 118). But most of all, James stresses, Milly represents, "in respect to the mass of money so piled on the girl's back, a set of New York possibilities" (I, 118). This is what makes Milly "*the* thing you were" (I, 136) for with her vast wealth and complete personal freedom she is truly "the heir of all the ages" (xi), with an unparalleled opportunity to encompass in herself all of the past which remains worthwhile.

Aware that the opportunity is hers but that the time is limited, Milly feels the need to grasp quickly the influences of the European cultural heritage. It is ironic that it is this heritage which kills her, but which also completes her in leaving her with an acute awareness. of life, and which she triumphs over in her forgiving generosity to her false lover, because of the hereditary and environmental power of her ethical innocence and goodness.

It is Milly's awareness of what she is that makes her a truly tragic character. She is never blinded by the London she encounters (except in the case of Densher). For, noticing the difference at a dinner party in Lord Mark's attitude toward Kate Croy and herself, Milly reflects that it was Kate, "one of his own species," who made him uncertain. But toward Milly his attitude is confident, for "about a mere little American, a cheap exotic, imported almost wholesale, and whose habitat, with its conditions of climate, growth, and cultivation, its immense profusion but its few varieties and thin development, he was perfectly satisfied" (I, 184). As the product of such an environment, born with every conceivable advantage but without the vigilance which experience usually inspires, Milly can flourish only for a moment's brilliant intensity and then die, knowing that her deceitful lover had been mainly actuated by mercenary motives.

What is most interesting in James's portrayal of Milly Theale's physician, Sir Luke Strett, is that James makes him on the surface a sort of demi-god and quite as much a psychiatrist as he is a physician. Throughout the story Sir Luke acts as the prime dispenser of understanding, sympathy and commands to action. And he is interested on Milly's behalf "in other questions beside the question of what was the matter with her. She accepted such an interest as regular in the highest type of scientific mind—his *being* the even highest, magnificently . . ." (I. 263). In this role, as something of a psychiatrist in the era of Walter Pater, he urges Milly on in the "pursuit of happiness." He tells her, "You've a right to be happy . . . You must accept any form in which happiness may come" (I, 265). Thus, Sir Luke, whom we may take as representing James's ambivalent attitude towards science, plays a strange role: unwittingly, he paves the way for Millie's gullible acceptance of Densher's pretended love, but he also administers "therapy" which may have been a factor in Milly's partial foregiveness of Densher. James appears (judging by his scientist in *Confidence* and *Washington Square)* to have absorbed something of Hawthorne's general view that the scientist has an inadequate insight into the emotional needs of distinctively human beings (cf Beatrice Rappaccini). Thus, James shows that Sir Luke in his prescibed treatment fails to predict that Lord Mark's jealous nature will motivate his telling Milly of the plot of Kate and Densher, and to realize that Milly's being told of Densher's duplicity will kill her. He also does not realize that Kate will lose Densher because of the wings of the dove which have eventually caused Densher to refuse to marry Kate if she keeps Milly's money secured by such duplicity.[13]

The rapid contemporary development of the science of psychology (in which his brother William's pioneering early studies were synthesized in 1890 in his *Principles of Psychology*[14]) influenced James's writing of *The Wings of the Dove*. As we have noted, Henry James is most obviously concerned with the psychological factors of consciousness and motivation. He seldom deals with his

[13] In "Lady Barberina," in a contexture contrasting the idle life of the British aristocracy with that of his hero, an American physician, James says the latter's "repression of pain, the mitigation of misery, constitute surely the noblest profession in the world." But the brilliant *and* cold-hearted Dr. Sloper in *Washington Square* illustrates James's ambivalent attitude toward men of medicine.

[14] "All my life I have . . . unconsciously pragmatized," Henry James wrote William (*Letters*, II, 83). "You are immensely and universally right" in evaluating ideas and conduct in terms of practical consequences as contrasted with Platonic absolutes. Densher fears that his duplicity (eventually brutally revealed to Milly by Lord Mark in his jealousy) will kill Milly in her delicate condition. She should have been more vigilant and pragmatic.

subject directly in an omniscient way; rather, he treats it from different points of view in terms of the varying consciousness of the observers. Thus, when Mrs. Stringham and Milly are introduced, their "more or less associated consciousness . . . " deals "unequally with the next presented fact of the subject" (xxviii), James notes in the preface.

James is even more concerned with the factor of motivation, for he is constantly probing for the "motive still finer" beneath the apparent actions and passions of his characters. The development of Densher and his reasons for becoming involved in such deep duplicity is a masterful study in motivation. Beginning as the son of a chaplain, Densher agrees to Kate's plan. This depends on many subsequent factors including love for Kate, financial needs, and the idealistic belief that his pretending to love Millie will prolong her life.

The influence of science is reflected in much of James's literary theory and practice, for he frequently refers to the "laws" which underly his writing. In developing his plot, James proceeds much after the scientific fashion of a construction-engineer. He describes the "fun" of establishing successive centers so that the portion of the subject commanded by them and accordingly treated from them would constitute "sufficiently solid *blocks* of wrought material, squared to the sharp edge, as to have weight and mass and carrying power; to make for construction, that is, to conduce to effect and to provide for beauty" (xvi). For example, James conceives of Kate Croy as "such a block (xvi). Thus, it is in Kate's consciousness at Milly's party in Venice that the drama is brought to a head, for there Kate "takes the measure of her friend's festival evening, squares itself to the same synthetic firmness as the compact constructional block inserted by the scene at Lancaster Gate" (xxiii).

James feels this scientific method of plot development—of devising blocks of action—is the best: "I have never . . . embraced the logic of any superior process," he says in his preface (xxi). The writer "places," he states, "after an earnest survey, the piers of his bridge—he has at least sounded deep enough, heaven knows, for their brave position; yet the bridge spans the stream, after the fact, in apparently complete independence of these properties, the principal grace of the original design" (xvii). Thus he sees *The Wings of the Dove* as blocks, each governed by a new center, although he deplores his "regular failing to keep the appointed halves of my whole equal." (xxiv).

James's method of describing persons and events through the consciousness of his characters is equally scientific and geometrical. He manipulates their consciousness like high-powered searchlights, revealing with dimensional intensity the elements of his story when they are turned on the object. Thus in the suspenseful final sections, while the center "dwells mainly . . . in the depths of Milly Theale's 'case'" (xxviii), it is through the other characters that actual events are related. In discussing the functional purpose of Milly's party in her Venetian palace, James very clearly describes his scientific and mechanical method of reflecting persons and events. "My registers or 'reflectors,'" he writes, "as I so conveniently name them (burnished indeed as they generally are by the intelligence, the curiosity, the passion, the force of the moment, whatever it be directing them), work . . . in arranged alternation . . ." (xxii). So it is in Venice that Kate Croy is "turned on . . . where the appearances, rich and obscure and portentous . . . as they have by that time become and altogether exquisite as they remain, are treated almost wholly through her vision of them and Densher's" (xxii).

James, then, engineers his scenes around carefully selected centers of consciousness which, in turn, are the determined products of their heredity and environment and which color the scenes in these terms.

His concern with environmental determinism is also reflected in his use of environment as an organic and quite functional background for his story. Mrs. Lowder's home is more than a simple setting for her part in the novel; it *is* Mrs. Lowder, and it gives her a dimensional expression beyond the power of direct descriptions. When Densher visits her he is dismayed by the massive and ostentatious furnishings of her house. He takes in "the message of her massive florid furniture, the immense expression of her signs and symbols . . ." (I, 85). He feels the "language of the house itself" speak to him, "writing out . . . the ideals and possibilities of the mistress. Never, he flattered himself, had he seen anything so . . . ugly—operatively, ominously so cruel" (I, 87). In Venice, when Lord Mark tells Milly of Densher's duplicity and Milly "turns her face to the wall," the weather immediately reflects the psychological climate. The sunny days end and the city becomes " a Venice all of evil . . . . A Venice of cold lashing rain . . . of general arrest and interruption, with the people engaged in all the water-life huddled, stranded and wageless, bored and cynical, under archways and bridges" (II, 283). With the arrival of Sir Luke and with Milly's psychological improvement, the weather changes and comes "into its own again" with "a suffusion of bright sound that was one with the bright color . . ." (II, 320).

In summary, it seems apparent that James's interpretation of life in *The Wings of the Dove*, as imaged in the destructive aspects at least, is parallel in many ways to the ideas associated with the science of James's era. These ideas certainly mesh with his concept of the social struggle for existence which underlies his presentation of English society in Kate Croy, "the modern London girl," in contrast with the American Milly Theale. The same parallel to current science is also evident in James's concern with partially[15] explaining conduct in the light of heredity and environment, and in his ambivalent attitude toward Milly's physician-psychiatrist, Sir Luke Strett. Finally, James's concern with motivation, presented in all its complexity, and his psychological concern with "centers of consciousness" and other practices of literary artistry and formal proportioning[16] also parallel current ideas in science. A reading of the novel in these terms seems to make most potent the significance of the struggle for existence which James is depicting, for the unscrupulous world over which Milly must triumph is most terrifying in its determined animalistic aspects.

One must finally recognize, of course, that in *The Wings of the Dove* the struggle for existence in terms of money-getting and grasping for happiness in the face of disease which medical science cannot cure is counter-balanced by an anti-materialistic idealism. Thus, Milly's ultimate victory over Kate's predatory spirit is the more triumphant for its non-materialistic, ethical and moral basis. Several students of James have concluded that the common denominator of the climaxes in his major fictional works involves a free-willed renunciation of something of price for something priceless, especially for one's self-respect.

While James never joined any sectarian religious group, it has been said that he develops his favorite characters as if they were approaching a religious state of grace after an initiation which had warned them that they should have been more vigilant of the world's evils of a naturalistic kind. The very title phrase, "The Wings of the Dove," from Psalm 55 suggests that Milly, after learning how she had been betrayed, might have yearned for the "wings of the dove" in order to escape from the city of deceit and fly from those who pretended to be her friends.[17]

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[15] For a discriminating discussion of this question, see Arnold Goldsmith, "Henry James's Reconciliation of Free Will and Fatalism," *Nineteenth Century Fiction* XIII (Sept., 1958), 109–126, a discussion condensed from his doctoral dissertation written at the University of Wisconsin.

[16] In addition to James's regret that this novel, unlike *The Ambassadors,* is not limited to having all the action refracted through only one unifying "centre of consciousness," he deplores (in his *Letters,* 1920, I, 403) the fact that "The centre . . . isn't in the middle, or the middle, rather, isn't in the centre but ever so much too near the end, so that what was to come after it is truncated." For a discriminating analysis of such formal matters, see Joseph Warren Beach's *The Method of Henry James* (New Haven, 1918).

[17] See also the subtle study of Ernest Sandeen, "*The Wings of the Dove* and *The Portrait of a Lady*", *PMLA* LXIX (Dec., 1954), 1060–75.

Another strong influence on James was the semi-platonic Emerson, the spokesman of a spiritual self-reliance. Emerson distinguished sharply between the "law for man" and the "law for thing" (materialism). And James, who wrote three appreciative essays on him, concluded that Emerson, while prone to have a too "ripe unconsciousness of evil," was right in seeing that "the prize was within." Of course James's devotion to George Eliot (on whom he wrote five essays) and other Victorians such as Arnold would also have militated against the materialism of the English upper class. Such materialism struck him "in many ways very much the same rotten and collapsible one as that of the French aristocracy before the revolution—minus cleverness and conversation."[18]

Whatever the sources, the great renunciation scene at the end of *The Wings of the Dove* in which the chaplain's son "won't touch the money" and will not marry Kate unless she too gives it up, is beautifully moving evidence that, fully as James realized the parallels to Darwinism in the socialite life of his time, he also paid homage to the need for the protective and contagious power of ethical innocence and goodness.[19]

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[18] *Letters,* I, 124.

[19] In the latest book-length study of Henry James, *The Madness of Art* (Lincoln, Nebraska, 1962, p. 55–56) Walter F. Wright follows his predecessors in scarcely mentioning social Darwinism. But he does show insight in finding a recurrence "in novel after novel" of two conflicting commandments. "The one commandment was 'Live all you can!' The other was 'Renounce, renounce!' The symbol of the first was often Europe; of the second, America, and particularly puritan New England. We should hasten to say that we are speaking only of those instances in which the geographic terms were used as symbols."

HENRY JAMES: A SENTIMENTAL TOURIST AND RESTLESS ANALYST

Donald Emerson

Henry James wrote accounts of travel over nearly forty years. In the rage of anthologizing which has rescued from magazines even his earliest uncollected accounts, critical attention has dwelt heavily on James's report of what he saw. The more interesting subject, however, is James himself, for the travel literature powerfully confirms James's realization that he was exclusively, for whatever vivid or deficient reactions the fact might involve, a man of imagination. Thus the travel accounts add striking brush-strokes to the self-portrait which he sketched in his notebooks, letters, and criticism, as well as in more forthright self-revelations.

In the autobiography written in his last years, he recalled himself as a small boy always dawdling and gaping, and saw in that memory the very pattern of his always wanting "just to *be* somewhere . . . and somehow receive an impression." He remembered feeling that to stop looking would be to take a long step towards not living at all. When in his twenties he began writing travel sketches, he made picturesque contrasts, impressions, and sketchable details one of his constant subjects. His other chief subject is the reaction of his powerful imagination, which at first outran actual experience and later suffered correction.

For at first he yielded to a tendency to "make images in advance." As a youthful "sentimental tourist" he gave Saratoga in anticipation "a shape and figure . . . a certain complexion, a certain colour." When he found the place different from the construction of his imagination, he acknowledged that his unsophisticated visions gained by their transmutation into fact. "There is an essential indignity in indefiniteness," he acknowledged; "you cannot allow for accidents and details until you have seen them. They give more to the imagination than they receive from it."[1] The Saratoga of reality proved more satisfactory than the "all-too-primitive Elysium" he had constructed in advance. But three years later, in the Roman church of Santa Maria Maggiore, he reflected that his

* Paper read at the 93rd annual meeting of the Wisconsin Academy of Sciences, Arts, and Letters.

[1] *Portraits of Places* (London, 1883), p. 324 f.

"perfect feast of fancy" was largely the product of his "capricious intellect."[2] Over the years, James found that in the realm of travel experience "the virtue of the business" rested more in what he brought by imagination than in what he took by observation.

The travel accounts express James's reaction to acts of possession. He had seen Europe in childhood and received part of his education there, but when he returned in 1869 he went to seize it. He wrote of his experience then and later, but even after forty-five years, in his final recollection of the experience, he expressed nothing so keenly as his avidity for impressions and the complexity of his imaginative response.

England and Italy held the greatest charm for him, and after them, France; the Low Countries, Switzerland, and Germany had lesser appeals. He never saw more of Spain than San Sebastian, and never attained his wish to visit Greece. He longed vaguely for the East, but he had scant interest in remote parts of the world. He wrote most interestingly of his own country after twenty years of absence had given him an eagerness to penetrate mysteries much like the receptiveness with which he had approached Europe in his youth.

The collected travel accounts are more or less connected series of essays arranged to give the impression of continuous tours. James generally attempts to compose his details into a pleasing pictorial account of the places he visited.[3] He evolved a casual, easy, and graceful style for his travel pieces, and cultivated a cosmopolitan urbanity of tone. This is the manner of the "sentimental tourist." The "restless analyst" who much later wrote *The American Scene* speaks with a different voice.

James seldom muses on scenery. Even as a small boy he was "positively conscious" that the social scene would say more to him than anything else, and it was the human note he wanted, even among impressions of nature. In Switzerland he found that there was "a limit to the satisfaction with which you can sit staring at a mountain," and he preferred "the more equal intercourse between man and man."[4] In the placid English countryside he found his chief delight in the human associations of a scene in which "every-

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[2] *Transatlantic Sketches* (Boston, 1875), p. 125 f.

[3] He criticized Stendhal for failing to do this, noting that Stendhal ". . . is never pictorial . . . he never by any chance makes an image . . . his want of appreciation of the picturesque—want of the sketcher's sense—causes him to miss half the charm of a landscape." *A Little Tour in France* (Boston, 1900), p. 220 f. Gautier, on the other hand, seemed to James "the prince of travellers" because he simply looked and enjoyed, and his fancy was always on the alert. Unsigned review of Theophile Gautier's *A Winter in Russia*, *Nation*, XIX (Nov. 12, 1874), p. 321.

[4] *Transatlantic Sketches*, p. 36

thing . . . has a history, has played a part, has a value to the imagination."[5]

His human associations with natural scenes were frequently drawn from history and literature. At Poitiers, for example, he could look out from the Promenade de Blossac, through uncertain whether he was regarding the actual battlefield, and lose himself in reflections and associations. In Warwickshire, he peopled the landscape with characters from Trollope, and regarded his doing so as an example of the way Americans must bring imagination into play in the presence of English life.[6] He complained that the American scene was deficient in the poetry of association, whether from history or literature,[7] and by contrast cited the way in which the Roman scene provided an unbroken continuity of impressions at once "historic, literary, and suggestive."[8]

What James termed his "historic imagination" is actually a sentimental attachment to a sense of the past. He was almost entirely deficient in the sense of history, so far as that involved understanding of the motives and values of other times. He cared little for accuracy; his having a subjective impression was quite enough. His reflections on the battlefield of Poitiers sufficiently indicate the type of reaction he repeatedly experienced.

> It is carrying the feeling of race to quite inscrutable lengths when a vague American permits himself an emotion because more than five centuries ago, on French soil, one rapacious Frenchman got the better of another. Edward was a Frenchman as well as John, and French were the cries that urged each of the hosts to the fight. French is the beautiful motto graven round the image of the Black Prince as he lies forever at rest in the choir of Canterbury: *a la morte ne pensai-je mye*. Nevertheless, the victory of Poitiers declines to lose itself in these considerations; the sense of it is part of our heritage, the joy of it a part of our imagination, and it filters down through the centuries and migrations till it titillates a New Yorker who forgets in his elation that he happens at that moment to be enjoying the hospitality of France. It was something done, I know not how justly, for England; and what was done in the fourteenth century for England was done also for New York.[9]

In like fashion, the Citadel at Quebec evoked for James an image of the English past, as the Chateau d'Amboise recalled the French wars of religion.

In the same way that literary reference added interest to natural scenery, it created at times the very appeal of a church or a city. In the Cathedral at Tours, James found that the "profane name of Balzac" added an interest to the venerable sanctuary, and he wrote

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5 *Portraits of Places,* p. 271.
6 *Ibid.,* p. 256.
7 *Hawthorne* (New York, 1887), p. 12.
8 *Transatlantic Sketches,* p. 153.
9 *A Little Tour in France,* p. 164 f.

rather more of Balzac's novel, *The Cure of Tours*, than he did of the church. In the end he went in search of the house of one of Balzac's characters.[10] At Angoulême he found the chief interest of the town in the fact that Balzac's *Lost Illusions* had "placed" the characters of the fiction there for him. He even congratulated himself that those personages were more real than mere historic individuals, and successfully avoided the "vagueness of identity" that was the misfortune of historical characters.[11]

As for the suggestive—so far as it may be distinguished from what James regarded as the literary or the historic—it was an essence he frequently detected. He felt that "a general impression of the past" was the chief thing Siena had to offer a casual observer. In summing up his reactions to the Boboli Gardens of Florence, with the view of the Pitti Palace which recalled to him the generations of the Medici who had lived there, he defined at once what the past furnished him in Europe and what he missed in America. "What remains . . . now is a mere tone in the air, a vague expression in things, a hint to the questioning fancy. Call it much or little, this is the interest of old places."[12] It could even evoke the ghosts of the past. At Haddon Hall in the growing dusk James felt that if there had been a ghost on the premises he would have seen it, and decided afterwards that he had. "I did see it, as we see ghosts nowadays. I felt the incommunicable spirit of the scene with an almost painful intensity. The old life, the old manners, the old figures seemed present again."[13]

There were times when he felt a strong reaction in favor of the actual, but this mood was infrequent, and James habitually valued places and scenes in proportion as they carried a weight of association or suggestion, a value for the imagination. Calculated ceremony had little charm for him; he absented himself from London during the celebration of Victoria's jubilee. He preferred the leisurely, individual impression, and he gave advice on the best hours for avoiding crowds.

It is typical of James that his reactions to places should frequently depend on childhood impressions. Nothing in all the travel writing is more charming than his account of an excursion to Greenwich:

> It is doubtless owing to the habit of obtrusive and unprofitable reverie that the sentimental tourist thinks it very fine to see the Greenwich observatory lifting its two modest little brick towers. The sight of this useful edifice gave me an amount of pleasure which may at first seem un-

[10] *Ibid.*, p. 16.
[11] *Ibid.*, p. 166.
[12] *Transatlantic Sketches*, p. 256.
[13] *Ibid.*, p. 26.

> reasonable. The reason was, simply, that I used to see it as a child, in woodcuts, in school-geographies, in the corners of large maps which had a glazed, sallow surface, and which were suspended in unexpected places, in dark halls and behind doors. The maps were hung so high that my eyes could reach only to the lower corners, and these corners usually contained a print of a strange looking house, standing among trees upon a grassy bank that swept down before it with the most engaging steepness. I used always to think that it must be an immense pleasure to hurl one's self down this curving precipice. Close at hand was usually something printed about something being at such and such a number of degrees 'east of Greenwich.' Why east of Greenwich? The vague wonder that the childish mind felt on this point gave the place a mysterious importance, and seemed to put it into relation with the difficult and fascinating parts of geography—the countries of unintentional outline and the lonely-looking pages of the atlas. Yet there it stood the other day, the precise point from which the great globe is measured; there was the plain little facade with the old-fashioned cupolas; there was the bank on which it would be so delightful not to be able to stop running. It made me feel terribly old to find that I was not even tempted to begin.[14]

To such experience as this more is brought than is ever taken; it is in fact memories and associations that make the experience itself.

The most sentimental tourist, however, cannot foverver continue at the active pitch. In one ancient city on a hill-top, James found that his imagination refused to project into the dark old town "that sympathetic glow which forms half the substance of . . . genial impressions."[15] He recognized, too, the fact that observation of foreign lands is at best extremely superficial. At times he questioned the value of travel at all, if it meant leaving home only to see new forms of human suffering. There were moods of reaction against "beautiful useless things," though James reflected that the healthier state of mind was to allow time for intelligence to "make . . . its connections."[16]

At the end of his first visit to Rome in the early 1870's he departed with the "insistent faith" that his gathered impressions would "emerge into vivid relief if life or art should demand them." His art demanded a good many of them, and they emerged with sufficient vividness when he had had time to "make connections"; but he never mistook them for insights into the real life of Italy. England was another matter; it was never "foreign" to him, like Italy and France. After he settled in England he discarded the manners of the tourist and the relaxed enjoyment of impressions, for in England he was accepted into society, and he took his effort of understanding seriously. And within England, London provided a "banquet of initiation" which prolonged itself for years, until

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[14] *Portraits of Places,* p. 221 f.

[15] *Transatlantic Sketches,* p. 290.

[16] *Ibid.,* p. 287.

James felt that it had fed his intelligence more than any other source.[17]

In all James's accounts of travel before the turn of the century his imaginative experience forms the substance of the essays. He does not report, guide-book fashion, what is to be seen, but presents the experience of his own visit, with all its personal, imaginative accompaniments. This is the method of the sentimental tourist, as he frequently styled himself. But his interest in travel accounts dedeclined as the freshness of impression which prompted them gave way to accumulated impressions that nourished his fiction.

When James returned to America in 1904 after an absence of twenty years and reported his journey in *The American Scene* (1907), he considered himself now a "restless analyst," capable of criticism as he had not been in Europe. There is some irony to this delusion, for *The American Scene* differs from the earlier travel essays chiefly in the even greater quantity of what James "brings" and the richer and fuller notation of what he "takes." Like all the travel accounts, it is primarily a record of imaginative experience, now raised to a pitch which James exceeds only in his autobiography. But by an enrichment of irony, James actually does succeed in penetrating further into the American scene than the European by the very intensity of his entire reliance on impressions.

For one thing, expatriation had now made it possible for his imagination to respond to America as it could no more react to Europe. European complexity had become for him usual and calculable, while "with his relaxed curiosity reviving and his limp imagination once more on the stretch" James could now find "romance and mystery—in other words the *amusement* of interest," in America.[18] He had always valued the intensity of first impressions; he found now that they were accompanied by trains of association that receded to the dimness of his extreme youth. This struck him as a great advantage; besides the freshness of the inquiring stranger he had also, he felt, the acuteness of the initiated native; he was convinced he would vibrate with more curiosity than the most earnest of foreign visitors.

He was fully aware that he was incapable of providing information on "immensities of size and space, of trade and traffic, of organization, political, educational, economic." He would have nothing to do with statistics; his record would speak only of his personal adventure. "I would take my stand," he declared, "on my gathered impressions, since it was all for them, and for them only, that I returned; I would in fact go to the stake for them."[19] Direct

[17] *The Middle Years* (New York, 1917), p. 60.
[18] *The American Scene* (New York, 1907), p. 351.
[19] *Ibid.*, p. v.

perceptions, enriched by James's lifelong concern for the human subject and his "rage for connections," make up the substance of *The American Scene*. When repeatedly James discovered that his vivid impressions had emerged out of elements insufficient to account for them, he positively congratulated himself that he was not a journalist dependent on items.

Again and again he found his subject so thin as to require more of the imagination than it offered it. When he felt that the history he encountered was neither very stout nor the rarities of nature very rare, he confessed his need to be "shamelessly subjective" about both. This involved him in a problem of notation, for he found that a little of all his impressions was reflected in each of them. To detach or reject one was to mutilate or falsify the others, for the history of a given impression often resided in those which led up to it or accompanied it. This explains the density of James's notation, which for years was held to make *The American Scene* a curiosity of literature.

The American scene was for him primarily the American social scene. The "great lonely land" actually depressed him with its vastness. Nature in America seemed to him unfinished, as society was as yet unformed. During a twilight journey on Lake Worth, where palms silhouetted in the sunset made him think of the Nile, it seemed to him that the American lake was the greater antiquity—it was "*previous*" to everything.[20]

Even at best the historic impress on America appeared to James slight, and he repeatedly felt the necessity of "reading into" his American subjects before they could give out interest. He even created interest out of the blankness itself, as when he visited Richmond. That he felt justified in his method is evident from his definition of history, made at a moment when the triviality of his subject, though he made it the source of rich subjective experience, tempted him almost to apologize. He restrained the impulse, and drew courage from his reflection that "History is never, in any rich sense, the immediate crudity of what 'happens,' but the much finer complexity of what we read into it and think of in connection with it."[21]

This is precisely the "shameless subjectivism" of James's responses turned to aspects of the past, though prompted by the individual report of the immediate experience. Its interest lies in the observer, who must indeed be ready to go to the stake for his impressions, for he has almost nothing else. James felt, for ex-

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[20] *The American Scene,* ed. W. H. Auden (New York, 1946), p. 465. This passage was omitted from the original American edition.

[21] *The American Scene* (New York, 1907), p. 177.

ample, that any report of Independence Hall which he might make could be "news" only so far as it was news of himself; in that character it could pretend to freshness, even brilliance. He found that "every fact was convertible into a fancy," and that trivial events could again and again renew his appreciation of "the mystery and marvel of experience" by which small externals prompted an enormous inner enrichment. He felt nothing was more wonderful than the quantity of significant character a well-guided imagination could recognize in the scantest group of features, objects, or persons.[22] There were subjects, however, to which it failed utterly to respond; mere promiscuous encounter never alone evoked interest for James where he felt none or where, as with Wall Street, he was simply baffled.

James's account of America has the weakness of its omissions, but also the coherence of its consistent subjectivism. This was all, James felt, that it could very well have, for even to the most restless of analysts conclusions were impossible. The "great inscrutable answer to questions" hung in the vast American sky, to his imagination, as "something fantastic and *abracadabrant*" which would become legible only with time.[23] Meanwhile he noted the absence of social forms, the terrible impermanence of things in the face of money-making possibilities, the rampant commercialism, and the childishness of a society confident of its safety in an absence alike of doubts or convictions.

Though he spoke for himself in declaring that the unsatisfied wants of the spirit must be met somehow, and revealed himself, in his shameless subjectivism, busily knocking together substitutes, he discovered at last that the country at large was also knocking together, somehow, substitutes for an appetite very like his own.

> . . . the human imagination absolutely declines everywhere to go to sleep without some apology at least for a supper. The collective consciousness, in however empty an air, gasps for a relation, as intimate as possible, to something superior, something as central as possible, from which it may more or less have proceeded and round which its life may revolve—and its dim desire is always, I think, to do it justice, that this object or presence shall have had as much as possible of an heroic or romantic association. But the difficulty is that in these later times . . . the heroic or romantic elements . . . have been all too tragically obscure . . . so that the central something . . . has had to be extemporized rather pitifully after the fact, and made to consist of the biggest hotel or the biggest common school, the biggest factory, the biggest newspaper office, or, for climax of desperation, the house of the biggest billionaire. These are the values resorted to in default of higher, for with *some* colored rag or other the general imagination, snatching its chance, must dress its doll.[24]

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[22] *Ibid.*, pp. 277, 65, 380.
[23] *Ibid.*, p. 118.
[24] *Ibid.*, p. 279.

Dressing its doll seemed to James also an explanation for the great American artistic activity of "faking." The prevalence of it confirmed his view of the childish explanation of American society, for the public which could respond to the arts of fakery seemed to him "quite incalculably young."[25]

The American Scene is James's most coherent attempt to give an account of a society. In becoming the restless analyst, the whilom sentimental tourist approached his subject with a mature preceptiveness more penetrating than his youthful enthusiasm. But really, he did nothing but what he had always done. He lived by his imagination and cultivated impressions. Sentimental or analytical, James the tourist was consistent; his sentiments and his analysis alike depended upon the responses of a powerful imagination which ever, in its experiences, brought more than it took. The travel essays thus complement James's account of himself as a man of imagination. They are even proof that he could be nothing else.

[25] *Ibid.*, p. 440.

USE OF OTOLITHS TO DETERMINE LENGHTH AND WEIGHT OF ANCIENT FRESHWATER DRUM IN THE LAKE WINNEBAGO AREA

Gordon R. Priegel

The freshwater drum, *Aplodinotus grunniens* Rafinesque is an abundant, native fish species found in Lake Winnebago. Although much information is available concerning the current length-weight relationships of the drum, information is completely lacking on the size of the drum during aboriginal times.

This study was initiated to determine if there was any difference in drum length and weight during aboriginal times when the drum population was relatively unexploited and during present times when the drum population is exploited greatly by commercial fishing (Priegel, 1961).

Otoliths from drum have been found in the middens or cooking ruins of Indians who dwelled in the Winnebago area. Since there is a proportionate relationship between fish size and otolith size, as will be shown later, it was reasoned that aboriginal otoliths because of their non-deteriorated structure could be used to reconstruct a comparative size structure value for aboriginal drum. Witt (1960) demonstrated that there was a proportionate relationship between drum length and otolith length for drum collected from the Mississippi River.

In the fishes the otoliths are called sagitta in the sacculus, asteriscus in the lagena, and lapillus in the utriculus. In nearly all fishes the sagitta is the largest otolith and is the one used in this study. Otoliths have enameled surfaces etched with markings and peculiar grooves for passage of the fluids found in the inner ear. Because of distinctive shapes and markings, otoliths can be used to identify fish, and with their enamel surfaces, a skeletal structure is available that is usually well preserved and intact making it an ideal structure for comparison with similar structures of present-day fishes.

Methods and Material

During the summer of 1959, freshwater drum otoliths were collected from Lake Winnebago. Otoliths were obtained from 983 drum which ranged in total length from 0.5–29.5 inches. The otoliths were air dried for two months, weighed to the milligram, and their length measured to the tenth of an millimeter.

Aboriginal otoliths were obtained from three Indian Sites in Winnebago County, Wisconsin. The Oshkosh Public Museum and the Illinois State Museum were the source of 28 otoliths from the Bell Site which is located on the Bell farm along the south shore of Big Lake Butte des Morts (Horton, pers. comm.). This site was used between the early and mid-eighteenth century for approximately 50 years. At the Bell Site, 100 peculiar bell-shaped fire pits, 2 to 4 feet in diameter, were located. The otoliths from this site considering their age, are extremely well preserved.

Fifty-three otoliths from the McCauley Campsite were obtained at the Milwaukee Public Museum. The McCauley Site is located on the Jennie McCauley property, Lake Drive, in the city of Oshkosh, which is located on the west shore of Lake Winnebago (Kannenberg, 1932). These otoliths are associated with the upper Mississippi Culture and are estimated to date from 500–1750 A.D. The otoliths were well preserved.

The Oshkosh Public Museum was also the source of 160 additional otoliths from the Lesley Point Site which is located on the east shore of Lake Winneconne, one mile north of the Village of Winneconne. The site was used by the Winnebago aboriginals around 1600 A.D. and represents a large village (Bullock, 1940 and 1942). These otoliths were also extremely well preserved.

Results

The recent drum collection was arranged into one-half inch groups and corresponding average otolith lengths were determined for all otoliths (right and left) in each group (Table 1). After average body length in millimeters was determined for each group, a curve was fitted to these data (Figure 1) and the relationship between otolith length and body length of the drum can be described by the equation: $BL = -37.77 + 28.26\ OL$, where $BL =$ Body length in millimeters and $OL =$ otolith length in millimeters. This relationship can be used to estimate the length of aboriginal drum when otolith length is known.

Witt (1960) obtained a relationship between otolith length and body length of the drum from the Mississippi River and can be described by the equation: $BL = -70.3253 + 29.8974\ OL$.

Corresponding average otolith weights were determined for each half-inch group and an empirical curve showing the relationship between otolith weight and body length was plotted, but no relationship was calculated due to the wide variation in otolith weight of drum over 4 inches. This variation increased as body length increased. A wide variation existed if average weights were used for all otoliths in a given group or if only the average weights of the right or left otoliths in a given group were used. A lack of or excessive amounts of calcium deposits on the otoliths due to faster or slower growing individuals is probably responsible for the wide weight variation in the otoliths. Witt (1960) obtained a body length and otolith weight relationship for drum collected from the Mississippi River at Hannibal, Missouri, and is described: $\text{Log OW} = -3.1286 + 2.3534 \text{ Log BL}$, where OW = otolith weight and BL = body length, but he also found wide variation in otolith weight for larger drum.

The body length-weight relationship (Figure 2) was calculated for the recent drum from a sample of 923 drum taken on October 27–28, 1959, while trawling with a 12-foot bait trawl in pelagic areas of Lake Winnebago, and is described as: $\text{Log W} = -5.17129 + 3.10600 \text{ Log L}$, where Log W = weight in grams and Log L = total length in millimeters (Priegel, 1961).

With the above relationship established, lengths of otoliths from aboriginal drum can thus be substituted into the predetermined otolith length-body length equation and the calculated length of aboriginal drum can be obtained. This length can then be substituted into the length-weight equation and the weight of aboriginal drum can be estimated.

The size of recent and aboriginal drum was compared by the calculated lengths and weights of the aboriginal drum and actual lengths and weights of recent drum. Eroded aboriginal otoliths were not used since this would lead to under-estimates of body length and weight. Either the left or right otolith can be used in the otolith length-body length equation since the average difference in length for left and right side otoliths in each half-inch group did not vary more than one-tenth of a millimeter until the 23.5–23.9 inch-group where a difference of two-tenths of a millimeter existed (Table 1).

Discussion

Aboriginal otoliths collected from known campfire sites should only be used to determine length and weight of aboriginal drum common to the area. Otoliths used in this study were obtained from three different sites: Bell, McCauley, and Lasley Point Sites. The Bell Site was a fire pit area while the McCauley and Lesley Point Sites were village sites. Some of the otoliths from the Lasley Point Site were dark blue to black in color and this indicates a prolong stay in hot ashes which most likely means cooking fires. If aboriginal otoliths are obtained from sources other than known campfire sites, this may indicate that the drum otoliths were used for ornaments or money rather than only for their food value. Niehoff (1952) describes five aboriginal otoliths found in Wisconsin that were perforated at two points, indicating that they were strung, probably either for a necklace or a bracelet. Hubbs (in litt.) related the occurrence of aboriginal drum otoliths found in Utah in which region drum at the time were not native. These otoliths must certainly have been carried as some sort of trinket or wampum. If otoliths were sought only for ornaments or money, the tendency would probably be to acquire larger size otoliths which would be of more value, but would no doubt lead to an overestimate of aboriginal drum size when comparing them to present day drum.

The length frequency distribution of aboriginal otoliths from the three sites are very similar (Figure 3) and their calculated body length and weight ranges and means are very similar (Table 2). This would indicate that the drum were primarily taken for the same purpose (food), that similar selective fishing methods were employed, or that similar environmental conditions existed.

The mean length of 13.9 inches for present day drum from Lake Winnebago, is smaller than the mean lengths of drum from the aboriginal sites: Bell Site, 18.3 inches, McCauley Site, 18.6 inches; and Lasley Point Site, 18.1 inches. The drum length ranges indicate that the aboriginal Indians did not take many drum under 10 inches.

The fishing methods employed by the aboriginals during their use of the Bell, McCauley, and Lasley Point Sites would certainly allow the aboriginals to capture both large and small fish. Driver (1961) wrote that the aboriginals captured fish by every method known to modern commercial fishermen: weirs, traps, nets, spears, hooks, poison, arrows, snares, and rakes. Kuhm (1926) stated that much of the food supply of the early Wisconsin Indian consisted of fish so it seems likely that they would employ and develop numerous methods of capturing fish.

The smaller size of recent drum in Lake Winnebago is probably due to a combination of factors. Water pollution by industries and municipalities, and runoff over fertile soils as agriculture became important in the watershed, had much to do to increase the fertility of Lake Winnebago, thus making the lake a more favorable environment for the drum, but at the same time, creating a situation that led to a slow-growing population due to little or no exploitation until 1954, when an intensive removal program began. Hubbs and Lagler (1949) state that the drum occurs generally in large rivers and lakes, usually in silty waters. Lake Winnebago, because of its size (137,708 acres) and rectangular shape (28 miles long and 10.5 miles wide at its widest point) is continuously affected by wave action that prohibits aquatic plant growth and encourage turbid water. Profuse algal growth especially during the summer, keeps the water turbid, a situation preferred by the drum.

The sizes of fishes during aboriginal times are of value to ichthyologists and fishery biologists, but their sizes are poorly known. To estimate the size of fishes during aboriginal times, a skeletal structure must be well preserved and it must be possible to relate the size of this structure to the size of the same structure and to the size of present day fishes. The otolith in this study was well suited to estimate the size of aboriginal drum in the Lake Winnebago area.

TABLE 1. AVERAGE LENGTHS AND RANGES IN MILLIMETERS OF OTOLITHS FROM 983 FRESHWATER DRUM TAKEN FROM LAKE WINNEBAGO, 1959

LENGTH INTERVAL OF DRUM	NUMBER OF DRUM	RIGHT OTOLITH		LEFT OTOLITH	
		Range (mm)	Average (mm)	Range (mm)	Average (mm)
0.5– 0.9	13	0.6– 1.2	0.9	0.6– 1.2	0.9
1.0– 1.4	23	1.2– 2.2	1.6	1.2– 2.0	1.5
1–5– 1.9	24	2.0– 2.7	2.4	2.0– 2.7	2.4
2.0– 2.4	23	2.6– 3.2	2.9	2.6– 3.1	2.9
2.5– 2.9	13	3.1– 3.7	3.4	3.1– 3.7	3.4
3.0– 3.4	23	3.6– 4.2	3.9	3.7– 4.4	4.0
3.5– 3.9	16	4.1– 4.8	4.5	4.2– 4.8	4.5
4.0– 4.4	22	4.9– 5.8	5.2	4.7– 5.8	5.1
4.5– 4.9	23	5.6– 6.2	5.9	4.6– 6.2	5.8
5.0– 5.4	20	5.8– 6.7	6.3	5.8– 7.0	6.3
5.5– 5.9	20	6.3– 6.9	6.5	6.3– 6.9	6.6
6.0– 6.4	23	6.4– 7.5	6.9	6.7– 7.5	7.0
6.5– 6.9	24	6.7– 7.9	7.3	6.8– 7.9	7.3
7.0– 7.4	23	7.6– 8.9	7.9	7.7– 8.8	7.9
7.5– 7.9	22	7.8– 8.8	8.2	7.9– 8.9	8.3
8.0– 8.4	24	7.9– 9.0	8.5	7.7– 9.2	8.6
8.5– 8.9	22	8.2– 9.6	8.9	8.2– 9.7	9.0
9.0– 9.4	25	8.6–10.5	9.5	9.0–10.2	9.5
9.5– 9.9	19	9.3–10.2	9.8	9.4–10.2	9.9
10.0–10.4	25	10.2–11.0	10.6	10.0–11.0	10.6
10.5–10.9	25	10.1–11.7	11.0	10.2–11.9	11.0
11.0–11.4	25	10.8–12.4	11.5	10.8–12.6	11.5
11.5–11.9	25	11.2–12.8	11.9	11.2–12.7	11.9
12.0–12.4	25	11.9–13.5	12.7	11.9–13.6	12.6
12.5–12.9	23	12.3–14.0	13.2	12.1–14.0	13.1
13.0–13.4	25	12.5–15.3	13.8	11.9–15.3	13.7
13.5–13.9	25	13.1–16.3	14.4	13.0–16.1	14.3
14.0–14.4	25	13.4–16.0	15.1	13.6–16.4	15.1
14.5–14.9	25	14.2–16.9	15.8	14.2–16.7	15.7
15.0–15.4	25	15.1–17.5	16.1	15.1–17.5	16.1
15.5–15.9	25	15.0–17.3	15.9	15.1–17.4	16.0
16.0–16.4	25	15.4–17.9	16.5	15.1–17.9	16.5
16.5–16.9	25	15.8–18.7	17.2	16.2–18.6	17.1
17.0–17.4	25	16.4–19.0	17.5	16.0–19.1	17.6
17.5–17.9	25	16.0–20.2	17.8	15.8–20.3	17.8
18.0–18.4	25	16.6–20.0	18.2	16.4–19.9	18.3
18.5–18.9	25	16.5–19.7	18.2	16.5–19.7	18.2
19.0–19.4	24	17.1–21.1	19.1	17.3–20.8	19.2
19.5–19.9	23	17.6–20.4	19.0	17.5–20.8	19.1
20.0–20.4	14	18.3–20.6	19.3	18.1–20.6	19.3
20.5–20.9	20	18.4–22.5	20.1	18.3–23.0	20.1
21.0–21.4	17	19.1–21.9	20.3	19.3–22.1	20.3
21.5–21.9	10	19.2–22.1	20.4	19.1–22.3	20.4
22.0–22.4	7	20.3–22.4	21.5	19.9–22.5	21.4
22.5–22.9	2	21.2–21.4	21.3	21.0–21.4	21.2
23.0–23.4	4	21.3–23.0	21.9	21.5–22.7	22.0
23.5–23.9	2	21.7–22.7	22.2	21.7–23.0	22.4
24.0–24.5	4	20.8–24.5	22.6	21.0–23.5	22.3
26.0–26.4	2	23.3–24.4	23.9	23.3–24.4	23.9
26.5–26.9	2	23.7–24.8	24.2	22.7–24.9	23.8
27.5–27.9	1		26.2		26.0
29.5–29.9	1		25.0		25.0

FIGURE 1. Relationship between otolith length and fish length. Broken line equals empirical variation of otolith length.

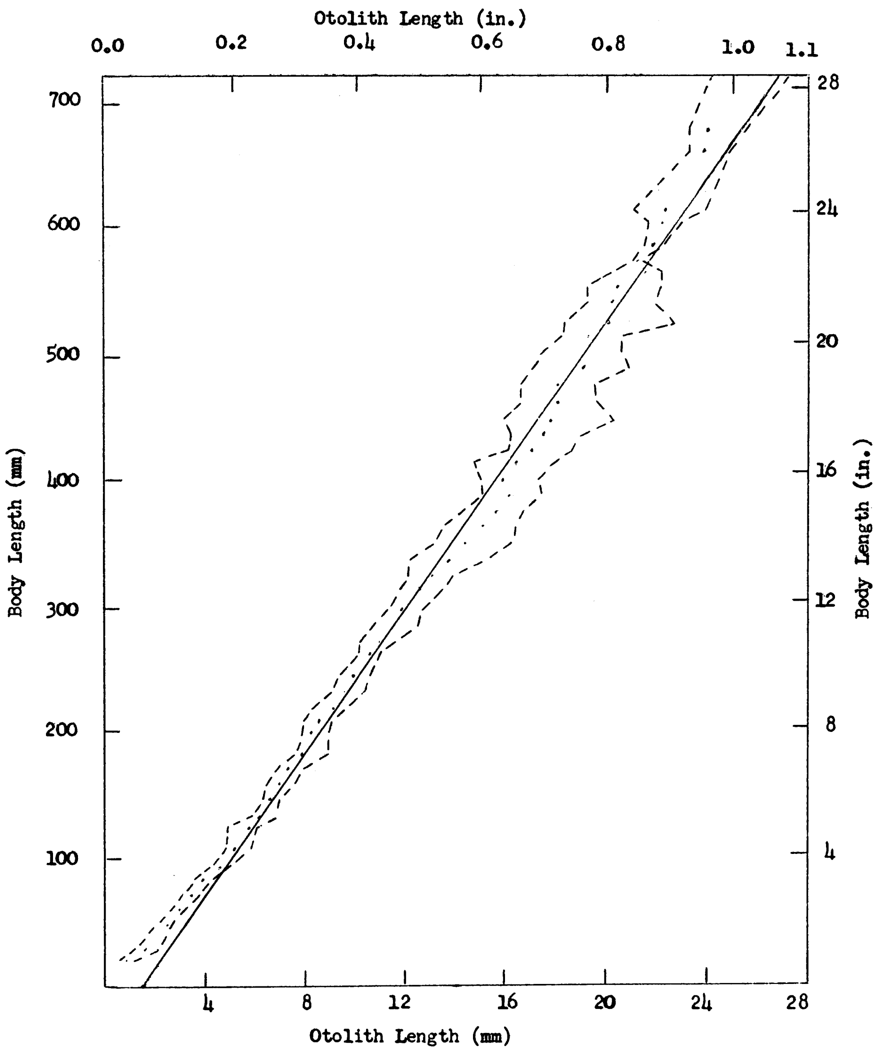

FIGURE 2. Length-weight relation of freshwater drum. The smooth curve represents the calculated weights and the dots represent the empirical weights.

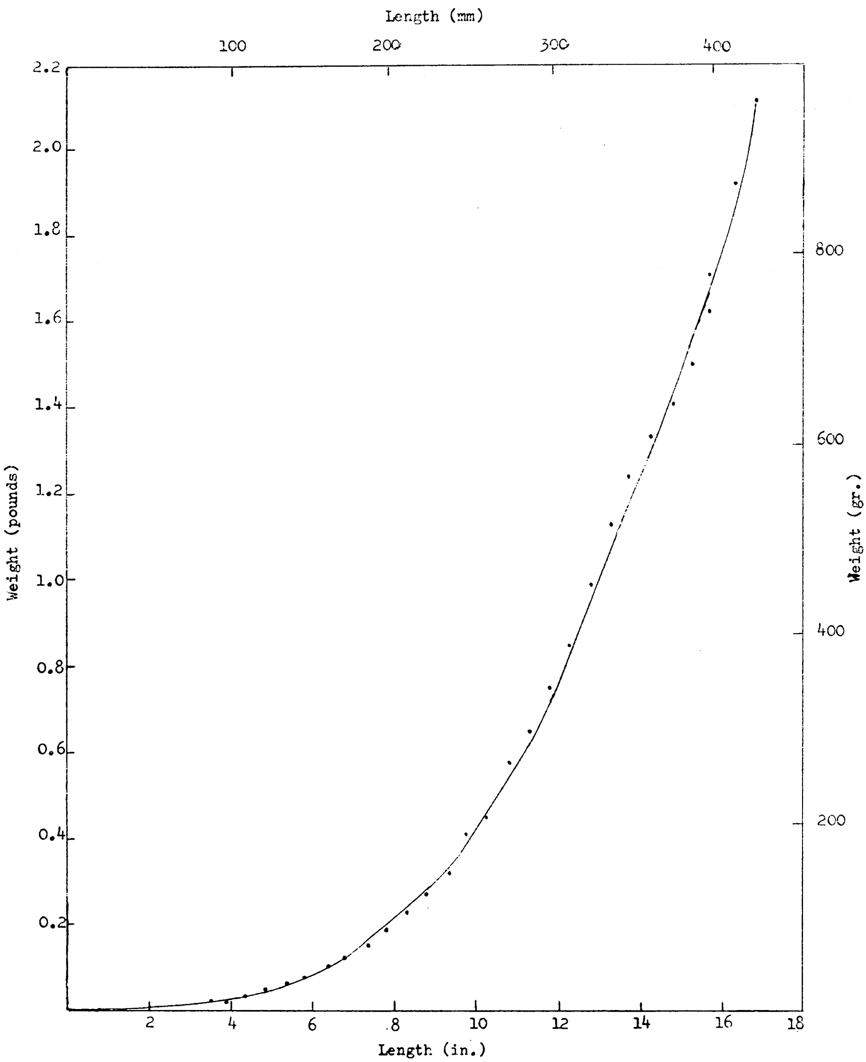

FIGURE 3. Length-frequency distribution of ancient otoliths from freshwater drum.

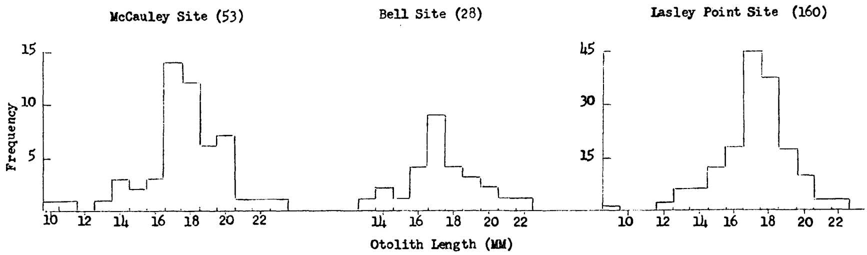

TABLE 2. CALCULATED TOTAL LENGTH IN MILLIMETERS (INCHES) AND WEIGHT IN GRAMS (POUNDS) OF ANCIENT FRESHWATER DRUM. ACTUAL LENGTHS AND WEIGHT FOR RECENT DRUM.

LOCATION	DATE	No.	LENGTH		WEIGHT	
			Range	Mean	Range	Mean
McCauley Site Winnebago Co., Wis.	500–1750 A.D.	53	270–635 (10.6–25.0)	472 (18.6)	240–3420 (0.53–7.54)	1356 (2.99)
Lasley Point Site Winnebago Co., Wis.	1600 A.D.	160	276–609 (9.9–22.9)	460 (18.1)	257–3004 (0.57–6.62)	1318 (2.91)
Bell Site Winnebago Co., Wis.	1700–1750 A.D.	28	329–595 (12.9–23.4)	465 (18.3)	444–2795 (0.98–6.16)	1330 (2.93)
Lake Winnebago	1959	923	183–447 (7.2–17.6)	353 (13.9)	81–1220 (0.18–2.69)	526 (1.16)

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THE FISHES OF LAKE MENDOTA

Donald C. McNaught

Lake Mendota has a relatively rich fauna of fishes. Sixty-one species belonging to 20 families are now present or have been reported in the past. Of these, 57 species in 19 families are well documented, while the remainder are questionable.* This lake lies in the valleys of the pre-glacial Middleton and Yahara Rivers, which were dammed with glacial drift at least 9,000 years ago. Geographically, the lake is part of the Mississippi drainage, although the fish fauna exhibits affinities to both the Mississippi and Great Lakes drainages. Mendota, the "Upper Lake" in the Yahara chain, drains into the Mississippi by way of the Yahara and the lower lakes and thence to the Rock River, entering the Mississippi near Rock Island, Illinois, at least 195 river miles below the lake.

Of the 61 species of fishes reported for Lake Mendota, 60 are listed among the 173 species in 29 families (28 families if the Coregonids are included with the Salmonids) found in the Great Lakes drainage (Hubbs and Lagler, 1958). The shortnose gar, *Lepisosteus platostomus,* not recorded by Hubbs and Lagler (1958), has recently been shown to have made the transition into the Great Lakes drainage by Priegel (1963). For zoogeographic purposes, the affinities of the primary fishes of Mendota to those of the Mississippi and Great Lakes drainages are more meaningful than a comparison of the entire fauna; the primary fishes being those which, with few exceptions, have been restricted to fresh-water throughout their known history. Among the fishes of Mendota, we find 43 primary species in 8 families, or about 16% of the primary fauna of the Mississippi drainage (260 species in 13 families, Miller 1958). All 43 fishes are included among the primary species found in the Great Lakes (112 species in 12 families, Miller, *op. cit.).* Thus while Mendota is a part of the Mississippi system, all of her fishes are now common to the Great Lakes.

The families Cyprinidae, with 15 species, and Centrarchidae, with a total of 9 species, contribute the largest number of species. The Percidae, with 6 species, and the Ictaluridae with 5 species, are also well represented.

* Taxonomy from Bailey *et al.* (1960).

THE PELAGIC FISHES

The yellow perch, *Perca flavescens,* and the white bass, *Roccus chrysops,* are numerically dominant among the larger pelagic fishes and provide for an important sport fishery. Both have been studied extensively, especially as concerns movement and feeding periodicity (Hasler and Bardach, 1949; Hasler and Villemonte, 1953; McNaught and Hasler, 1961), reproductive behavior (Horrall, 1961), and homing behavior as related to sun orientation (Hasler *et al.,* 1958). The perch population has been variously estimated at from 4 to 8 million (Bardach, 1949) to 15 million individuals (Pearse and Achtenberg, 1920), however, the fact that an estimated 1½ million perch were taken through the ice by anglers during the winter of 1956–57 makes the larger estimate more likely. The large population of white bass provides for a unique type of fishing. These fish feed actively at the surface at dawn and dusk, and may be taken in large numbers by stalking the schools by boat.

TABLE 1. CATCHES OF CISCO, *Coregonus artedii,* IN LAKE MENDOTA, WISCONSIN, BETWEEN 1867 AND 1962

YEAR	MAXIMUM CATCH PER MAN NIGHT	CATCH PER MAN SEASON*	FISH SIGHTED PER MAN SEASON*	LENGTH OF SEASON*	GEAR	AUTHORITY
1867	300				Spear	Cited by
1875	437				Spear	Neuenschwander (1946)
1884	480				Dip-net	
1930		24		1–4 Dec	Dip-net	Records of
1931		441		2–12 Dec	Dip-net	C. J. Telford* from
1932		303		23 Nov– 2 Dec	Dip-net	Neuenschwander (1946)
1933		265		20 Nov– 3 Dec	Dip-net	and John (1954)
1935		147		22 Nov– 7 Dec	Dip-net	
1936		189		21 Nov–30 Nov	Dip-net	
1937		198		22 Nov– 4 Dec	Dip-net	
1938	214	457		26 Nov– 4 Dec	Dip-net	
1939		372		26 Nov– 1 Dec	Dip-net	
1940	100	194		25 Nov– 8 Dec	Dip-net	
1941		11		26 Nov– 1 Dec	Dip-net	
1942	no run, some beneath ice			8–9 Dec	Dip-net	
1943		21		17 Nov– 9 Dec	Dip-net	
1944	no run					
1945	no run					
1946		1			Dip-net	
1952		7	16		Dip-net	Records of
1953		13	100		Dip-net	C. J. Telford*
1954		100	200		Dip-net	(personal communi-
1955		0	1		Dip-net	cation)
1956		1	5		Dip-net	
1957		0	1		Dip-net	
1958		0	1		Dip-net	
1959		7	12		Dip-net	
1960		—	—		Dip-net	
1961		3	6		Dip-net	
1962		0	0		Dip-net	

*Mr. C. J. Telford, 221 Kendall Avenue, Madison, Wisconsin.

The cisco, *Coregonus artedii,* formerly an important component of the pelagic fishery, has undergone catastrophic die-offs in recent years and is now a rare species. John (1954) concluded that fishing with gillnets in 1949 was five times poorer than in 1931 and at least ten times poorer than it had been in 1892. Catch records provided by Mr. C. J. Telford of Madison document the ciscoes' recent demise. Whereas during the late 1800's a single man could dip-net 300 to 400 fish per night, by the early 1940's 100 to 200 fish per night constituted a good catch. Mr. Telford has taken as many as 7 fish per season only once in the last 8 years (Table 1).

The Minnows

A general lack of information concerning the species of *Notropis* present, as well as both their ecological role and ethology, represents one of the largest gaps in our knowledge of Mendota's fishes. In their recent catalogue of the fishes of the United States and Canada, Bailey *et al.,* (1960) list 97 species of *Notropis,* thus the 9 species reported from Mendota represent only about 9% of the species belonging to this diverse and interesting genus.

The spottail shiner, *Notropis hudsonius,* was first reported from Lake Mendota in 1944 (Black, 1945), although earlier surveys failed to list this easily recognized species. The spottail may have entered Mendota early through the Mississippi drainage or more recently from the Great Lakes via the Chicago Sanitary and Ship Canal, the Illinois River and the Mississippi. The behavior of this most interesting fish merits future attention. Adults have been observed schooling with yearling white bass (McNaught and Hasler, 1961). Large aggregations of the shiner have been observed on the spawning grounds of the white bass, although it is not known if the shiner is likewise spawning (Horrall, 1961). A study of possible relationships between the spottail and the white bass seems desirable. Other members of this and related genera have been demonstrated to have certain close relationships with larger species of Centrarchids. The northern redfin shiner, *Notropis umbratilis,* is a nesting associate of the green sunfish, *Lepomis cyanellus* (Hunter, 1962). Similarly, the golden shiner, *Notemigonus crysoleucas,* has been described as utilizing the nests of the largemouth bass, *Micropterus salmoides* (Kramer and Smith, 1960).

Introduced Fishes

Species introduced to Lake Mendota during early stocking programs are most important in any consideration of the extant fauna. Certain fishes have become a nuisance. Carp were supplied to individuals in the Madison area beginning in 1887, although a carp was taken from Mendota on 24 November 1877 *(Wisconsin State Journal,* 27 November 1877, cited by Neuenschwander, 1946). Less than 600 fish were distributed to Madison residents between 1887 and 1893, yet in 1962 approximately 13,000 pounds of carp were removed by the State Conservation Department in an effort to control the population (personal communication, N. Miller). A close relative, the goldfish, *Carassius auratus,* was stocked in 1885 by Gov. Farwell and likely many times since by one-time aquarists or fishermen. Large specimens are infrequently taken (Footnote #13), however, and the goldfish is certainly not a problem at the present.

The white bass, *Roccus chrysops,* was abundant in Mendota as early as 1867 *(Wisconsin Union,* 15 December 1867, cited by Neuenschwander, 1946). Any influence on the population from those fish stocked in Lake Monona in 1891 or in Mendota in 1940 and 1943 would be difficult to assess. Yet the transfer of a few yellow bass, *Roccus mississippiensis,* a close relative of the white bass, may eventually alter the over-all population structure in Lake Mendota. The yellow bass was stocked in Lake Wingra sometime in the 1930's, likely during a rescue transfer from the Mississippi (Noland, 1951; Helm, 1958), and has since spread to the upper lakes. Previous to 1960, only one specimen had been collected during yearly fyke-netting operations at Governor's Island and Maple Bluff. In 1960, Horrall (1961) captured well over 100 yellow bass. He speculated that the 1960 invasion of Mendota may have resulted from an extremely large hatch in Lake Monona in 1957. The yellow bass was possibly aided in the expansion of its range during the construction of a new dam and lock at Tenney Park.

Although large numbers of muskellunge fry as well as fingerlings were stocked between 1933 and 1941, this favorite game fish has rarely been reported in the catch. The one substantiated report was that verified by Prof. J. C. Neess in 1946 (Footnote #11), quite possibly a return from the efforts of the 1930's. Likewise, the hook-and-line success for brook, brown and rainbow trout is insignificant. The majority of trout are stocked in tributary streams, although a few may spend the colder months in the lake (Footnote #7).

Approximately 109 million walleye fry and fingerlings were stocked in the lake between 1883 and 1958, making this game fish the most heavily stocked (Footnote #38). Other species frequently added to the lake include the northern pike, bluegill, smallmouth bass, largemouth bass, crappie, yellow perch, bullhead, and the cisco (Footnotes #23–38).

Unusual Fishes

Public interest is easily aroused by publicized catches or sightings of unusually large or uncommon fishes, whether native or exotic. The lake sturgeon was likely native to the Madison lakes. A Mr. Harnden took a sturgeon from Lake Monona sometime prior to 1876 (*Wisconsin State Journal,* 11 August 1876, cited by Neuenschwander, 1946). Attempts were made by the Conservation Department in 1934 and 1936 to bolster the population by stocking a limited number of adults from the Wolf River (Footnote #23). The recent capture of an apparently healthy specimen (Footnote #6) was unusual in that it was the first sturgeon taken by a member of the Laboratory since intensive fyke-netting operations began 9 years ago. Its age of 29 to 31 years makes it unlikely that it was one of those stocked in either 1934 or 1936; whether or not it was the result of a successful spawning in one of the tributary streams is purely speculative.

Before the white man succeeded the Winnebago on Mendota's shore, the American eel had access to the lakes via the Mississippi and Rock Rivers. An article in the *Wisconsin Union* for 15 December 1867 indicated that eels had not ascended into Lake Monona. However, the *Wisconsin State Journal* for 20 August 1880 (cited by Neuenschwander, 1946) reported the capture of an eel 2 feet in length in Lake Monona, thought to be the third or fourth eel captured in the lakes since Madison was first settled. By 1935 eels were becoming rare in the upper Mississippi due to the construction of dams (Greene, 1935). Obviously they were to die if prevented from reaching their presumed spawning ground in the Sargasso Sea, a journey of approximately 2900 miles from Mendota. Many of the more recent records in other areas of the state and especially the Mississippi were the result of stocking (Greene, *op. cit.*).

The channel catfish may have been transferred into Lake Wingra during rescue operations from the Mississippi (Noland, 1951). Just over 100 years ago a 40 lb. catfish 3½ feet in length was caught in Mendota (*Wisconsin State Journal,* 15 July 1862, cited by Neuenschwander, 1946). Certainly this beautiful fish must then be considered native to Mendota. Although now a rarity, a few specimens are taken in the annual netting operations of the Laboratory at Maple Bluff and Governor's Island.

Fishes of Other Lakes of the Upper Yahara Basin

The larger fishes of Lake Wingra were listed by Noland (1951). Lake Wingra lies west of Lake Monona and connects to it by Murphy Creek, whose channel was first dredged in 1905. Of those fishes reported for Wingra, only the muskellunge x northern pike cross, *Esox masquinongy* x *E. lucius,* the spotted sucker, *Minytrema melanops,* and the satinfin shiner, *Notropis analostanus* (Helm, 1958), have not been observed in Lake Mendota. The spotted sucker, along with a redhorse, channel catfish, white crappie and yellow bass were likely introduced into Lake Wingra from the Mississippi (Noland, *op. cit.).* Recently (10 September 1963) the northern hog sucker, *Hypentelium nigricans* (LeSueur), was taken while seining in Lake Wingra by T. Wright of this Laboratory.

The redfin shiner, *Notropis umbratilis,* was introduced into one of the University of Wisconsin Arboretum Gardner Ponds in 1954 (Hunter and Wisby, 1961). Now well established, it has access to Lake Mendota, Monona and Wingra and the Lower Lakes via Murphy Creek when the Ponds overflow during times of high water.

The golden redhorse, *Moxostoma erythrurum,* has been collected in Lake Waubesa (Footnote #48); likewise, the quillback, *Carpiodes cyprinus,* has been reported from Lake Kegonsa (Footnote #40). Neither species has been observed in Lake Mendota, although both must have ready access.

List of Fishes

Despite the interest in Lake Mendota among biologists, a detailed study of the fish fauna does not exist. Students of the fishes at the Laboratory have often felt a need for a check-list of its fishes. An effort was made in this direction by Dr. Roger Davis in 1955. His list was based upon the work of Pearse (1918), with additional species confirmed through interview with Laboratory personnel. In addition, Davis included an unconfirmed group whose probability of occurrence he felt to be reasonable, based on reports of fishermen. As of this writing, only four species mentioned by Davis have not been confirmed; also, a number have been added.

The list presented here includes the species encountered by Pearse (1915, 1918) in his studies of the foods of local fishes; those listed, and in most cases examined by Greene (1935) from Lake Mendota; those captured by Horrall (1961) over a period of 9 years of fyke-netting in the area of Maple Bluff and Governor's Island; and those catalogued in the Museum of the Department of Zoology. Additional valuable information was gained through access to the stocking records of the Wisconsin Conservation Department.

The taxonomy used by the earlier workers has been revised according to Bailey *et al.* (1960). The various species are all within the range of distribution indicated for them by Trautman (1957).

List of Fishes

Scientific Name (Family, Genus and Species)	Common Name	Authority
Petromyzontidae—lampreys		
Lampetra lamottei (LeSueur)	American brook lamprey	4
Acipenseridae—sturgeons		
Acipenser fulvescens Rafinesque	Lake sturgeon	6, 23
Lepisosteidae—gars		
Lepisosteus osseus (Linnaeus)	Longnose gar	1, 2, 3, 10
Lepisosteus platostomus Rafinesque	Shortnose gar	2, 8
Amiidae—bowfins		
Amia calva Linnaeus	Bowfin	1, 2, 3
Salmonidae—trouts, whitefishes, and graylings		
Coregonus artedii LeSueur	Cisco or lake herring	2, 9, 10, 26
Salmo gairdneri Richardson	Rainbow trout	27
Salmo trutta Linnaeus	Brown trout	7, 28
Salvelinus fontinalis (Mitchill)	Brook trout	29
Umbridae—mudminnows		
Umbra limi (Kirtland)	Central mudminnow	1, 2
Esocidae—pikes		
Esox americanus vermiculatus LeSueur	Grass pickerel	39
Esox lucius Linnaeus	Northern pike	1, 2, 3, 10, 24
Esox masquinongy Mitchill	Muskellunge	11, 25
Cyprinidae—minnows and carps		
Carassius auratus (Linnaeus)	Goldfish	13
Cyprinus carpio Linnaeus	Carp	1, 2, 3, 30
Notemigonus crysoleucas (Mitchill)	Golden shiner	1, 2, 3, 41
Notropis anogenus Forbes	Pugnose shiner	2
Notropis atherinoides Rafinesque	Emerald shiner	2
Notropis blennius (Girard)	River shiner	2
Notropis cornutus (Mitchill)	Common shiner	2
Notropis heterodon (Cope)	Blackchin shiner	1, 2, 42
Notropis heterolepis Eigenmann and Eigenmann	Blacknose shiner	2, 43
Notropis hudsonius (Clinton)	Spottail shiner	3, 12, 44
Notropis spilopterus (Cope)	Spotfin shiner	5
Notropis umbratilis (Girard)	Redfin shiner	14
Pimephales notatus (Rafinesque)	Bluntnose minnow	1, 2
Pimephales promelas Rafinesque	Fathead minnow	1, 2
Semotilus atromaculatus (Mitchill)	Creek chub	5
Catostomidae—suckers		
Catostomus commersoni (Lacépède)	White sucker	1, 2, 3
Ictiobus cyprinellus (Valenciennes)	Bigmouth buffalo	3, 45
Moxostoma macrolepidotum (LeSueur) = *M. aureolum* (LeSueur)	Northern redhorse	5, 47
Ictaluridae—freshwater catfishes		
Ictalurus melas (Rafinesque)	Black bullhead	1, 2, 3, 31
Ictalurus natalis (LeSueur)	Yellow bullhead	2, 3, 31
Ictalurus nebulosus (LeSueur)	Brown bullhead	1, 2, 3, 10, 31
Ictalurus punctatus (Rafinesque)	Channel catfish	3, 15
Noturus gyrinus (Mitchill) = *Schilbeodes mollis* (Herman) or *S. gyrinus*	Tadpole madtom	1, 2, 50
Anguillidea—freshwater eels		
Anguilla rostrata (LeSueur) = *A. bostoniensis*)	American eel	16
Cyprinodontidae—killifishes		
Fundulus diaphanus (LeSueur)	Banded killifish	1, 2
Fundulus notatus (Rafinesque)	Blackstripe topminnow	2
Gadidae—codfishes and hakes		
Lota lota (Linnaeus)	Burbot	2, 17, 49
Gasterosteidae—sticklebacks		
Eucalia inconstans (Kirtland)	Brook stickleback	1, 2
Serranidae—sea basses		
Roccus chrysops (Rafinesque)	White bass	2, 3, 10, 32
Roccus mississippiensis (Jordan and Eigenmann)	Yellow bass	3

Scientific Name (Family, Genus and Species)	Common Name	Authority
Centrarchidae—sunfishes		
Ambloplites rupestris (Rafinesque)	Rock bass	1, 2, 3
Chaenobryttus gulosus (Cuvier)	Warmouth	21
Lepomis cyanellus Rafinesque	Green sunfish	3
Lepomis gibbosus (Linnaeus)	Pumpkinseed	1, 2, 3
Lepomis macrochirus Rafinesque	Bluegill	1, 2, 3, 33
Micropterus dolomieui Lacépède	Smallmouth bass	1, 2, 3, 10, 34
Micropterus salmoides (Lacépède)	Largemouth bass	1, 2, 3, 35
Pomoxis annularis Rafinesque	White crappie	3, 10, 36
Pomoxis nigromaculatus (LeSueur)	Black crappie	1, 2, 3, 10, 36
Percidae—perches		
Etheostoma exile (Girard)	Iowa darter	1, 2
Etheostoma flabellare Rafinesque	Fantail darter	1, 2
Etheostoma nigrum Rafinesque	Johnny darter	1, 2
Perca flavescens (Mitchill)	Yellow perch	1, 2, 3, 10, 37
Percina caprodes (Rafinesque)	Logperch	2, 18
Stizostedion vitreum vitreum (Mitchill)	Walleye	3, 38
Sciaenidae—drums		
Aplodinotus grunniens Rafinesque	Freshwater drum	3, 10
Cottidae—sculpins		
Cottus bairdi Girard	Mottled sculpin	1, 2
Atherinidae—silversides		
Labidesthes sicculus (Cope)	Brook silverside	1, 2

AUTHORITY

1. Pearse (1918).
2. Greene (1935).
3. Horrall (1961).
4. Davis (1955) considered the American brook lamprey, *Lampetra lamottei*, as unconfirmed but probable, based on reasonably reliable reports of fishermen.
5. Davis (1955) confirmed as present the spotfin shiner, *Notropis spilopterus*, the northern redhorse, *Moxostoma macrolepidotum*, and the creek chub, *Semotilus atromaculatus*, through discussion with members of the Laboratory, although they have not been mentioned in the literature.
6. A lake sturgeon, *Acipenser fulvescens*, was captured, tagged (UW #825) and released by H. F. Henderson from a fyke-net located off Governor's Island on 22 May 1963. (Length 156.6 cm or 61¾ inches, age of 29–31 years).
7. Brown trout, *Salmo trutta*, caputred in a fyke-net at Maple Bluff by H. F. Henderson on 28 May 1963. (Length 51.7 cm).
8. Shortnose gar, *Lepisosteus platostomus*, examined and verified by Prof. John C. Neess from a sample taken from carp-holding pens in the Catfish Bay–Yahara River area. Lake Mendota is close to the northern limit of the shortnose gar according to Trautman (1957).
9. John (1954).
10. Tibbles (1956).
11. Muskellunge, *Esox masquinongy*, caught and taken to a local butcher shop; identified there by Prof. Neess (personal diary, 1946).
12. Published accounts: Black (1945), McNaught and Hasler (1961), Horrall (1961).
13. Goldfish, *Carassius auratus*, stocked in 1855 by Gov. Farwell; captured in a gill-net by R. M. Horrall about 1960.
14. Redfin shiner, *Notropis umbratilis*, introduced into one of the University of Wisconsin Arboretum Ponds in 1954 (Hunter and Wisby 1961). Now established, with access to the Madison lakes via Murphy Creek.
15. Channel catfish, *Ictalurus punctatus*, captured in Mendota in 1862 (Neuenschwander 1946).
16. American eel, *Anguilla rostrata*, captured in Lake Monona in 1880 (Neuenschwander, 1946); Greene (1935) noted presence in the Mississippi River, Crawford Co., Wis.
17. Burbot, *Lota lota*, examined from Lake Mendota, as indicated by map on pg. 217, by Greene (1935); this was possibly the specimen collected by Wagner (Footnote #49).
18. Log perch, *Percina caprodes*, observed in what was possibly a spawning aggregation of approximately 500 individuals below the Sherman Ave. Bridge at the Yahara River outlet to Lake Mendota, during the first week of May 1963, by C. W. Voigtlander.
19. Bluntnose minnow, *Pimephales notatus*, collected along the shore at Maple Bluff with cast-net by G. Hergenrader, 22 May 1963.
20. The banded killifish, *Fundulus diaphanus*, is especially abundant in the area of Spring Harbor.
21. The warmouth, *Chaenobryttus gulosus*, is infrequently taken by fishermen (Warden A. Koppenhaver, May 1963).
22. Black (1945) noticed that many perch taken during winter ice-fishing regurgitated one or more emerald shiners, *Notropis atherinoides*, although suggesting that the species was not usually considered common in Mendota.

These additional notes (23–38) have been compiled from stocking records on file with the Wisconsin Conservation Department (*indicates stage of development uncertain, flg. = fingerling, ad. = adult).

23. Lake sturgeon, *Acipenser fulvescens*, 20 individuals from the Wolf River were stocked in Lake Mendota during Sept.–Oct., 1934; an additional 51 adults were planted in 1936.

24. Northern pike, *Esox lucius,*

1922	340,000 fry*		
1929			300* (from Mississippi)
1935		3,750 fgl.*	
1936		2,500 fgl.*	
1937–39		19,250 fgl.	
1940–44	65,000 fry	5,942 fgl.	
1948–49	30,000 fry		35 ylg.
1958			32 ad.
1961			334 ad.*
1962			36 ad.*

25. Muskellunge, *Esox masquinongy,*

1933		80 fgl.
1935	40,000 fry	
1936	52,250 fry	
1937	181,750 fry	
1938	62,500 fry	95 fgl.
1939	60,000 fry	50 fgl.
1940	60,000 fry	
1941		300 fgl.

26. Cisco, *Coregonus artedii,*

1852–55	(Stocked by Gov. Farwell)
1880	75,000 fry
1886	180,000 fry
1946	6,282,086 fry*

27. Rainbow trout, *Salmo gairdneri,* first stocked in Door Creek tributary to Monona in 1889, and in Token Creek tributary to Mendota in 1908.
28. Brown trout, *Salmo trutta,* stocked in Token Creek beginning in 1927 and later in the Pheasant Branch.
29. Brook trout, *Salvelinus fontinalis,* stocked in Six Mile and Token Creeks beginning in 1877 and frequently thereafter.
30. Carp, *Cyprinus carpio,* first supplied to individuals in the Madison area in 1887 and continued until at least 1893.
31. Bullheads (species not indicated),

1939		25,000 ylg.	
1942	25,000 fgl.		500 ad.
1943		1,800 ylg.	200 ad.

32. White bass, *Roccus chrysops,*

1891	2,000,000 fry* (Lake Monona)		
1940		15,000 fgl.	
1943			12,500 fgl.

33. Bluegill, *Lepomis macrochirus,*

1937	10,000 fgl.	3,000 ylg.	
1941–44	18,500 fgl.	12,000 ylg.	1,200 ad.

34. Smallmouth bass, *Micropterus dolomieui,*

1940–48	100,000 fgl.

35. Largemouth bass, *Micropterus salmoides,*

1906–09	65,100 fgl.*	Likely largemouth, but shown only as black bass.		
1910–19	68,500 fgl.*			
1920–29	none			
1930–34	28,102 fgl.*			
1937–39	27,207 fgl.		500 ylg.	192 ad.
1940–49	107,692 fgl.		725 ylg.	20 ad.
1950–58	10,052 fgl.			

36. Crappie (species not indicated),

1937	5,000 fgl.	
1941		150 ad.

37. Yellow perch, *Perca flavescens,*

1936	352,000 fgl.*
1940	15,000 fgl.
1943	12,904,400 eggs

38. Walleye, *Stizostedion vitreum vitreum,*

1883–89	10,850,000		(Mendota, Madison Lakes and Six Mile Cr.)
1890–99	3,400,000 fry*		
1900–09	16,310,000 fry*		
1910–19	26,445,000 fry*		
1920–29	8,025,000 fry*		
1935–36	5,476,000 fry*		
1937–39	10,938,000 fry*		
1940–49	27,375,000 fry	42,045 fgl.	
1958		1,500 fgl.	

The following notes (39–50) have been compiled from records in the fish collection in the Museum of the Department of Zoology, The University of Wisconsin.

39. Grass pickerel, *Esox americanus vermiculatus,*

Lake Mendota	K. Ackley	Dec. 1961	#15628

40. Quillback, *Carpiodes cyprinus,*

L. Kegonsa	J. D. Black	2 May 1944	#382

41. Golden shiner, *Notemigonus crysoleucas,*

L. Mendota	A. S. Pearse	13 April 1915	#364

42. Blackchin shiner, *Notropis heterodon*,			
L. Mendota	G. Wagner	4 Sept. 1905	#1214
L. Mendota	G. Wagner	3 Aug. 1914	#373
L. Mendota	G. Wagner	1 Sept. 1914	#1216
L. Mendota	A. S. Pearse	13 April 1915	#1198
43. Blacknose shiner, *Notropis heterolepis*,			
L. Mendota	G. Wagner	4 Sept. 1905	#1007
L. Mendota	G. Wagner	3 Aug. 1914	#359, 369
L. Mendota	A. S. Pearse	13 April 1915	#372
44. Spottail shiner, *Notropis hudsonius*,			
L. Mendota	Black & Marshall	3 April 1944	#13
L. Mendota	Marshall	28 Jan. 1945	#165
45. Bigmouth buffalo, *Ictiobus cyprinellus*,			
L. Monona	J. D. Black	16 Oct. 1944	#389
46. Spotted sucker, *Minytrema melanops*,			
L. Wingra	J. D. Black	26 Oct. 1944	
47. Northern redhorse, *Moxostoma macrolepidotum*,			
L. Waubesa	J. D. Black	12 May 1945	
L. Wingra	J. D. Black	17 June 1945	
L. Kegonsa	J. D. Black	18 June 1945	
48. Golden redhorse, *Moxostoma erythrurum*,			
L. Waubesa	J. D. Black	12 May 1945	#814
49. Burbot, *Lota lota*,			
L. Mendota	G. Wagner	no date	#118
50. Tadpole madtom, *Noturus gyrinus*,			
L. Mendota	G. Wagner	6 Aug. 1914	#907

ACKNOWLEDGMENT

Acknowledgment is made to Prof. Arthur D. Hasler, Director of the Laboratory of Limnology. His support of this project, comments concerning the fishes of the Madison area, and his critical reading of this manuscript are especially appreciated. Mr. H. E. Neuenschwander, a former student of Prof. Hasler, spent many hours searching through newspaper files in order to document the history of the cisco and other fishes in Lake Mendota.

Permission for the use of the original drawings by Mr. Douglas Tibbitts is gratefully acknowledged. The originals, made directly from specimens taken from Mendota, are on permanent display at the Laboratory of Limnology. These drawings were made possible by a grant from the Research Committee of the Graduate School.

The stocking records of the Wisconsin Conservation Department for 1877 through 1937 are located at the Nevin Fish Hatchery, and were made available through the cooperation of Mr. Thomas Wirth. Those for the period 1937 to the present are located at the Pennsylvania Avenue office of the Department and were examined with the permission of Mr. Harold H. Kernan.

Mr. C. J. Telford of Madison, through many years of fishing the cisco on Lake Mendota, has accumulated a valuable reservoir of knowledge on this species. His long-term records document the decline of the cisco better than a short-term scientific study could possibly do.

This work was supported by a research grant from the Wisconsin Conservation Department as well as through funds of the Wisconsin Alumni Research Foundation administered by the Research Committee of the Graduate School.

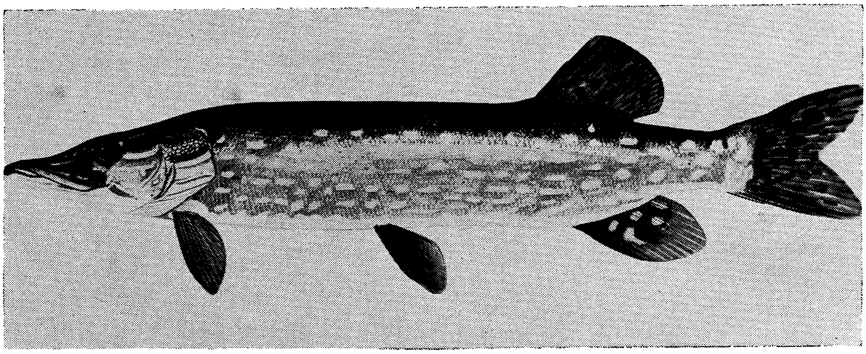

FIGURE 1. Northern Pike, *Esox lucius* Linnaeus. From an original drawing by Douglas Tibbitts.

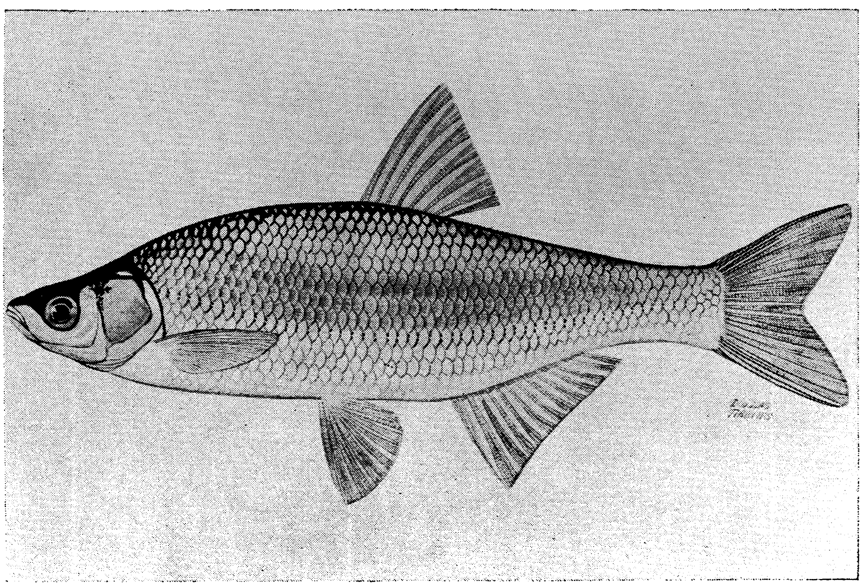

FIGURE 2. Golden shiner, *Notemigonus crysoleucas* (Mitchill). From an original drawing by Douglas Tibbits.

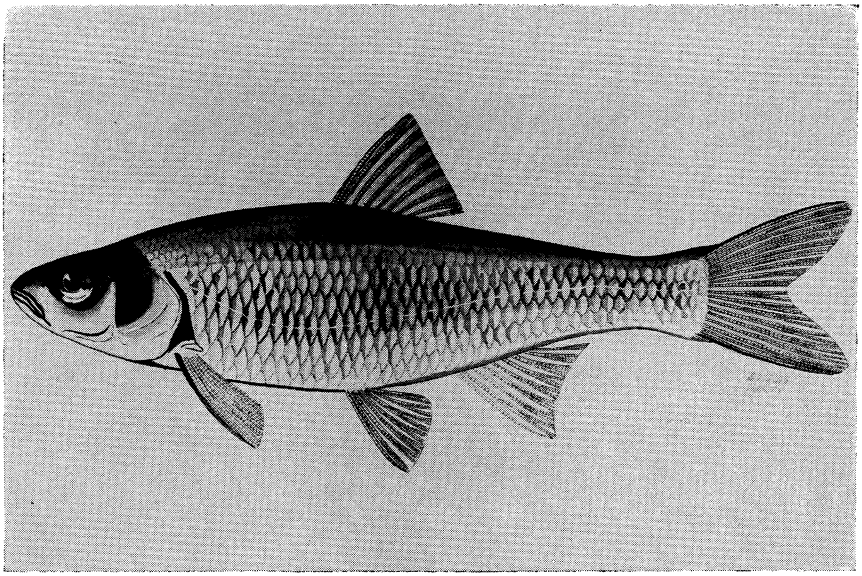

FIGURE 3. Common Shiner, *Notropis cornutus* (Mitchill). From an original drawing by Douglas Tibbitts.

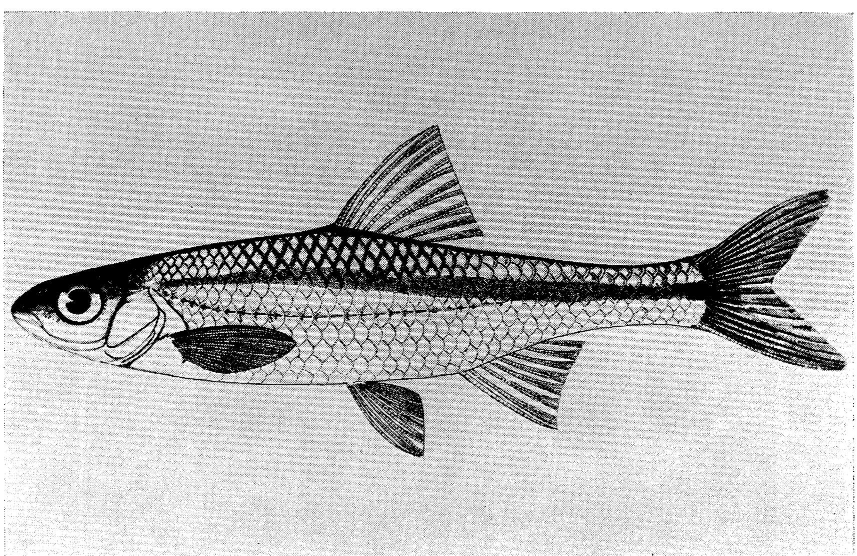

FIGURE 4. Spottail shiner, *Notropis hudsonius* (Clinton). From an original drawing by Douglas Tibbitts.

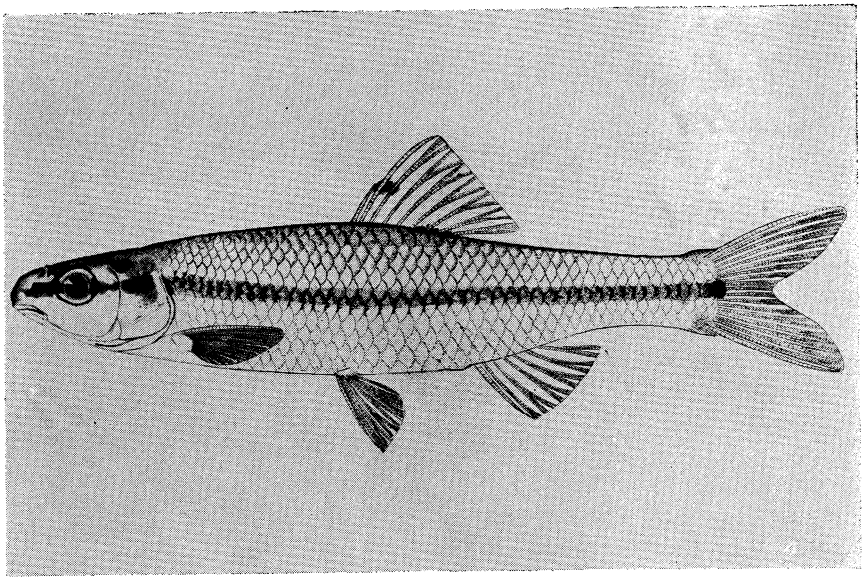

FIGURE 5. Bluntnose minnow, *Pimephales notatus* (Rafinesque). From an original drawing by Douglas Tibbitts.

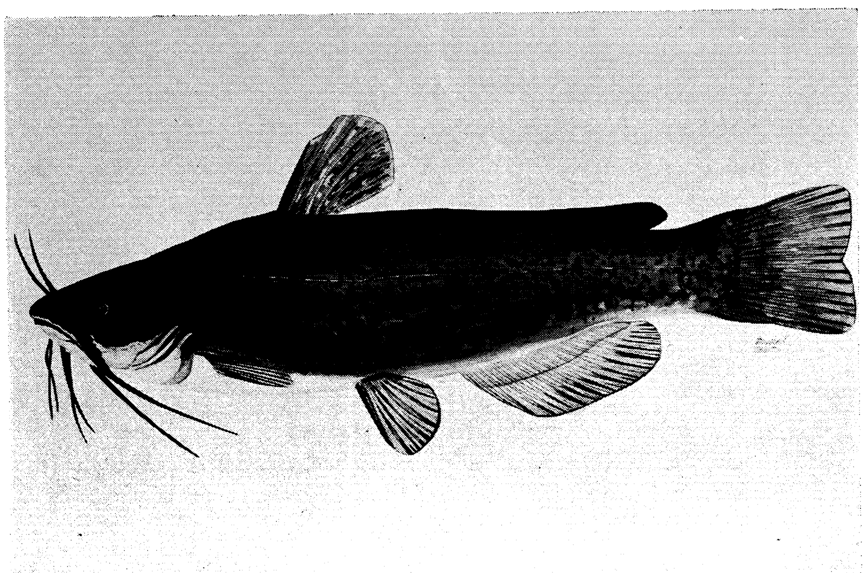

FIGURE 6. Brown bullhead, *Ictalurus nebulosus* (LeSueur). From an original drawing by Douglas Tibbitts.

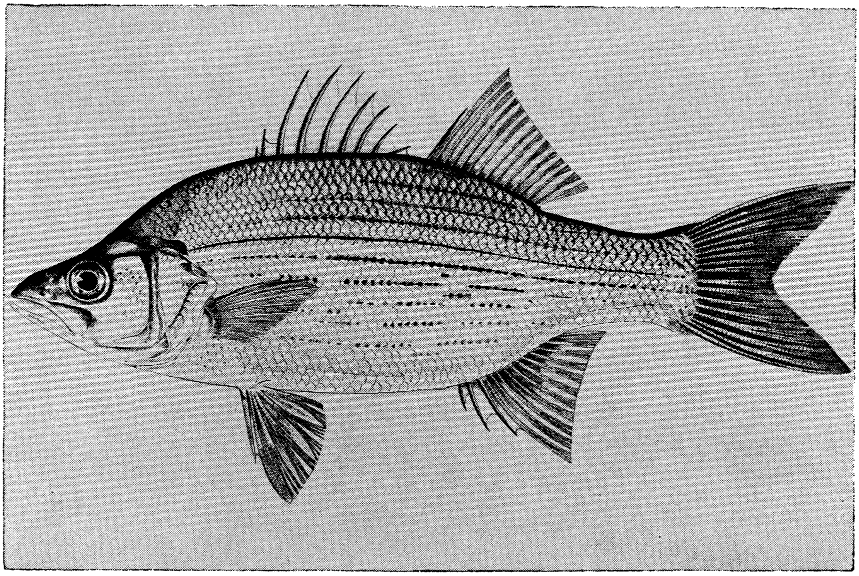

FIGURE 7. White bass, *Roccus chrysops* (Rafinesque). From an original drawing by Douglas Tibbitts.

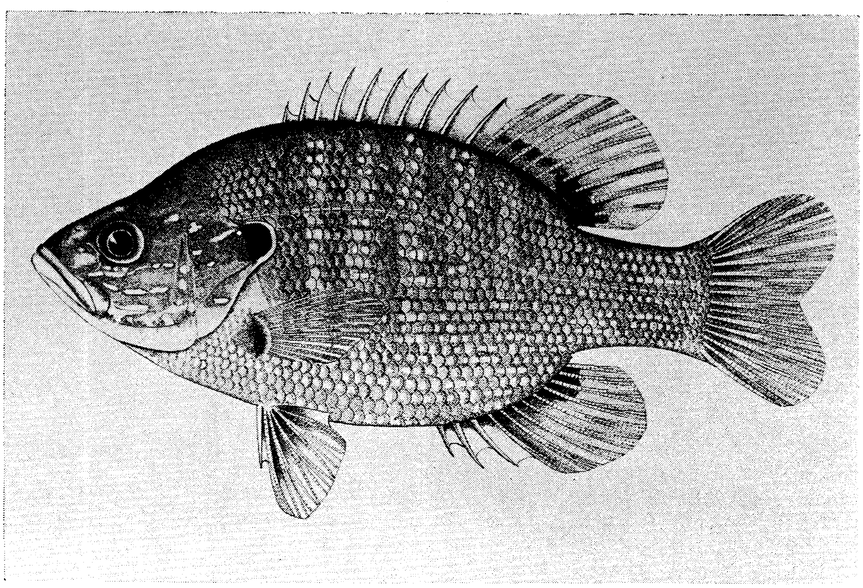

FIGURE 8. Green sunfish, *Lepomis cyanellus* Rafinesque. From an original drawing by Douglas Tibbitts.

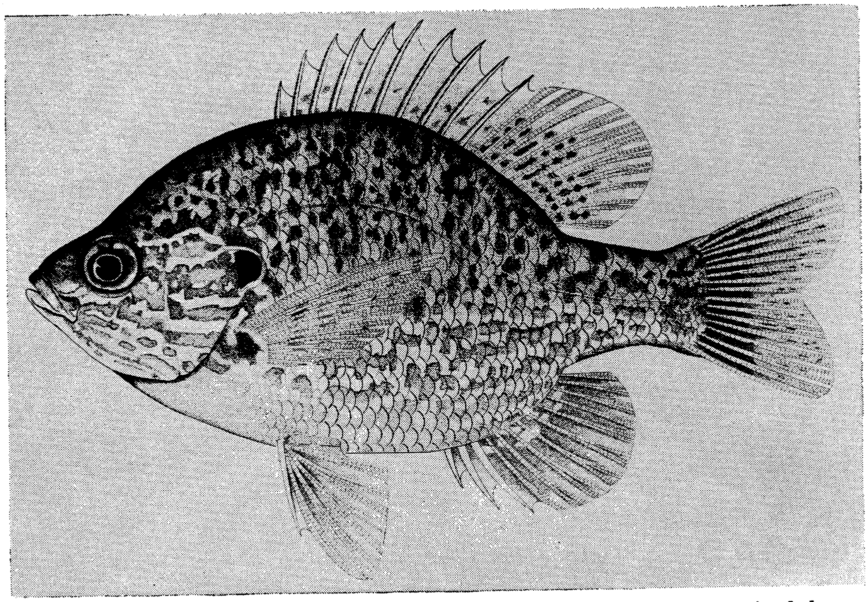

FIGURE 9. Pumpkinseed, *Lepomis gibbosus* (Linnaeus). From an original drawing by Douglas Tibbitts.

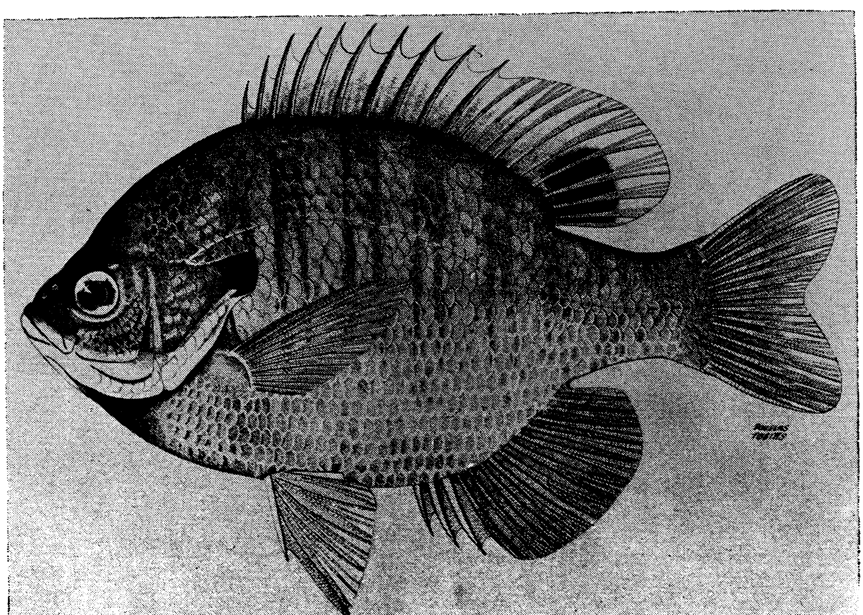

FIGURE 10. Bluegill, *Lepomis macrochirus* Rafinesque. From an original drawing by Douglas Tibbitts.

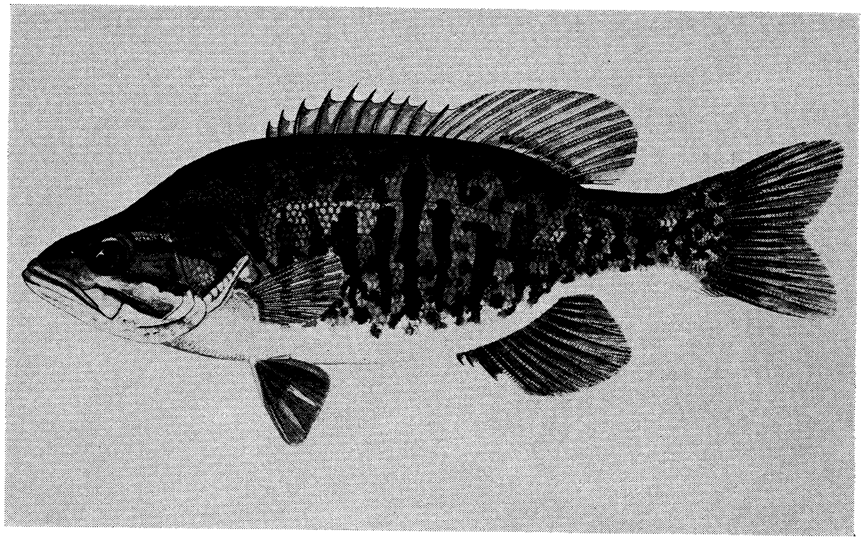

FIGURE 11. Smallmouth bass, *Micropterus dolomieui* Lacépède. From an original drawing by Douglas Tibbitts.

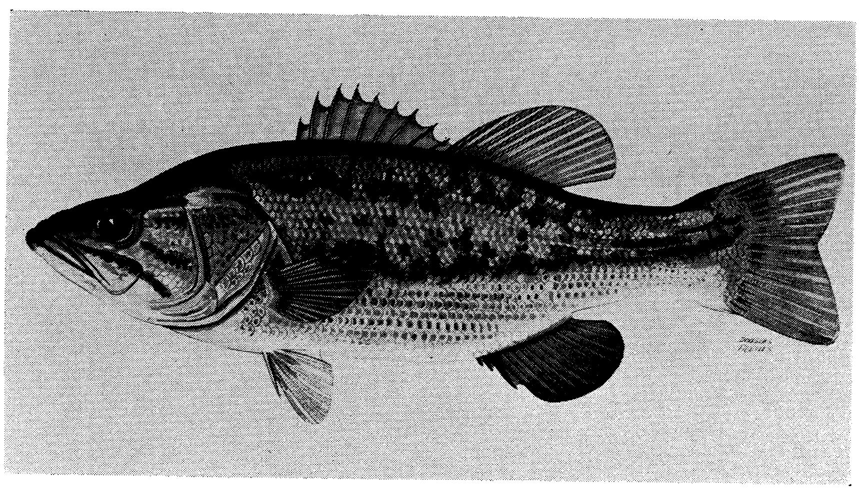

FIGURE 12. Largemouth bass, *Micropterus salmoides* (Lacépède). From an original drawing by Douglas Tibbitts.

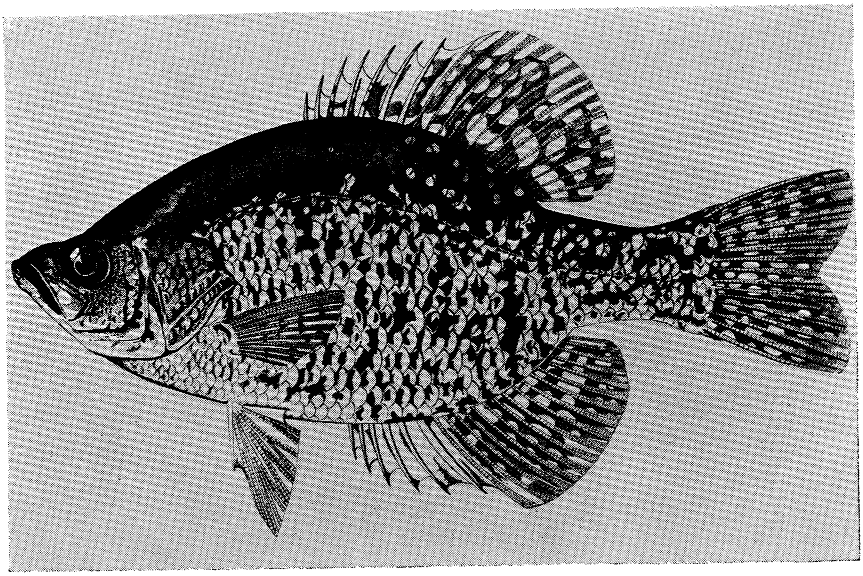

FIGURE 13. Black crappie, *Pomoxis nigromaculatus* (LeSueur). From an original drawing by Douglas Tibbitts.

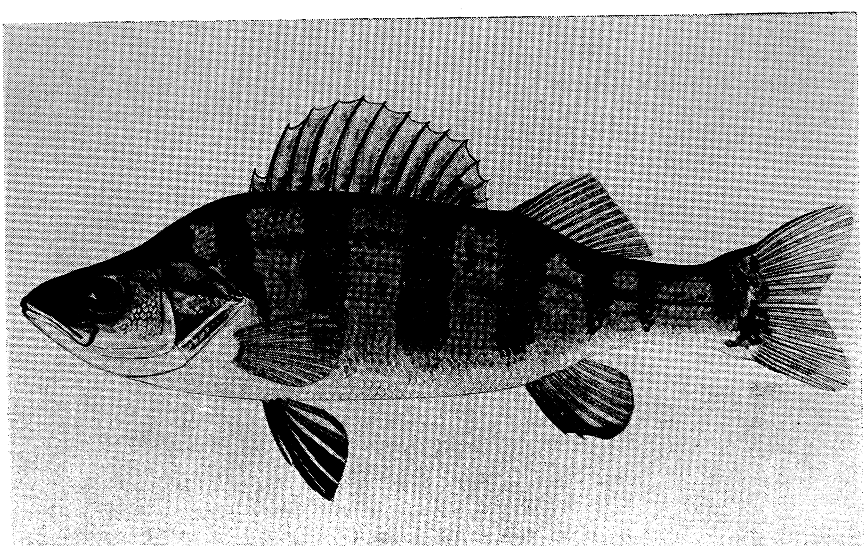

FIGURE 14. Yellow perch, *Perca flavescens* (Mitchill). From an original drawing by Douglas Tibbitts.

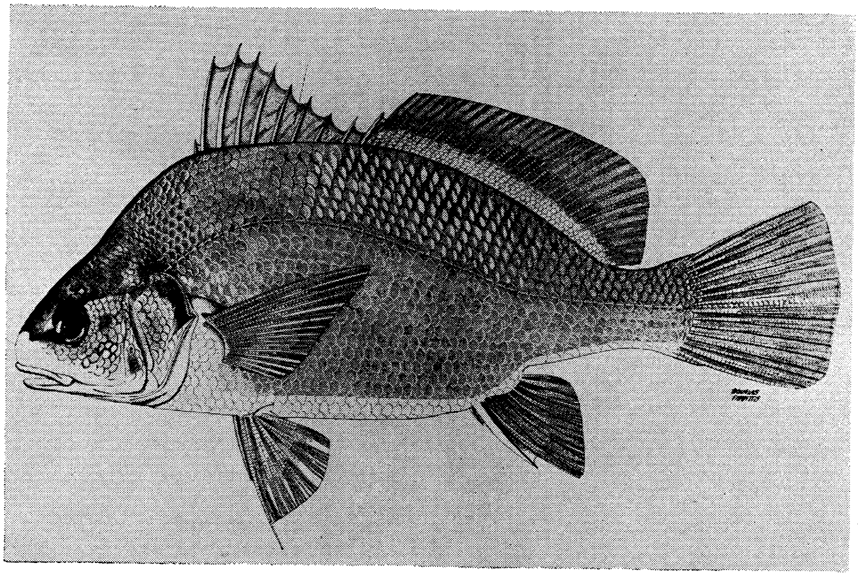

FIGURE 15. Freshwater drum, *Aplodinotus grunniens* Rafinesque. From an original drawing by Douglas Tibbitts.

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THE GEOGRAPHY OF WISCONSIN'S TROUT STREAMS

C. W. Threinen and Ronald Poff

Trout of the brook, brown and rainbow species are a highly valued and relatively scarce fish resource largely restricted to cold-water streams. The location of those cold-water streams capable of supporting trout, therefore, becomes a matter of interest for management of the fish and habitat protection purposes, because of the tenuous character of these limited habitat conditions. In order to show locations, all known trout streams are noted on a hydrographic map of the state. The circumstances leading to their origin are then interpreted.

Certain environmental requirements which become limited to trout formed the basis for this interpretation. Cool water in summer is the primary requirement. Trout of all three species (brook, brown, and rainbow) have thermal tolerances which can be exceeded by summer temperatures. This temperature is generally recognized to be 77.5° F. for brook trout under prolonged exposure (Brett, 1956) and somewhat higher for the other species (Needham, 1938). Brett (1956) noted the optimum temperature for growth and feeding for brook trout was 19° C (66.2° F).

Since brook and brown trout spawn during fall and rainbow trout spawn during fall or spring, water conditions have to be suitable for spawning and development of eggs and young. Trout usually spawn in October and November at which time the females seek out water of suitable temperatures and conditions, dig redds in gravel riffles and, following fertilization, bury their eggs. As a reflection of these conditions, concentrations of spawning trout (especially brook trout) occur near springs. The eggs are dependent upon steady percolation of water through the gravel for aeration, and development of the egg proceeds most rapidly and successfully with steady and moderate water temperatures. Mortalities of eggs are known to be high where the water temperatures are low (near freezing).[1] Ground water springs are, therefore, essential to produce these conditions.

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[1] Unpublished research of the Wisconsin Conservation Department.

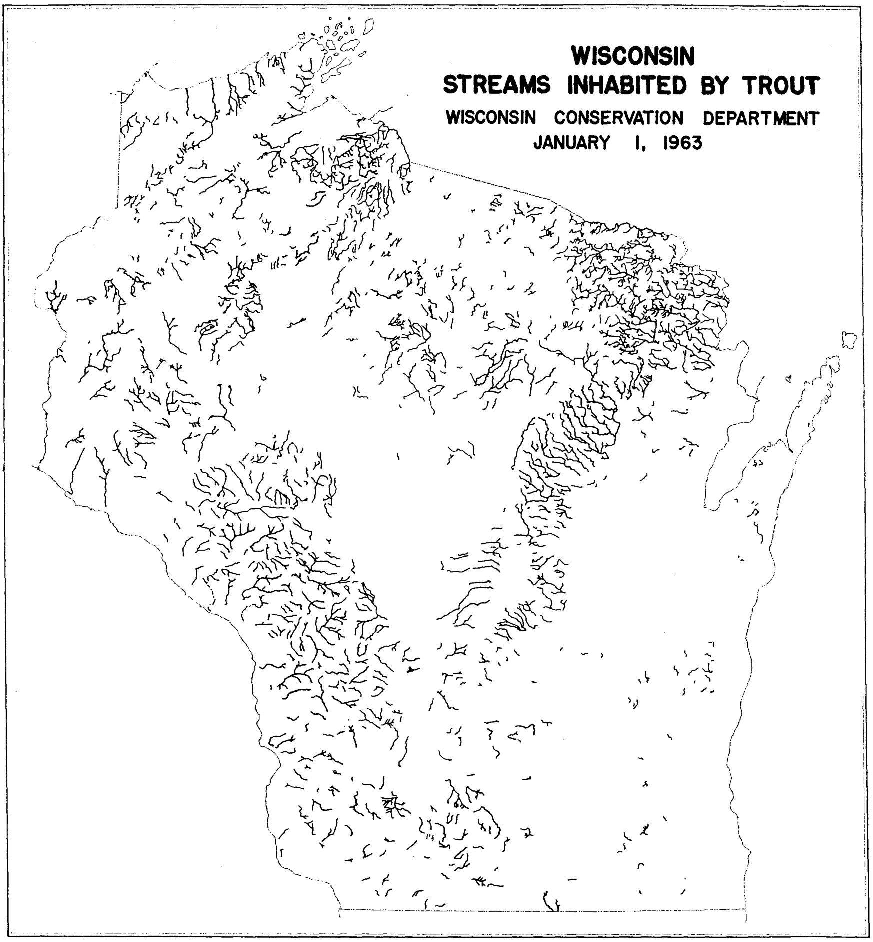

FIGURE 1. State hydographic map with trout streams darkened.

Another possible limiting factor cited by other workers in the mountain states is the formation of anchor ice (Maciolek and Needham, 1952). Under very cold conditions in the northern part of the state, anchor ice can form over the rocks and riffles and result in the movement or displacement of the stony bottom materials and destruction of redds and food resources. Obviously warm waters would not allow the formation of anchor ice. A usual characteristic of good trout waters is that they are seldom covered by ice because of the warmer temperatures of the ground water springs feeding trout streams with temperatures between 48° and

50° F. These are streams fed by significant amounts of ground water. Benson (1953) called streams free of ice on cold days "good" trout streams and those ice covered "poor".

Climate Conditions and the Hydrological Cycle

Rain falling on the ground either soaks in to become part of the ground water, becomes absorbed by the surface soils or runs off on the surface. If it percolates into the ground to become part of the ground water, it will flow downhill later to reach surface drainage. The capability for percolation into the ground and movement underground will obviously be best when soils are light and where sufficient hydraulic gradient prevails, and it will be poorest with heavy soils and poor gradient. With trout streams heavily dependent upon cool water, the ground water flow, circumstances providing slope and surface infiltration will be the conditions most productive of trout streams. All streams are dependent upon ground water for their base flow but to have importance for trout during critical periods, a high portion of the base flow must be recently expressed ground water which has not yet warmed or cooled to surrounding temperatures.

Water absorbed by surface soils is of no immediate value to trout streams. It either evaporates or is transpired by plants. The heavy soils will hold more water and infiltrate less than light soils and therefore make a lesser contribution to ground water and make more available to evaporation and transpiration. Similarly surface runoff is of limited value to trout streams because it closely reflects surrounding temperatures, and it lacks permanence because of the intermittency of rainfall.

Wisconsin has a northern climate typical of the continental land mass. It is characterized by hot summers (July average, 66°–72° F) and cold winters (January average, 10°–22 F). Daytime summer temperatures are hot enough to warm surface waters above the maximum tolerated by trout. Winter temperatures are sufficiently cold to freeze surface waters and to cause moisture storage in the form of snow from December through March. Although there are intermittent thaws which make contributions to the surface water, this weather cycle causes some of the lowest runoff of the year to occur in the winter. Streams or portions of streams without strong ground water sources, therefore, tend to fluctuate in both volume and temperatures more than those with and, therefore, provide a less stable habitat for fish. Another low period in stream discharge usually occurs in the summer when vegetation is actively transpiring water and evaporation rates are high. Drescher (1956) described rapid rises in ground water levels in the spring, and discharge exceeding recharge during the growing season.

Rainfall averages about 30 inches a year in Wisconsin divided as follows: 17.2 per cent falls in the winter months of December, January, February, and March; 22.5 per cent falls during the nongrowing season of April, October and November; and 60.3 per

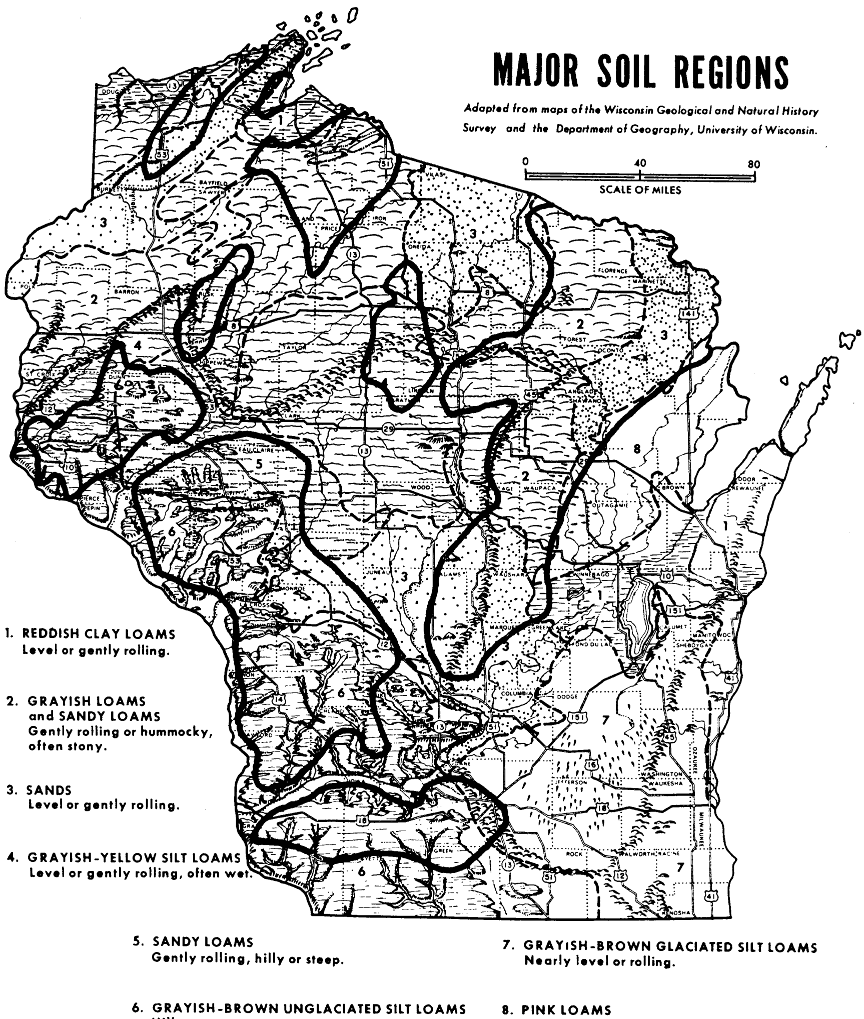

FIGURE 2. Trout stream complexes superimposed on a soils and topographic map of Wisconsin.

cent falls during the growing season (USDA, 1941). The humid climate of Wisconsin has ground water within 100 feet of the surface except beneath high, steep-sided hills (Drescher, 1956).

Wojta's (1949) summary reported 6 per cent runoff on the surface, 15 per cent went to subsurface runnoff, 70 per cent went to evaporation and transpiration and 9 per cent went to ground water. It must be recognized, however, that great variation can occur. Ground water levels closely correspond to precipitation, so changes in spring flow can be expected to result from changes in precipitation (Drescher, 1956). The term "spring" as used in this report is defined as surface expression of ground water.

Distribution and Character of Trout Streams

Designation of streams as "trout streams" is the product of many years of surveys and creel observations gathered by the field personnel of the Wisconsin Conservation Department. This designation means that a stream has shown consistent ability to support trout without excessive natural mortalities. It is recognized that stream habitat conditions change and could affect this designation. This is particularly true where impoundments have been constructed. Such structures frequently change a cold-water environment to a warm-water environment.

Although there are individual and partial losses of trout water which have been reported, these have not been great enough to alter seriously the general geography of Wisconsin's trout streams. In our opinion, most of the alterations have occurred within the present complexes of trout streams. Perhaps the greatest change has occurred in the cranberry and duck mash areas of central Wisconsin in the bed of glacial Lake Wisconsin.

We have several complexes of trout streams plus some scattered streams. The largest and most important complex occupies an arc beginning in Adams and Marquette Counties and extending north and northeast into Florence and Marinette Counties. Within this belt are some of the best-known trout streams in the state and almost without exception there is substantial natural reproduction of trout in them. The complex second in size and trout concentration lies in the northern tier of counties most of whose drainage flows into Lake Superior. This includes some of the more spectacular streams with high gradients such as the Brule. The third major complex occupies the unglaciated southwestern part of the state. There are minor complexes centered in Lincoln County and portions of adjoining counties, and in Rusk, Barron, Dunn, Pierce, and St. Croix Counties.

Regions conspicuously lacking trout streams or lightly represented are the lake regions of the north, the heavy soil regions of Marathon, Taylor, Clark and Wood Counties, much of the bed of old glacial Lake Wisconsin, and most of southeastern Wisconsin. Further inspection of the hydrography will show that the trout streams are not unique to particular drainages, but that they do have regional distribution. The largest complex has streams flowing into both the Lake Michigan drainage and the Wisconsin River.

The gradient characteristics of trout streams vary greatly. They include everything from white water to spring ponds, and from ditches and tiny feeders to rivers. Some examples of the extremes follow: The Little Brule in Florence County has much white water; the Nine Mile in Langlade County is a slow, meandered stream flowing through a swamp; Trout Springs is a spring pond in Vilas County; Ten Mile Creek is a ditch through a former marsh in Portage County; the Wolf River in Langlade County is a substantial river at least 50 feet in width. In many cases only a part of the stream will be trout water, with summer water too warm both above and below, an example of which is Rocky Run Creek, Columbia County. Most have this in common: They are generally the headwaters of river systems, and the big river trout stream is the exception rather than the rule.

Relationship to Topography

The major complexes of trout streams have been superimposed on a combination soils and relief map adapted from Whiteson, (1927) and Martin (1932) (Fig. 2). In the absence of an elaborate topographic map with contours, the topography of the state is evident in the hydrographic map (Fig. 1) by noting the drainage divides. State elevations begin at 1,650 feet in the northern highlands and drop to 595 feet in the Mississippi, 581 feet in Lake Michigan and 602 feet in Lake Superior. Wisconsin is fundamentally a sculptured plain which slopes gradually from the northern highlands to the south, east, and west and more abruptly to the north. Major water courses originate in the highlands and flow in these directions. The hills of the terminal moraines generally are some of the highest features on the landscape, and they often form the drainage divides. In the southwest, erosion has cut through the level plain of the upland with elevations of 1000-1200 feet to form deep valleys or coulees leading to the major water courses with elevations approximately 600–700 feet.

Almost all the trout stream complexes are associated with some hilly topography but not all hilly topography has trout streams.

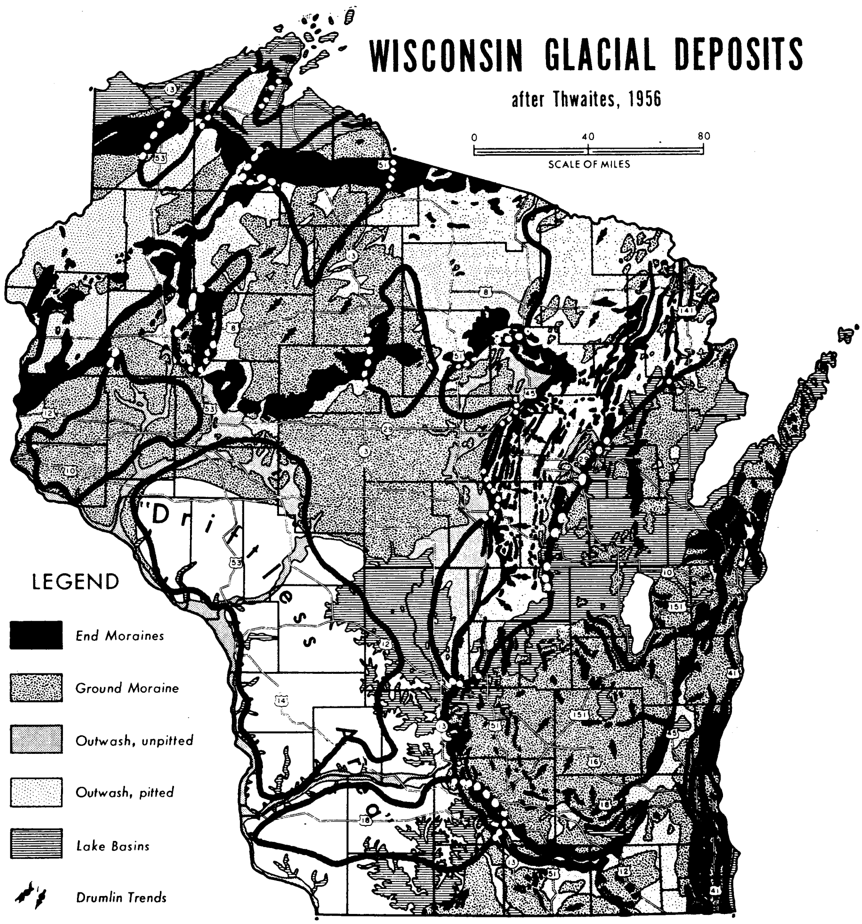

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FIGURE 3. Trout stream complexes superimposed on a glacial deposit map of Wisconsin.

The largest complex has as its center the terminal moraines of the Green Bay lobe of the last Wisconsin glacial period and streams flow in both directions. Although many of the trout streams are associated with hilly moraine areas, this feature is not always productive of trout streams as will be noted by the scarcity of trout streams in the extensive Kettle Moraine hills. Surface topography is important in this regard: The ground water moves from recharge areas, which are usually divides and hills, toward discharge points of lower elevation, and springs occur where the ground water table coincides with the surface. Thus, the hills provide hydraulic gradient toward points of discharge. Also, where the stream cutting exposes an aquifer endowed with water, or the ground water itself, a spring can originate. Surface cutting and erosion has not been great in the younger surface of the glaciated regions, but it has been extremely important in the unglaciated portion of southwestern Wisconsin. Sharply cut and deeply eroded valleys which have carved the plateau are characteristic of this region.

Another factor can be the stream gradient. A sluggish stream does not have the water exchange of a stream with large gradient, and thus is less likely to retain the cool summer and warm winter temperatures required of a trout stream. As noted, however, some trout streams are sluggish. The typical drainage sytem in the unglaciated portions of Wisconsin has small feeder streams of high gradient and a sluggish main stream of lower gradient.

Aside from the unglaciated region, we note that the hilly topography of the Lake Superior drainage and the Barron Hills has a high incidence of trout streams, but the hilly western portion of Marathon County, eastern Clark County and southern Taylor County has relatively few trout streams. It is a well-known fact that streams in this region have seasonal flows comprised mainly of surface runoff. There are relatively few springs feeding these streams and they may become intermittent. Although having sufficient gradient, ground water storage is limited because of the thin ground water reservoir.

Evidently sharp topography is not always necessary for the presence of trout streams. There is a group of them that flows through part of the extremely flat bed of old glacial Lake Wisconsin and in the sand and gravel deposits in the central sand plain in Adams and western Portage Counties. One group consists of the drainage ditches that drained the old Buena Vista Marsh, a very flat piece of landscape. These streams owe their existence to exceptionally favorable ground water conditions. On the other hand the bed of old glacial Lake Oshkosh has not a single trout stream in it. This area is generally the lower part of the major drainages and is impregnated with numerous shallow lakes and marshes. Few springs occur in this region.

Glacial Geology

The glaciers had a profound influence on all the Wisconsin landscape except parts of the driftless area. For an evaluation of the contribution of glacial geology, the trout stream complexes have been superimposed on the glacial map of Thwaites (1956) (Fig. 3).

Basically the repeated glaciers filled the valleys with sediments, leveling the landscape, giving much of Wisconsin a gently rolling character alternately consisting of low hills and lowlands of the ground moraine with its poor drainage, produced outwash plains of sandy soils, some pitted, some not and gave rise to steep hilly topography in the terminal moraines. Pitted outwash plains of the glaciers gave rise to most of the lake regions (Thwaites, 1959). Unpitted outwash consists of the well-drained sandy till which has such excellent water-bearing and transmission qualities. Such streams as the Chippewa, Black, Wisconsin, and Mississippi Rivers were major drainages to the south, which carried the load of melt water.

The gently rolling hills and lowland of southeastern Wisconsin, with drainage to the south, has few trout streams except on its western edges. The western-most streams have cut through the higher elevation of the plateau of the driftless area and terminal moraine to join the lower main stream. The streams of southeastern Wisconsin aside from these are geologically young with less elevation and have not eroded down into deep valleys as compared with those of southwestern Wisconsin. Almost nowhere is bedrock exposed by their erosive action and the clay till of southeastern Wisconsin has poor waterbearing characteristics. Almost all the streams in southeastern Wisconsin have low gradients (except when they originate in the hills of a moraine) and low runoff (Table 1). Here and there among the gravel hills of the Kettle Moraine, there are large deposits of sand and gravel furnishing a good ground water reservoir. The local steep gradient of the ground water table produces springs of sufficient magnitude to permit the existence of a trout stream. Trout streams are, however, conspicuously absent all along the shore of Lake Michigan where there is usually quite a fall. Almost all the smaller streams up and down the Michigan shore are intermittent also because of the poor water-bearing qualities of the soil, although subterranean drainage is naturally toward the lake as is the surface drainage. Artesian conditions prevail along much of the shore because of impermeable rock and soil conditions along the shore.

TABLE 1. COMPARISON OF YEARLY RUNOFF OF 5 TROUT STREAMS AND 5 NONTROUT STREAMS[1]

STREAM	YEARS OF RECORD	RANGE IN RUNOFF (IN.)	MEDIAN RUNOFF (IN.)
Trout Streams			
Wolf River (Keshena)	40	9.00–17.14	12.76–12.80
Embarrass River (Embarrass)	31	5.11–16.46	10.03
Brule River (Brule)	7	15.97–23.00	18.04
Pike River (Amberg)	35	7.59–19.25	12.36
Prairie River (Merrill)	27	8.90–22.89	15.74
Nontrout Streams [2]			
West Branch Fond du Lac River (Fond du Lac)	10	1.74– 8.43	3.53– 3.54
Cedar Creek (Cedarburg)	19	2.12–13.08	6.55
Duncan Creek (Bloomer)	6	5.07–10.91	8.12– 8.18
Crawfish River (Milford)	18	2.10–11.62	6.02– 6.24
Turtle Creek (Clinton)	10	6.44– 8.49	7.14– 7.52

[1]Source: USGS water supply papers 1307 and 1308.
[2]Only streams not having any trout streams as tributaries were utilized.

The flat bed of old glacial Lake Oshkosh in the Green Bay lobe has no trout streams in it. It is significant that much of this basin is covered with reddish clay loam, a soil not well adapted to water infiltration or lateral movement. Marshes and shallow lakes are characteristic of this region and in many places artesian water conditions prevail.

Moraines appear to have a high incidence of trout streams, especially the moraine that marks the edge of the Green Bay lobe of the glacier. A high incidence also occurs in the moraine of glacial Lake Duluth. This is, however, not always the picture. Trout streams are relatively scarce in most of the Kettle Moraine and scarce in the moraine stretching across Taylor County. As a whole trout streams are notably scarce in the unsorted glacial till but well represented in the alluvium, with some exceptions. These exceptions are the important lake districts such as the highlands of Vilas and Oneida Counties; the northwest lake district of Polk, Burnett, Washburn, Sawyer and southern Bayfield and Douglas Counties; and the small, concentrated lake district occupying northern Chippewa County and southern Rusk County. The lakes act as impoundments and cause the water to become too warm for trout in the summer time. Only a few short streams occur in this region. Elsewhere lakes are not so concentrated that they influence the location of trout streams.

The coarse, well-sorted sandy alluvium such as found in central and northwestern Wisconsin makes an excellent infiltration bed for

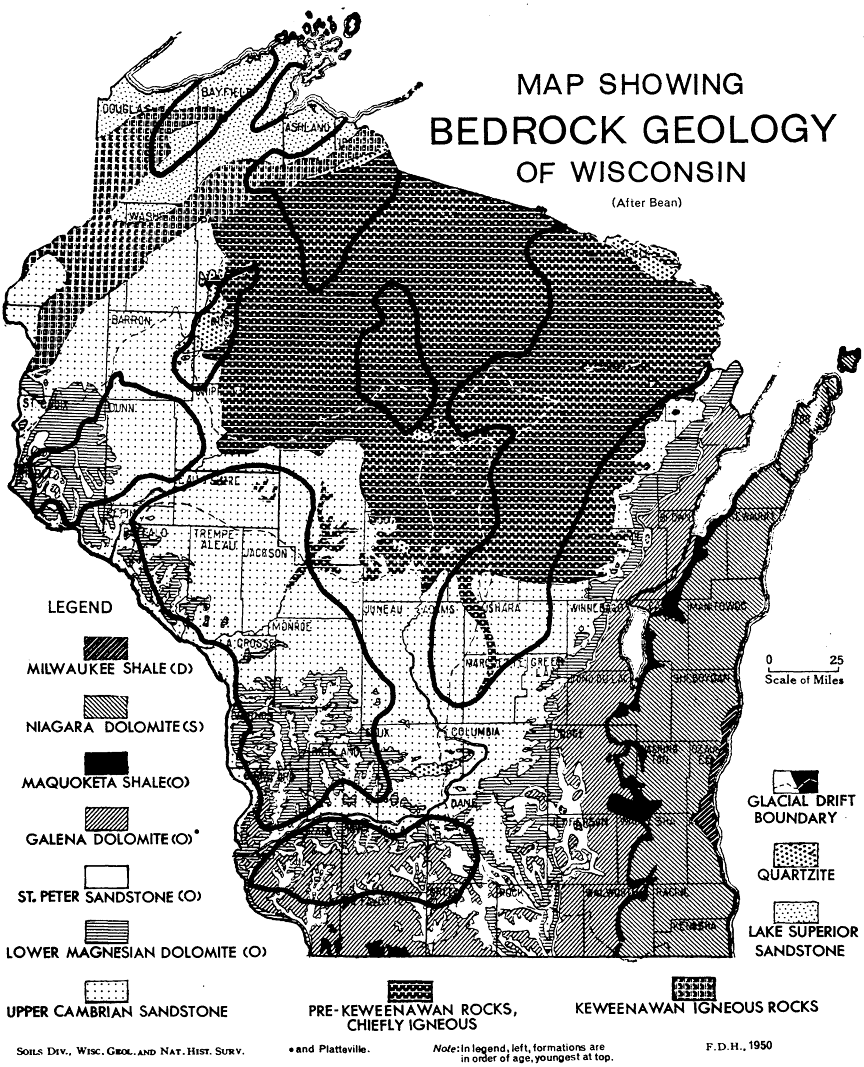

FIGURE 4. Trout stream complexes superimposed on a map of bedrock geology.

the recharge of ground water, the source of springs. Comparatively less water will be held by the sands in these surface layers and remain available for evapotranspiration. The unsorted till, on the other hand, contains the poorly sorted soil mixtures and pockets strong on the silts and clays which inhibit free percolation and lateral movement of ground water and yet hold a great deal of it.

The fractions of the soil particles of various sizes are reproduced from Weidman and Schultz (1915) to illustrate this point (Table 2).

Soil Types

The location of trout streams in relation to soil types is presented by imposing the trout stream complexes upon a soils map of the state. The conventional soils map of Whitson (1927) was adapted for this purpose (Fig. 2).

This map is indicative of the infiltration capabilities of the various soils. There is a good correlation between trout stream location and certain soil types, with some exceptions which of course are what would be expected from our review of the glacial geology. In most areas, the trout streams do not occur in the clay and glaciated clay loams and silt loams which include the red clay region of glacial Lake Oshkosh, the grayish-brown glaciated silt loams of the southeast, and the grayish-yellow silt loams of the north central region. Some local exceptions occur. Many of the streams flowing into Lake Superior pass through the red clay belt along the shore. Most, however, originate in the lighter sandy soils to the south.

Streams in the southwest originate from lands covered with soils originating from sandstones and dolomite. In recognition of the greater presence of springs in the southwest than the southeast, it must be concluded that unglaciated silt loam is capable of contributing to ground water through percolation and porous rock formations capable of taking it up. Thus, other conditions being favorable, it will give rise to springs and trout streams. Evidently, the gradient or topography and bedrock formations determine whether or not a soil region gives rise to springs. In the southwest there is a soil mantle of variable thickness which in many places is eroded right down to or into the bedrock. Erosion of the surface soils and rock has nowhere proceeded to this extent in the southeast.

Bedrock Geology

The circumstances which produce springs most commonly are: (1) a ground water table which reaches the surface or, in other words is exposed by the surface elevations, and (2) less permeable stratum that restricts the downward movement of water and allows it to move laterally to discharge as a spring. We have seen how this would readily occur in the southwestern part of the state with its eroded stream courses which cut deeply into the soil and rock mantle (Fig. 7). The question is, how does the bedrock geology affect spring development elsewhere? The trout stream complexes have been superimposed on the geologic map of the state (Bean, 1947) for an illustration (Fig. 4).

The greatest concentration of trout streams is located over the impervious Canadian Shield or near its edge with some notable gaps. One of these gaps occurs in the silt loams of north central Wisconsin—a heavy soil region where poor percolation, poor lateral subsurface movement and little storage would be expected. Of special interest is the fact that the line of streams coinciding with the Green Bay lateral moraine also lies right on the edge of the Canadian Shield. The topography overlying the Shield has its highest point in the northeastern highlands of Vilas County and slopes off toward the various water courses. It is the edge of this slope with a high gradient where subsurface water movement is readily intersected by the surface drainage. A cross-sectional diagram of this scheme adapted from Weidman and Schultz (1915) appears in Fig. 5.

The ground water level of the sandy soils of this region is maintained by the impervious rock substrate. The existence of this slope and movement of ground water can be illustrated by the Wolf River. Most of its feeders known to be trout water are on the west side. This does not, however, explain the southern extension of this group of streams, which occur in Waushara, Marquette and Adams Counties, all underlain by Upper Cambrian sandstone. In this general area there is still a hydraulic gradient arising from the moraine hills and adequately recharged through the sandy soils. It is perhaps significant that the Pre-Cambrian granite comes to the surface in some localities in Marquette County and may contribute to this slope.

Many streams flowing over trap rock or the Lake Superior sandstones have rich spring sources from overlying alluvium. A high

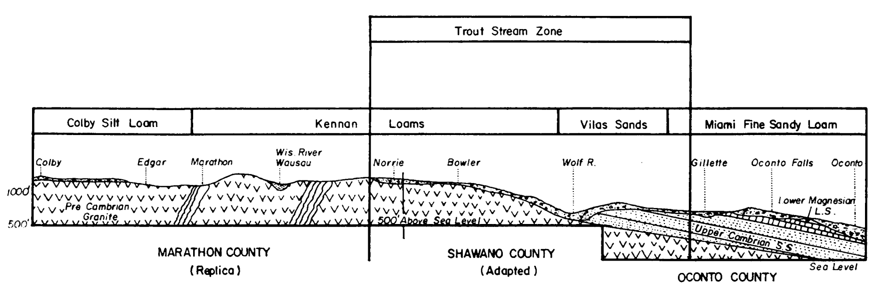

FIGURE 5. Geology, soils and trout stream distribution across an east-west section of Wisconsin at the latitude of Wausau. Adapted from Wiedman and Schultz (1915) and Whitson (1926).

ground water level is maintained by the impervious cemented sandstone of the trap rock, and the high elevation of this region gives the ground water ample hydraulic gradient to flow downhill through the sandy till to emerge as springs. Most of the springs supplying the Brule and other south shore streams have their origin above the lacustrine clay belt that marks the bottom of glacial Lake Duluth and their infiltration bed is the Brule sand barrens. Bean (1944) diagrammed this picture in detail.

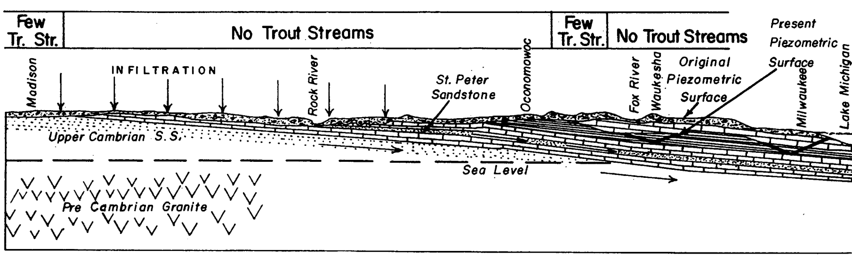

FIGURE 6. An east-west geologic section from Madison to Milwaukee with areas of trout stream occurrence noted. Recopied from Thomas (1952) who adapted work of Wiedman and Schultz (1918).

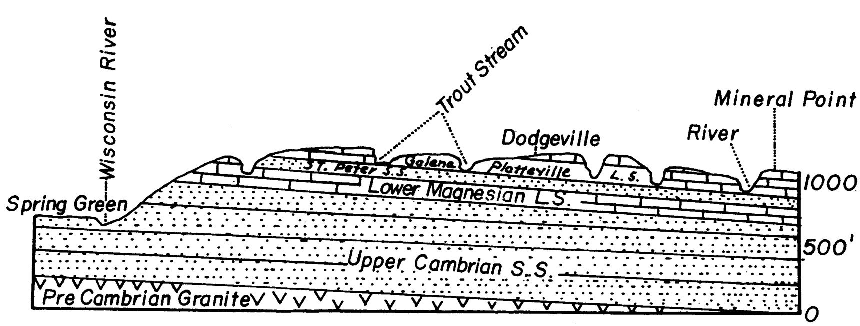

FIGURE 7. A north-south geological cross-section of the terrain that creates spring sources and trout streams in southwestern Wisconsin (Wiedman and Schultz, 1915).

The southeastern part of the state does not have many large springs nor much gradient to its streams. The deep layer of poorly sorted drift over porous bedrock in many places is not conducive to development of numerous and consistent spring sources. The clay loams have poor recharge properties and, should water reach the rock aquifers, it would flow toward areas of discharge (streams, lakes, wells, etc.) to the east or south. Rock aquifers include the porous St. Peter sandstone, Cambrian sandstone, the less porous Prairie du Chien dolomite, and the Galena dolomite. Cities digging wells in this region usually seek either the St. Peter sandstone or the Cambrian sandstone. Even the Niagara limestone which underlies all the lake shore counties is reasonably permeable due to the numerous fractures and joints. A simplified diagram of the system has been reproduced from the report of Thomas (1952) (Fig. 6).

There is much to be gained by observing the runoff of important streams which lie within these regions. It is low for the streams in the southeast and much higher for the streams which originate on the Canadian Shield and streams that originate in the Southwest. This is further evidence that precipitation enters the ground to be expressed at distant points and does not become an immediate part of surface discharge; is retained by the clayey soils to enter the evapotranspiration cycle; or is impounded in marshes or lakes. The streams with good spring sources on the other hand have a high base flow with little fluctuation which is well distributed through the year (Table 1).

Discussion

Wisconsin has abundant rainfall amounting to 27–34 inches per year—enough to make contributions to the ground water, surface runoff, evaporation and vegetation growth. The fraction that enters the ground and becomes expressed as springs and seeps in what interests us the most because of the trout's dependence on the cool ground water. This amounts to 5.0 inches per year for southern Wisconsin according to Wojta's (1949) review and much higher in sandy regions, reaching 80–90 per cent (Drescher, 1955). Most of this recharge takes place during the periods when vegetation is not actively transpiring water, and it is very much greater in porous materials than in semi- or nonporous materials. With sufficient water for recharge, we can assume the potential for trout stream development always exists provided other physical conditions occur. An additional requirement is springs of sufficient number and size to sustain desired water temperatures. The size of streams inhabited by trout is suggestive of temperature requirements. Large streams do not make good trout water except seasonally. They have too much of their water volume derived from distant sources, which would have been subject to the tempering influence of weather conditions and excessively warmed or cooled, to have other than very local or seasonal value to trout. It will, therefore, be only the small- and medium-sized waters which can be sufficiently cooled or warmed by ground water springs—the head-

TABLE 2. MECHANICAL ANALYSIS OF TYPICAL SOILS OF WISCONSIN*

		Per Cent of Soil Fraction						
		Fine Gravel 2 to 1 mm.	Coarse Sand 1.0–0.5 mm.	Medium Sand 0.5–0.25 mm.	Fine Sand 0.25–0.1 mm.	Very Fine Sand 0.1–0.05 mm.	Silt 0.05–0.005 mm.	Clay 0.005–0 mm.
Plainfield sand	Outwash	0.5	17.8	30.9	33.9	5.8	6.5	4.5
Plainfield sandy	Outwash	0.1	25.5	23.6	16.5	2.0	22.6	9.1
Boone fine sandy loam	Outwash	0.2	5.9	13.5	54.9	5.8	14.7	5.1
Chelsea (Coloma) loam	Outwash	0.1	5.7	4.0	4.0	19.4	53.6	12.8
Colby silt loam	Ground moraine	0.1	3.2	4.0	3.6	12.6	61.9	13.6
Knox silt loam	Unglaciated—loess	0.1	0.6	.5	1.2	5.3	80.8	11.6
Miami fine sandy loam	Ground moraine	0.9	5.9	9.4	24.6	18.5	33.1	7.4
Miami clay loam	Ground moraine	0.8	4.0	4.0	11.5	12.4	43.2	23.2
Superior clay	Lake bed	0.2	1.1	1.5	5.4	5.3	28.6	58.2

*Reproduced in part from Weidman and Schultz (1915).

waters for most streams. Usually the trout water will extend down about a mile below the significant spring sources.

The circumstances which have produced significant springs are multiple. First and most important, it takes a good porous soil to make contributions to the ground water through infiltration. This requirement has been well met by the glacial alluvium with its sandy soils. Trout streams are abundantly represented in this surface type or in conjunction with it. The second requirement is ground water with sufficient hydraulic gradient to cause the ground water to reach the surface such that interception by drainage is possible. The slopes of the Canadian Shield, moraine hills and coulees provide this requirement.

Thirdly, there must be free lateral underground movement of the ground water so that it can reach the surface drainage systems which have cut down into the surface deposits. Free movement is permitted in the sorted alluvium with its predominantly sands and gravels in the overlay, but it is not permitted in the unsorted till or original lake clays with their higher fraction of clays or frequent pockets of clay and silt. Free movement of water is permitted in some of the sandstones which are exposed in the central and the western parts of the state.

It is perhaps fortunate that sandy soils and hilly regions are most productive of trout streams. Intensive agriculture will not be so demanding of these waters for irrigation nor will there be complete tillage of the soil with attendant erosion. The one crop that thrives on the sandy silt loams of outwash flats is potatoes. Since this crop gives the best yields when irrigated, competition for surface water from spring sources in such areas can be expected. The sandy soils and hillsides are more intensively dedicated to forest enterprises, a land use that indirectly contributes to rainfall infiltration, delayed runoff and utimate expression as ground water springs.

The geography besides heavy soil types which is unproductive of trout streams contains many lakes. Also, it is a well-known fact that an impoundment will mark the lower limits of trout water. Impounded waters whether in lakes of glacial or man-made origin usually have surface outflow and become warmed beyond the tolerances of trout. These circumstances suggest that if protection of trout streams is to be achieved, impounding of trout waters should be avoided. The trend toward construction of small impoundments for farm pounds, private fish hatcheries and other recreational and business enterprises is regarded as a serious threat to the future of trout streams.

SUMMARY

Trout streams in Wisconsin have been located on a hydrographic map of the state. In this manner the geography leading to the existence of the streams can be seen. Since the trout require cold waters in summer and warm waters in winter, they are dependent upon ground water for these conditions. Trout streams occur abundantly in regions with good slope that provide a hydraulic gradient for ground water, in regions that have permeable sandy soils which permit ready infiltration and lateral movement of ground water. Trout streams are lacking in regions of little slope and clay soil types, and in regions containing abundant lakes. Impoundment of trout streams is regarded as the greatest threat to the maintenance of trout waters.

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THE MILWAUKEE FORMATION ALONG LAKE MICHIGAN'S SHORE

Katherine G. Nelson and Jeanette Roberts

The presence of Devonian rocks in southeastern Wisconsin was recognized more than 100 years ago by Increase A. Lapham, who reported their discovery in 1860 to the Milwaukee Geological Club, and later to the St. Louis Academy of Sciences and in the American Journal of Science.[1] He made his correlation on the basis of fish fossils. While relatively rare, where present these fossils are very conspicuous and leave little doubt that they are representatives of the "Age of Fishes", as the Devonian is commonly called. About this same time, James Hall was commissioned to make a geological survey of Wisconsin, and in his report of 1862, he describes the rock and correlates it with the Hamilton beds of New York. As State Geologist of New York, he was the outstanding authority of his time on the Devonian.

The name "Milwaukee Formation" was not applied formally until 1906, when W. C. Alden's *Milwaukee Special Folio* was published by the United States Geological Survey. The term "Milwaukee Cement Rock", however, had appeared in print as early as 1883 in T. C. Chamberlin's *Geology of Wisconsin,* Volume I,[2] and had probably been in use considerably earlier. It was Lapham who had pointed out the possibility of using the shaly dolomite to make cement in 1874, and two years later the Milwaukee Cement Company began operations in the vicinity of the type locality along the Milwaukee River at Berthelet, north of what is now Capitol Drive.

The cement industry became a booming one, not only at the Milwaukee site, but at others where the hydraulic limestone could be located. Outcrops were few, for two reasons: as the topmost of the Paleozoic formations exposed in Wisconsin, most of it had been removed by erosion during the Mesozoic and Cenozoic Eras; and most of what is left is buried under glacial drift. Since the Paleozoic rocks in general dip away from north central Wisconsin,

[1] Cleland, H. F., *The Fossils and Stratigraphy of the Middle Devonic of Wisconsin,* Wisconsin Geological Survey, Bull. 21 (sc. s. 6), 1911. pp. 21–22.

[2] Chamberlin, T. C., *The Geology of Wisconsin,* Vol. I, p. 201, Wis. G. S., 1883.

the rocks along the eastern border of the state have a general regional dip to the southeast. Thus, the area underlain by the Devonian—the youngest of the sequence of dipping beds—is confined to a narrow strip, nowhere extending more than 3 to 4 miles west of Lake Michigan, and stretching less than 50 miles in a north–south direction. The gentle regional dip toward the lake is generally obscured in the outcrop areas by local warping. The warping, itself, is in part responsible for some of the outcrops, causing them to arch toward the surface through the glacial drift. Whether the strata are continuous under the drift is doubtful—it is likely that pre-glacial erosion has cut through the Devonian to the underlying Silurian beds in many places.

The two most prominent exposures of the Devonian are the type area along the Milwaukee River, and the region along the shore of Lake Michigan east of Lake Church, about 30 miles north of the former. Both of these areas and their fossil content were described in some detail by Cleland in 1911.

One of the more obscure outcrops is located on the lake shore in Fox Point, just north of Whitefish Bay, and this is the area with which the present study is most concerned. Cleland gives only six lines to this location:

> "The Hamilton formation outcrops about two miles north of Whitefish Bay station on the lake shore. It was here that Whitfield obtained some of his specimens for Volume IV of the Geology of Wisconsin. The rock here was formerly mined by tunneling by the Consolidated Cement Company, but in 1907 no work was being done, and the rock was inaccessible except on the shore of the lake."[3]

Alden, in 1906, stated that the Consolidated Cement company did not begin production until 1900[4] Why was this enterprise so short-lived? Why was it located there in the first place? Apparently, for about six years, the company had an extensive layout there, evidence of which can still be seen in concrete abutments and rusting steel tracks along the shore. Probably the cessation of operations was influenced by the same factor that has made it difficult to locate this outcrop in recent years—the level of Lake Michigan. Alden stated that the exposure was at the foot of the bluff on the shore of "Whitefish Bay, a few feet *above* the water's edge".[5] The cement company's operation was a mine, reached by a shaft from the top of the bluff, which extended 22 feet *below* the level of the beach. Several times during the 1940's and early 1950's the senior author and others attempted to locate the outcrop along

[3] Cleland, op. cit., p. 10.

[4] Alden, W. C., *Description of the Milwaukee Quadrangle, Wisconsin,* U.S.G.S. Atlas, Milwaukee Special Folio (No. 140), p. 10, 1906.

[5] Ibid., p. 3 (The italics *(above)* are the present authors'.)

the shore in this vicinity, to no avail, and the conclusion was reached that the slight area where bedrock had once been visible had been buried either by beach sand or by creep of the glacial till at the base of the bluff. During the summer of 1956, when the lake was lower than it had been for several years, the authors looked for it again, on a hot summer day, and discovered it under the water, a bit east of the edge of the beach. It was accessible only by wading, but obviously the slabs of rock were in place, and represented several beds of the long-sought Milwaukee Formation. In the fall of 1962, the junior author found that the lake level was even lower, and that there was a good exposure of the Devonian rocks visible for a distance of several hundred feet along the beach. Enough of it was out of the water so that specimens could be collected.

When winter and the formation of massive ridges of ice along the beach put a temporary stop to field studies, the junior author delved into the records of what is now the city of Glendale to see if she could learn more about the operations of the Consolidated Cement Company that is described in the Milwaukee Folio. Alden stated that the company had opened a shaft in the bluff several years earlier, to supply its mill above, but that production did not begin until 1900.[6] This is the year when the name of the Consolidated Cement Company first appears in the Personal Property Assessment Roll, with a listing of "Wagons, Carriages and Sleighs—1, Value $10" and "Personal Property, $18,000". By 1901, the company had 4 wagons, with a value of $100, and the same entry appears for 1902. The 1903 records list only the personal property valuation of $18,000, but in 1904, two houses, with a value of $100 are listed, and the location of the plant in School District #5 (now Green Tree District) is cited. This year must mark the end of successful operation of the company, for on page 231, Volume 6 of the Town Clerk's Record, we find the following notations:

> "July 13, 1904—Mr. Griese of the Consolidated Cement Company who has an $18,000 assessment on the personal property against the company said the assessment was 50% too high. He stated that the identical plant newly installed would cost but $12,000. His case was taken under advisement."
>
> "July 14, 1904—Messrs. Griese and Kiewert appeared again on behalf of the Consolidated Cement Company and the board determined to place the assessment on their personal property of $18,000 at $13,000, a reduction of $5,000. They were satisfied with this reduction."

The next year's assessment record shows the value of personal property further reduced to $10,000, and in 1906 and thereafter, the Consolidated Cement Company is no longer listed on the tax rolls.

[6] Ibid., p. 10.

While harbor expediters and ships' captains have worried about the low level of Lake Michigan in 1963, it must be stated that this spring's near-record low level of the Great Lakes has been most helpful to the authors in their research. With the level of Lake Michigan 1.6′ lower than the ten year average, and a foot lower than it was just a year earlier, the Milwaukee Formation along the shore of Whitefish Bay in Fox Point is better exposed that it has been for many years. It is no longer necessary to wade to reach it. Army engineers forecast a further drop of nearly a foot by July and August. Although many shake their heads in dismay at this prospect, there are at least two geologists who are looking forward to walking out farther on the bedrock that is now submerged, in the hope of finding fossils of interest[7].

The character of the rock and its fossil content have been the primary concern of the writers. Cephalopods characteristic of Zone B of the Milwaukee Formation are present. These include several specimens of *Ovoceras,* and several that appear to be *Gyroceras.* It will take considerable study before an accurate and complete listing can be made, because the fossils that are found in place are almost all in the form of casts and molds, and rapid identification is not often possible. Several typical brachiopods have been recognized, however—among them *Stropheodonta, Atrypa, Cyrtina, Spirifer,* and *Mucrospirifer.* Pelecypods of the genera *Palaeoneilo* and *Nuculites* have also been recognized, as well as an unidentified coral, bryozoan molds, and gastropods. All of these have been found in place in the rock at the water's edge. Besides this brownish, rather hard dolomite with some weak, shaly layers, there are numerous fragments on the beach of a greyer, more fossiliferous rock. Most of these are probably derived from the material thrown out of the shaft, as noted in Alden's description. This fine-grained, hydraulic limestone, he noted, was characterized by abundant pyritized fossils, pyrite crystals and calcite, and traces of bitumen. Today grey fragments of limestone with an abundance of crinoid stem fragments, *Tentaculites,* an occasional trilobite *(Phacops rana),* spirifers and other brachiopods, and bryozoans can be picked up on the beach. Sometimes they contain pyrite and calcite crystals, and vugs lined with asphaltic material. Some of this bitumen has also been found in the rocks cropping out at the water's edge, by the authors,

[7] In mid-July, 1963, the authors have found new exposures extending a little to the south, but the shifting character of the beach sands and gravels has brought about burial of some of the beds studied in March and April.

and this leads to speculation as to whether there might some day be a strike of off-shore oil for Wisconsin to turn over to the Federal government. Or how far out would the state's rights extend?

We wonder whether this ticklish problem will ever be put to the test.

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PARASITES OF EASTERN WISCONSIN FISHES

James D. Anthony

ABSTRACT

In a survey of fish parasites undertaken during the summer of 1960 from 17 lakes and pounds, 324 fishes representing 25 different species were examined. Those infected with at least one species of parasite totaled 300 and represented 93% of the total autopsied. The number of fish infected with each parasite is presented. The most common parasites found were monogenetic trematodes, of the Order Gyrodactyloidea, on the gills, scales and fins of 15 species of fish and *Neascus* spp. in 11 species of fish.

INTRODUCTION

This is the first of what is hoped to be a series of papers surveying the parasitic fauna of Wisconsin fishes. It is expected that future papers will attempt to show a correlation between th parasitic burden of lake and stream fishes with the chemical composition of the waters.

Surveys of fish parasites in northern Wisconsin by Fischthal (1947, 1950, 1952), and Bangham (1946) indicate that approximately 93% of the fishes collected were parasitized. This is, in general, higher than studies made in other parts of the United States but compares favorably with the results of the present study.

Collections were made with hook and line and with an electric shocker. The fish were examined as soon as possible after they were caught. Since the electric shocking was usually done at night the parasite examinations were conducted the next day after the fish had been on ice over night. The acanthocephalans and tapeworms were allowed to relax in the refrigerator and were then placed, along with the trematodes and other parasites, in Bouin's or formalin-alcohol-acetic acid fixative. Staining was done with borax carmine or haematoxylin. Mountaing was in piccolyte.

Special appreciation is due Mr. Vernon Hacker of the Wisconsin Conservation Department, the various district fish managers and

[1] Supported in part by the Research Committee of the Graduate School from funds supplied by the Wisconsin Alumni Research Foundation.

the crew of the boat containing the shocker, without whom it would have been impossible to conduct this survey. The identifications of the fish were aided by the above persons. Thanks are also due Dr. Ludwig Pauly for furnishing fish from Lake Beulah and Mr. Robert Calentine for confirming the diagnosis of *Khawia iowensis*. The fish names used are those in Hubbs and Lagler (1958).

LAKES AND PONDS SURVEYED

NAME	COUNTY	LOCATION	ACREAGE	DATE
1. Lake Bernice..........	Fond du Lac	Southeast	30	1 July 1960
2. Weyer's Lake.........	Manitowoc	East Central	10	6 July 1960
3. Beechwood Lake.......	Sheboygan	Southwest	14	12 July 1960
4. Jetzer's Lake..........	Sheboygan	North	12	13 July 1960
5. Black Otter Lake......	Outagamie	Southwest	62	15 July 1960
6. Lake Beulah..........	Walworth	Northeast	570	17 July 1960
7. Westfield Pond........	Marquette	Northwest	....	20 July 1960
8. East Alaska Lake......	Kewaunee	East	60	28 July 1960
9. Europe Lake..........	Door	North	220	2 Aug. 1960
10. McDill Pond..........	Portage	Central	140	2 Aug. 1960
11. Fish Lake.............	Waushara	West	177	17 Aug. 1960
12. Lake Nagawicka.......	Waukesha	Northwest	918	22 Aug. 1960
13. Iola Pond.............	Waupaca	West	150	31 Aug. 1960
14. Alderly Pond..........	Dodge	Southeast	....	13 Sept. 1960
15. Random Lake.........	Sheboygan	South	210	27 Sept. 1960
16. Little Green Lake......	Green Lake	Central	467	5 Oct. 1960
17. Green Lake...........	Green Lake	Central	7325	29 Nov. 1960

LIST OF FISH

Amia calva Linnaeus—Bowfin

Coregonus artedii birgei (Wagner)—Green Lake Cisco

Catostomus commersonnii commersonnii (Lacépède)—Common White Sucker

Erimyzon sucetta kennerlii (Girard)—Western Lake Chubsucker

Cyprinus carpio Linnaeus—Carp

Semotilus atromaculatus atromaculatus (Mitchill)—Northern Creek Chub

Notemigonus crysoleucas auratus (Rafinesque)—Western Golden Shiner

Notropis cornutus frontalis (Agassiz)—Northern Common Shiner

Pimephales notatus (Rafinesque)—Bluntnose Minnow

Ictalurus melas melas (Rafinesque)—Northern Black Bullhead

Ictalurus nebulosus nebulosus (LeSueur)—Northern Brown Bullhead
Ictalurus natalis natalis (LeSueur)—Northern Yellow Bullhead
Schilbeodes gyrinus (Mitchill)—Tadpole Madtom
Umbra limi (Kirtland)—Central Mudminnow
Esox lucius Linnaeus—Northern Pike
Perca flavescens (Mitchill)—Yellow Perch
Stizostedion vitreum vitreum (Mitchill)—Yellow Walleye
Percina caprodes (Rafinesque)—Logperch
Micropterus dolomieui dolomieui Lacépède—Northern Smallmouth Bass
Micropterus salmoides salmoides (Lacépède)—Northern Largemouth Bass
Lepomis cyanellus Rafinesque—Green Sunfish
Lepomis gibbosus (Linnaeus)—Pumpkinseed
Green Sunfish X Pumpkinseed
Lepomis macrochirus macrochirus Rafinesque—Common Bluegill
Ambloplites rupestris rupestris (Rafinesque)—Northern Rock Bass
Pomoxis nigromaculatus (LeSueur)—Black Crappie

Amia calva Linn.—Bowfin 5/5

Three fish from Lake Bernice and two fish from Lake Beulah were examined and all were infected. Those from Lake Bernice had *Azygia augusticauda* in two; *Contracaecum* sp. in three; *Proteocephalus* sp. in two; *Macroderoides parvus* in three; *Neoechinorhynchus cylindratus* in two; *Spiroxys* sp. in one and *Haplobothrium golbuliforme* in one. The two fish from Lake Beulah had *A. augusticauda* in two; *Contracaecum* sp. in two; *Proteocephalus* sp in two; *Macroderoides typicum* in two; *N. cylindratus* in one and *H. globuliforme* in one.

Coregonus artedii birgei (Wagner)—Green Lake Cisco 6/8

The five cisco from Little Green Lake and one of the three from Green Lake were heavily infected with *Cystidicola stigmatura* in the swim bladder. Two of the fish had over two hundred of these large nematodes and the others averaged approximately seventy-five per fish.

Catostomus commersonii commersonii (Table 1) 58/59

The suckers from Europe Lake were all heavily infected. All of them had *Diplostomulum* sp. in the lens of the eye and in most cases several hundred were present making the lens almost opaque. There was undoubtedly some loss of vision. Many of these fish also carried *Octomacrum lanceatum* on the gills; *Clinostomum marginatum* embedded in the flesh and *Neoechinorhynchus crassus* in the intestine.

Erimyzon sucetta kennerlii (Girard)—Western Lake Chubsucker 1/2

One of the two chubsuckers from Iola Pond was infected with one immature *Camallanus oxycephalus* and an immature Carophyllaeidae which appears to be *Glaridacris catostomi* but which cannot be positively identified.

Cyprinus carpio (Table 2) 38/45

Fourteen of the twenty carp from Alderly Pond were infected with *Khawia iowensis* as were two of the fish from Lake Bernice. This species was described by Calentine and Ulmer (1961) and the identification has been confirmed by these authors. The other caryophyllaeids were too immature to identify.

Semotilus atromaculatus atromaculatus (Mitchill)—Northern Creek Chub 8/8

The eight specimens from Lake Nagawicka were all parasitized. Gyrodactyloidea were found in seven; *Contracaecum* sp. in five; *Neascus* sp. in four; *Posthodiplostomum minimum* in two; *Proteocephalus* sp. in two and *Allocreadium lobatum* in two.

Notemigonus crysoleucas auratus (Rafinesque)—Western Golden Shiner 16/20

Four of the six fish from Lake Bernice had Gyrodactyloidea on the gills and three had *Neascus* sp. Nine of the eleven fish from Beechwood Lake had Gyrodactyloidea; five were infected with *Neascus* sp and *Plagiocirrus primus* occurred on three. The three fish from Random Lake all had Gyrodactyloidea. Two of the fish from Lake Bernice and two from Beechwood Lake were negative.

Notropis cornutus frontalis (Agassiz)—Northern Common Shiner 8/9

All of the common shiners were secured from Lake Bernice. Gyrodactyloidea and *Rhabdochona cascadilla* were found in four; *Allocreadium lobatum* was found in three and *Neascus* sp. in two.

Pimephales notatus (Rafinesque)—Bluntnose minnow 1/1

The one bluntnose minnow from Europe Lake had ten *Neascus* sp. metacercaria on the scales, immature *Contracaecum* sp. encysted in the liver and larval *Diplostomulum* sp. in the lens of the eye.

Ictalurus melas melas (Table 3) 19/19

Most of the black bullheads carried a heavy infection of *Aloglossidium corti* and *Corallobothrium fimbriatum* in the intestines as well as numerous Gyrodoctyloidea on the gills.

Ictalurus nebulosis nebulosis (Table 4) 30/30

Many of the brown bullheads had *Proteocephalus* sp. which was not found in the black bullheads and a lighter load of *Alloglossidium* sp. The infection of *Corallobothrium fimbriatum* and Gyrodactyloidea was about the same.

Ictalurus natalis natalis (LeSueur)—Northern Yellow Bullhead 3/4

Three of the four yellow bullheads from Iola Pond had Gyrodactyloidea; one had *Contracaecum* sp. and one had both *Dichelyne robusta* and *Phyllodistomum staffordi.*

Schilbeodes gyrinus (Mitchill)—Tadpole Madtom 1/1

This fish from McDill Pond was kept alive and autopsied a week after capture. It was found to have a heavy infection of Gyrodactyloidea and five *Trichodina* sp. on the gills. There were also eight *Spiroxys* sp. encysted on the mesenteries.

Umbra limi (Kirtland)—Central Mudminnow 5/7

Two of the three mudminnows from Jetzer's Lake had *Spiroxys* sp. and one had a single *Bunoderina eucaliae.* Three of the four from Iola Pond had *B. eucaliae* and three were single infections of *Proteocephalus* sp., *Clinostomum marginatum* and *Leptorhynchoides thecatus.*

Esox lucius Linn.—Northern Pike 3/3

The one pike from Jetzer's Lake contained twenty-six *Proteocephalus pinguis;* the one from Iola Pond had *Neascus* sp. and six *Leptorhynchoides thecatus;* the one from Random Lake had several hundred *Neascus* sp., three *Protocephalus pinguis* and four *Crepidostomum cooperi.* The low number of these fish secured indicates their ability to escape capture with an electric shocker.

Perca flavescens (Table 5) 16/16

The yellow perch in Lake Bernice and Europe Lake had relatively large numbers of *Bunodera sacculata.* The fish from Lake Bernice and Iola Pond had many Gyrodactyloidea on the gills.

Stizostedion vitreum vitreum (Mitchill)—Yellow Walleye 1/3

One of the three walleyes from Little Green Lake had an immature *Proteocephalus* sp. These were all young fish which had been planted after the lake had been poisoned. This perhaps is one method of controlling heavily parasitized lakes.

Percina caprodes (Rafinesque)—Logperch 1/1

The one logperch from Lake Bernice had three *Illinobdella* sp., one immature *Proteocephalus* sp. and one *Phyllodistomum etheostomae.*

Micropterus dolomieui dolomieui Lacepede—Northern Smallmouth Bass 3/3

The three fish from Europe Lake were all infected with *Neascus* sp., two of them had *Proteocephalus amblopkitis,* one had a light infection of *Diplostomulum* sp. and *Contracaecum* sp. occurred in two.

Micropterus salmoides salmoides (Table 6) 29/30

The largemouth bass were not heavily infected with any one parasite but had more of a variety of parasites than the other fish. Since these came from more different localities there seems to be a correlation between the number of different parasites and the variety of the habitats.

Lepomis cyanellus Rafinesque—Green Sunfish 5/5

The three fish from Weyer's Lake had an average of eighteen Gvrodactyloidea on the gills. The two fish from Random Lake had large numbers of *Diplostomulum* sp. in the lens of the eyes; one was infected with two immature *Proteocephalus* sp. and the same fish had one *Spinitectus* sp.

Lepomis gibbosus (Table 7) 7/8

The pumpkinseeds carried light infections with the exception of the Gyrodactyloidea on the gills, fins and scales.

Green Sunfish X Pumpkinseed 2/2

One of the two hybrids from Little Green Lake had one immature *Proteocephalus* sp. while each of the two fish contained two *Crepidostomum cooperi.*

Lepomis macrochirus macrochirus (Table 8) 26/26

The bluegills had almost the same parasitic infections as the pumpkinseeds except that *Bothriocephalus cuspidatus* was found in the former. Since these were from different lakes the occurrence is probably not significant. *Neascus* sp. was not found in the bluegills in Random Lake but was found in the pumpkinseeds.

Ambloplites rupestris rupestris (Rafinesque)—Northern Rock Bass 4/4

The rock bass were all collected from Europe Lake. All were infected with *Neascus* sp., *Capillaria catenata, Camallanus oxycephalus, Proteocephalus ambloplites* and Gyrodactyloidea. Three also had *Crepidostomum cooperi* and *Neoechinorhynchus cylindratus. Clinostomum marginatum* and *Spinitectus* sp. were found in two. One had a moderate infection of *Diplostomulum scheuringi.*

Pomoxis nigromaculatus (LeSueur)—Black Crappie 4/5

Two of the three crappies from Jetzer's Lake were parasitized with immature *Proteocephalus* sp. Both of the fish from Random

Lake had heavy infections of *Neascus* sp. in the fins and scales. Both also had light infections of *Proteocephalus pearsei, Crepidostomum cornutum* and *Spinitectus* sp. in the intestines.

Check List of Parasites

TREMATODA

Allocreadium lobatum Wallin, 1909
Allogossidium corti (Lamont, 1921)
Alloglossidium geminus (Mueller, 1930)
Azygia augusticauda (Stafford, 1904)
Bunodera sacculata Van Cleave and Mueller, 1932
Bunoderina eucaliae Miller, 1938
Clinostomum marginatum (Rudolphi, 1819)
Crepidostomum cooperi Hopkins, 1931
Crepidostomum cornutum Osborn, 1903
Diplostomulum scheuringi Hughes, 1929
Diplostomulum spp.
Gyrodactyloidea
Macroderoides parvus (Hunter, 1932)
Neascus spp.
Octomacrum lanceatum Mueller, 1934
Phyllodistomum etheostomae Fischthal, 1942
Phyllodistomum staffordi Pearse, 1924
Posthodiplostomum minimum (MacCallum, 1921)
Triganodistomum attenuatum Mueller and Van Cleave, 1932

CESTODA

Bothriocephalus cuspidatus Cooper, 1917
Caryophyllaeidae
Corallobothrium fimbriatum Essex, 1927
Glaridacris catostomi Cooper, 1920
Haplobothrium globuliforme Cooper, 1914
Khawia iowensis Calentine and Ulmer, 1961
Proteocephalus ambloplitis (Leidy, 1887)
Proteocephalus pearsei La Rue, 1919
Proteocephalus pinguis La Rue, 1911
Proteocephalus spp.

NEMATODA

Camallanus oxycephalus Ward and Magath, 1917
Capillaria catenata Van Cleave and Mueller, 1932
Contracaecum spp.
Cystidicola stigmatura (Leidy, 1886)
Dichelyne robusta (Van Cleave and Mueller, 1932)
Rhabdochona cascadilla Wigdor, 1918

Spinitectus gracilis Ward and Magath, 1917
Spinitectus spp.
Spiroxys sp.

ACANTHOCEPHALA

Leptorhynchoides thecatus (Linton, 1891)
Neoechinorhynchus crassus Van Cleave, 1919
Neoechinorhynchus cylindratus (Van Cleave, 1913)
Octospinifer macilentus Van Cleave, 1919
Pomphorhynchus bulbocolli Linkins, 1919

PROTOZOA

Trichodina sp.

COPEPODA

Achtheres micropteri Wright, 1882
Argulus catostomi Dana and Herrick, 1837
Ergasilus caeruleus Wilson, 1911

HIRUDINEA

Illinobdella sp.

TABLE 1. *Catostomus commersonii commersonii* (LACÉPÈDE)—
COMMON WHITE SUCKER

	Lake Bernice	Jetzer's Lake	Westfield Pond	East Alaska Lake	Europe Lake	Alderly Pond
Examined 59	3	14	11	3	17	11
Infected 58	3	14	10	3	17	11
Argulus catostomi	0	0	1	0	0	0
Clinostomum marginatum	0	0	0	0	6	0
Diplostomulum sp.	0	0	0	0	17	0
Glaridacris catostomi	2	0	10	0	3	4
Gyrodactyloidea	2	4	6	1	3	9
Neoechinorhynchus crassus	1	6	0	1	8	0
Octomacrum lanceatum	0	0	0	0	12	0
Octospinifer macilentus	0	2	0	1	0	2
Pomphorhynchus bulbocolli	0	4	0	2	2	0
Proteocephalus sp.	0	0	0	0	0	3
Triganodistomum attenuatum	1	3	5	0	0	5

TABLE 2. *Cyprinus carpio* LINNAEUS—CARP

	LAKE BERNICE	JETZER'S LAKE	WEST-FIELD POND	ALDERLY POND	RANDOM LAKE
Examined 45	5	3	14	20	3
Infected 38	3	2	11	19	3
Caryophyllaeidae	1	0	0	5	0
Gyrodactyloidae	3	2	8	15	1
Khawia iowensis	2	0	0	14	0
Pomphorhynchus bulbocolli	0	0	0	0	3
Proteocephalus sp.	0	2	0	0	0
Spinitectus sp.	0	0	5	3	0

TABLE 3. *Ictalurus melas melas* (RAFINESQUE)—NORTHERN BLACK BULLHEAD

	LAKE BERNICE	BEECH-WOOD LAKE	BLACK OTTER LAKE	RANDOM LAKE
Examined 19	5	4	7	3
Infected 19	5	4	7	3
Alloglossidium corti	4	3	5	3
Azygia augusticauda	1	0	2	0
Corallobothrium fimbriatum	3	4	3	1
Dichelyne robusta	1	2	2	2
Gyrodactyloidea	4	4	6	3
Leptorhynchoides thecatus	0	0	1	0
Pomphorhynchus bulbocolli	0	1	0	0
Spinitectus gracilis	2	0	0	0

TABLE 4. *Ictalurus nebulosus nebulosus* (LESUEUR)—NORTHERN BROWN BULLHEAD

	EAST ALASKA LAKE	LAKE BEULAH	FISH LAKE	IOLA POND
Examined 30	15	5	6	4
Infected 30	15	5	6	4
Alloglossidium corti	0	2	0	1
Allogoloosidium geminus	2	0	1	0
Clinostomum marginatum	0	0	1	0
Corallobothrium fimbiratum	11	4	6	2
Dichelyne robusta	3	0	1	0
Diplostomulum sp.	2	1	0	0
Gyrodactyloidea	13	5	3	3
Leptorhynchoides thecatus	2	0	1	0
Proteocephalus sp.	6	3	3	1
Spinitectus sp.	1	0	0	0

TABLE 5. *Perca flavescens* (MITCHILL)—YELLOW PERCH

	LAKE BERNICE	EUROPE LAKE	IOLA POND	RANDOM LAKE
Examined 16	6	4	4	2
Infected 16	6	4	4	2
Bothriocephalus cuspidatus	0	0	2	0
Bunodera sacculata	4	3	0	0
Camallanus oxycephalus	0	1	0	1
Clinostomum marginatum	0	2	0	0
Diplostomulum sp.	0	1	0	0
Gyrodactyloidea	5	0	3	0
Neascus sp.	3	3	2	0
Neoechinorhynchus cylindratus	0	1	0	0
Proteocephalus sp.	1	1	0	0
Spinitectus sp.	2	0	1	2

TABLE 6. *Micropterus salmoides salmoides* (LACÈPÉDE)—NORTHERN LARGEMOUTH BASS

	Lake Bernice	Beech-wood Lake	Jetzer's Lake	East Alaska Lake	Fish Lake	Iola Pond	Random Lake	Little Green Lake
Examined 30	4	5	3	3	5	4	3	3
Infected 29	4	5	3	3	5	4	3	2
Achtheres micropteri	1	0	0	0	1	0	0	0
Azygia augusticauda	2	0	0	0	0	0	0	0
Clinostomum marginatum	1	1	0	0	0	0	0	1
Contracaecum sp.	0	0	1	0	0	1	0	0
Crepidostomum cooperi	0	0	0	0	2	0	0	0
Diplostomulum sp.	0	0	0	2	0	0	1	0
Ergasilus caeruleus	0	0	0	1	0	0	0	0
Gyrodactyloidea	3	5	2	0	2	4	3	0
Leptorhynchoides thecatus	0	2	1	2	0	0	2	0
Neascus sp.	0	3	1	0	0	2	0	0
Neoechinorhynchus cylindratus	1	0	0	0	0	0	0	0
Proteocephalus ambloplitis	2	2	2	1	3	0	2	0
Proteocephalus sp.	0	2	0	0	0	1	2	1
Spinitectus sp.	1	0	0	0	0	0	2	0

TABLE 7. *Lepomis gibbosus* (LINNAEUS)—PUMPKINSEED

	LAKE BERNICE	IOLA POND	RANDOM LAKE
Examined 8	2	3	3
Infected 7	2	2	3
Camallanus oxycephalus	0	0	1
Clinostomum marginatum	1	0	0
Diplostomulum sp.	0	0	2
Gyrodactyloidea	2	2	3
Neascus sp.	0	1	3
Posthodiplostomum minimum	1	0	1
Spinitectus sp.	1	0	1

TABLE 8. *Lepomis macrochirus macrochirus* RAFINESQUE—COMMON BLUEGILL

	JETZER'S LAKE	LAKE BEULAH	FISH LAKE	ALDERLY POND	RANDOM LAKE
Examined 26	9	1	7	4	5
Infected 26	9	1	7	4	5
Bothriocephalus cuspidatus	2	1	5	0	0
Crepidostomum cooperi	3	0	6	3	2
Diplostomulum sp.	0	0	0	0	4
Ergasilus caeruleus	0	0	1	1	0
Gyrodactyloidea	5	1	3	4	4
Illinobdella sp.	1	0	0	0	0
Leptorhynchoides thecatus	1	0	1	1	3
Proteocephalus ambloplitis	0	0	3	0	0
Spinitectus carolini	2	0	2	0	1

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ZUR KENNTNIS DER SCOLYTIDAE— UND PLATYPODIDAE— FAUNA AUS COSTA RICA

Marian Nunberg

Editors Note: The costs involved in publishing this paper have been paid in full from funds allocated to the Department of Entomology, University of Wisconsin, for research on insects affecting the cocoa tree. The studies are supported in large part by the American Cocoa Research Institute, Washington, D. C. and the Ambrosia Chocolate Company of Milwaukee (Schoenleber Fund). Institutions and organizations cooperating in the research are the Agricultural Experiment Station, College of Agriculture, University of Wisconsin; the Inter-American Institute of Agricultural Sciences of the O.A.S. located at Turrialba, Costa Rica; the Inter-American Cacao Center, Turrialba, Costa Rica; and the United Fruit Company through the Compania Bananera de Costa Rica.

It is interesting to observe that entomologists from Wisconsin are working in Costa Rica, that the insects involved in this paper were named by an authority on bark beetles in Poland and that the article is written in German. This illustrates well the cooperation occurring among organizations and individuals in the scientific field.

Im J. 1962 erhielt ich vom Herrn Prof. R. D. Shenefelt, University of Wisconsin, U.S.A., eine Sendung von 497 Käfern aus oben erwähnten Familien zum Bearbeiten.

Alle Käfer stammen aus Costa Rica, Ortschaft LaLola; sie waren an das Licht gefangen. Aus diesem Grunde darf man annehmen, dass alle Käfer schon ausgefärbt, ja die pilzzüchtende Holzbrüter selbst im ausgereiften Zustande waren.

Für das Ermöglichen dieser Arbeit möchte ich an dieser Stelle Herrn Professor R. D. Shenefelt meinen besten Dank aussprechen.

FAMILIE: SCOLYTIDAE

Bekannte Arten

1. *Pagiocerus frontalis* (F.)
   26.VII.61–1 Ex. (Weibchen); 24.VIII.61–1 Ex. (Männchen).

2. *Neodryocoetes hymenaeae* Egg.
   10.VII.61–2 Ex.; 17.VII.61–2 Ex.; 28.VII.61–1 Ex.
   So weit nach Norden wurde diese Art noch nicht gefunden. Bis jetzt gemeldet aus Brasilien, Fr. Guayana und Hol. Guayana.

3. *Pityophthorus guadeloupensis* Nunb. (= *denticulatus* Egg.)
   8.VIII.61–1 Ex.
   Diese Art wurde bis jetzt nur aus der Insel Guadeloupe bekannt.

4. *Pterocyclon plaumanni* Schedl
   12.VII.61–1 Ex.; 23.VIII.61–1 Ex.
   Bis jetzt bekannt nur aus Brasilien.

5. *Xyleborus affinis* Eichh.
   12.VII.61–1 Ex.; 17.VII.61–1 Ex.; 21.VII.61–1 Ex.; 25.VII.61–2 Ex.; 26.VII.61–2 Ex.; 30.VII.61–1 Ex.; 8.VIII.61–2 Ex.; 23. VIII.61–2 Ex.; 24.VIII.61–5 Ex.
6. *Xyleborus ferrugineus* (F.).

   13.V.58–4 Ex.; 10.VII.61–3 Ex., in cacao plantation; 11.VII. 61–1 Ex.; 15.VIII.61–1 Ex.; 23.VIII.61–7 Ex.; 24.VIII.61–10 25.VII.62–1 Ex.; 26.VII.61–1 Ex.; 28.VII.61–4 Ex.; 29.VII. 61–1 Ex.; 30.VII.61–2 Ex.; 31.VII.61–2 Ex.; 4.VIII.61–12 Ex.; 8.VIII.61–6 Ex.; 10.VIII.61–1 Ex.; 11.VIII.61–1. Ex.; 13.VIII. 61–2 Ex.; 15.VIII.61–1 Ex.; 23.VII.61–7 Ex.; 24.VIII.61–10 Ex.; 26:VIII.61–1 Ex.

7. *Xyleborus macer* Bldf.
   23.VIII.61–1 Ex.

8. *Xyleborus perforans* (Woll.).
   13.V.58–1 Ex.; 17.VII.61–3 Ex.; 18.VII.61–2 Ex.; 19.VII.61–1 Ex.; 20.VII.61–2 Ex.; 21.VII.61–2 Ex.; 26.VII.61–1 Ex.; 28. VII.61–1 Ex.; 30.VII.61–1 Ex.; 4.VIII.61–1 Ex.; 8.VIII.61–1 Ex.; 10.VIII.61–1 Ex.; 11.VIII.61–1 Ex.; 13.VIII.61–2 Ex.; 15.VIII.61–2 Ex.; 23.VIII.61–7 Ex.; 24.VIII.61–4 Ex.; 26. VIII.61–2 Ex.

9. *Xyleborus spinulosus* Bldf.
   23.VIII.61–1 Ex.
   Weit verbreitet in Süd- und Mittelamerika (Antillen eingerechnet) aber in Costa Rica noch nicht gefunden.

10. *Xyleborus volvulus* (F.)
    10.VII.61–1 Ex.; 12.VII.61–1 Ex.; 17.VII.61–3 Ex.; 18.VII. 61–5 Ex.; 19.VII.61–13 Ex.; 20.VII.61–10 Ex.; 21.VII.61–3 Ex.; 25.VII.61–9 Ex.; 26.VII.61–10 Ex.; 28.VII.61–4 Ex.; 29. VII.61–7 Ex.; 30.VII.61–5 Ex.; 31.VII.61–4 Ex.; 4.VIII.61–13 Ex.; 8.VIII.61–12 Ex.; 15.VIII.61–1 Ex.; 23.VIII.61–35 Ex.; 24.VIII.61–25 Ex.; 28.VIII.61–3 Ex.
    Neue Arten

11. *Pityophthorus semiermis* sp. n.
    Männchen (Taf. I.Fig. 1–4).
    Länge: 1,7 mm.

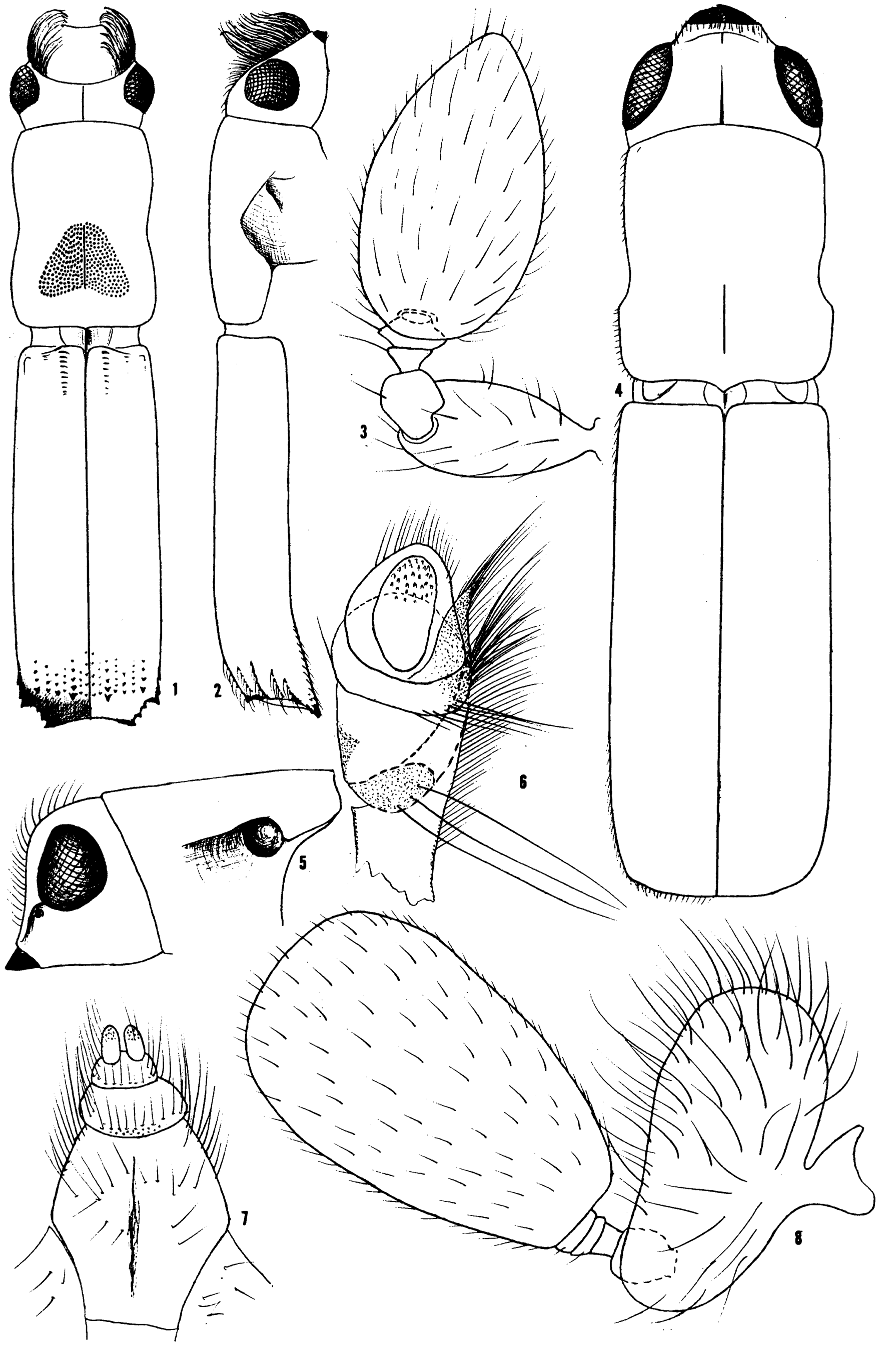
Hellbraun, auf dem Absturze und dem Halsschilde etwas dunskler. Behaarung spärlich; im unteren Teile der Stirn und auf der vorderen Hälfte des Halsschildes im Bereiche der Schuppenkörnchen ziemlich dicht aber kurz behaart; in der hinteren Hälfte der Flügeldecken sind einzelne aufrechte Haare zu bemerken.

Stirn im unteren Teile zwischen den Augen auf einer halbbkreisförmigen Fläche schwach eingedrückt und fein punktiert, am oberen Rande des Eindruckes mit einem undeutlichen Höckerchen. Augen sehr gross, vorne tief ausgerandet. Fühlerkeule eiförmig, mit zwei Einkerbungen im Umriss und zwei bogig gekrümmten und unvollkommen septierten Nähten; die dritte Naht nur durch Borsten angedeutet. Die Keule etwas länger als die Geissel und ebenso lang wie der Schaft.

Halsschild kaum länger als breit, an der Basis fast gerade, Seiten in der basalen Hälfte parallel dann schwach eingeengt, der Vorderrand ziemlich schmal gerundet, Seitenrand deutlich aber nicht scharf. Halsschild ohne deutlichen Buckel und gleich dahinter leicht eingedrückt. Die erste Höckerreihe läuft entlang des Vorderrandes und ist aus kleinen gleichgrossen Höckern gebildet; oberhalb der ersten liegt ein breiter glatter fein punktierter Streifen; die zwei weiteren Höckerreihen liegen in gleicher Entfernung voneinander und in der Mitte zeigen sie eine unregelmässige Anordnung der Höcker; gleich vor dem Summit sind keine Höcker mehr nur quere feine Runzeln. In der basalen Hälfte fein punktiert und eine ziemlich breite Mittellinie freilassend.

Schildchen breit dreieckig.

Flügeldecken 1, 6 mal so lang wie der Halsschild, an der Basis kaum schmäler als dieser, hinter der Schulterbeule schwach ausgebaucht, von da an allmählich convergierend und am Ende ziemlich schmal abgerundet. Oben in der Länge flach, im ersten Drittel schwach eingedrückt; Absturz beginnt im letzten Drittel und ist sanft abgewölbt. Flügeldecken in unregelmässigen Reihen punktiert, speziell an der Basis stehen die Punkte in grosser Unordnung. Zwischenräume fein quer gerunzelt und mit einzelnen feinen Pünktchen. Die Naht in nicht grosser Entfernung hinter dem Schildchen erhöht, stärker auf dem Absturze, hier glatt, ohne Körnchen; die Furche auf dem Absturze läuft im Bereiche des zweiten Zwischenraumes (Nahtzwischenraum eingerechnet), ziemlich tief; die Seitenwülste kaum höher als die Naht, mit drei kleinen spitzen, borstentragenden Körnchen.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FIGURENERKLÄUNG DER TAFELN I, II

TAFEL I

FIGURE 1. *Pityophthorus semiermis* sp. nov., von oben.

FIGURE 2. *Pityophthorus semiermis* sp. nov., von der Seite.

FIGURE 3. *Pityophthorus semiermis* sp. nov., Kopf von vorne.

FIGURE 4. *Pityophthorus semiermis* sp. nov., Fühler, Vergr. 115 x.

FIGURE 5. *Sampsonius costaricensis* sp. nov., Fühler, Vergr. 115 x.

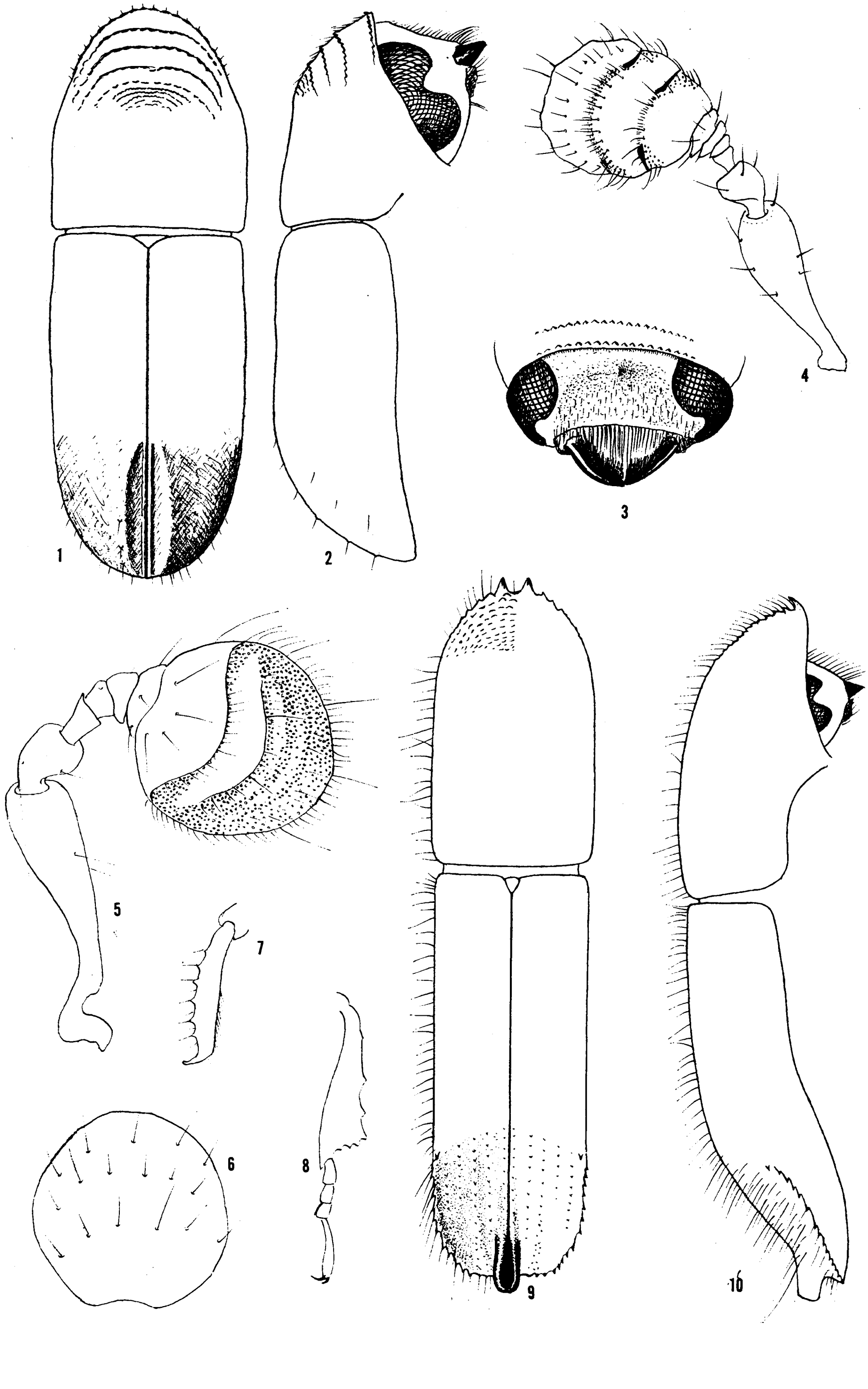
FIGURE 6. *Sampsonius costaricensis* sp nov., Fühlerkeule, die Rüskseite, Vergr. 115 x.

FIGURE 7. *Sampsonius costaricensis* sp. nov., Vordertibie.

FIGURE 8. *Sampsonius costaricensis* sp. nov., Hintertibie und Tarsus.

FIGURE 9. *Sampsonius costaricensis* sp. nov. Weibchen, von oben.

FIGURE 10. *Sampsonius costaricensis* sp. nov., Weibchen, von der Seite.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TAFEL II

FIGURE 1. *Cenocephalus lalolaensis* sp. nov., Weibchen, von oben.
FIGURE 2. *Cenocephalus lalolaensis* sp nov., Weibchen, von der Seite.
FIGURE 3. *Cenocephalus lalolaensis* sp. nov., Fühler, Vergr. 115 x.
FIGURE 4. *Costaroplotus shenefelti* sp. nov., Weibchen, von oben.
FIGURE 5. *Costaroplatus shenefelti* sp. nov., Kopf und Halsschild, von der Seite.
FIGURE 6. *Costaroplatus shenefelti* sp. nov., Maxille, Vergr. 115 x.
FIGURE 7. *Costaroplatus shenefelti* sp. nov., Unterlippe, Vergr. 115 x.
FIGURE 8. *Costaroplatus shenefelti* sp nov., Fühler, Vergr. 42 x.

Unterseite heller as die Oberseite. Die Vorder -und Mitteltibien aussen mit drei Zähnchen; neben den Vorderhüften, etwas seitlich, befindet sich ein ovaler Schlitz (?). Die Vorderhüften stossen zusammen, die beiden anderen Paare sind getrennt. Die Mittelfurche an der Hinterbrust sehr fein, zieht sich nach vorne bis zu ⅔ der Brustlänge. Die Bauchringe an den Seiten breiter, die zwei ersten schwach bogig, andere stärker; Pygidium von unten sichtbar als halb kreisförmige Platte.

Type in Sammlung der Universität Wisconsin.

Nach dem Bau des Kopfes und Halsschildes dem *P. elegans* Schedl ähnlich, aber die Höker auf dem Halschilde stehen bei der letztger nannten Art mehr locker; auf dem Absturze des *P. elegans* befinden sich auf der Naht feine Körnchen, während bei *semiermis* die Naht glatt ist.

Die Fühler sind sehr ähnlich denselben bei vielen Arten z. B. *Pit. regularis* Blkm. Nach dem Absturze erinnert die neue Art an *Pit. sambuci* Blkm. bei welchem aber auf dem breit abgerundetem Absturze die Punktstreifen 1. und 2. gut sichtbar sind.

12. *Sampsonius costaricensis* sp. n.

Weibchen (anatomisch festgestellt) (Taf. I. Fig. 5–10).
Länge: 3,4 mm.

Dem *Sampsonius dampfi* Schedl sehr ähnlich und am nächsten verwandt, aber verschieden durch andere Proportionen der Körperabschnitte, die Körnelung des Absturzes und Ausbildung des Fortsatzes auf dem Absturze.

Beim *S. dampfi* ist der Käfer 3,7 mal so lang wie breit, beim *costaricensis* m. 4,4 mal; die Ursache liegt in der Länge des Halsschildes, welcher beim *dampfi* Schedl 1,25 länger als breit ist, bei der neuen Art aber 1,66 mal. Die Flügeldecken sind bei der neuen Art verhältnismässig kürzer: beim *dampfi* Schedl sie sind "nahezu doppelt so lang wie der Halsschild"—beim *costaricensis* nur 1,5 mal.

Beim *dampfi* Schedl stehen auf dem Absturze die Körnchen nur auf den Zwischenräumen 3,4 und 5 und sind einreihig geordnet. Bei *costaricensis* m. sind die Körnchen auf den Zwischenräumen 1–5; die Körnchen des 1–n (Nahtzwischenraumes) und 2–n verschwinden auf der Höhe der Fortsatzbasis, auf dem dritten, welcher bis zum Apikalrande zieht, stehen sie in der oberen Absturzhälfte einreihig in der unteren mindestens zweireihig (kurz vor dem Apikalrande auch dreirehig); auf dem 4–n sind nur etwa 4–5 Körnchen, auf dem 5–n zieht sich die Körnchenreihe etwas weiter nach hinten, auf dem 6–n steht nur am oberen Absturzrande ein stärkeres Zähnchen; der 7–e bildet wie beim *dampfi* Schedl den Absturzseitenrand. Die Punktreihen sind auf dem Absturze zwischen den Körnchenreihen nicht "grob quergerun zelt"—sondern fein chagriniert, matt. Die Absturzfläche ist leicht gewölbt, der 2–3 Zwischenraum leicht vertieft, wodurch die Naht und der dritte Zwischenraum gehoben erscheinen; der letzte ist im apikalen Drittel etwas verbreitet. Die Zwischenräume 4–6 fallen gegen den Seitenrand allmählich ab. Beide Fortsätze an der Naht bilden beim *dampfi* Schedl "ein gemeinschaftliches stumpfes Horn". Beim *costaricensis* m. bilden sie (bei geschlossenen Flügeldecken) ein löffelartiges Gebilde, welches oben tief ausgehöhlt ist.

Die Fühlerkeule trägt auf der Aussenseite, kurz vor der Mitte, eine volkkommene Naht; die zweite mehr weniger parallele Naht verliert sich zwischen den dicht stehenden Punkten neben dem Rande; es sind noch Spuren von Weiteren zwei Nähte, welche nur durch mehrreihige Punktstreifen markiert sind. Das erste Keulenglied trägt einige steife Borsten. Auf der Rückseite sind drei bogige Borstenreihen, welche fast auf derselben Höhe laufen, wie die Nähte der Vorderseite.

Die Tibien des ersten Beinpaares sind schmal, aussen nur schwach bogenförmig erweitert und hier auf ganzer Länge mit etwa 5–6 Zähnchen. Der Endhaken ist stark und nach aussen gekrümmt. Die Tibien des zweiten und dritten Beinpaares sind allmählich erweitert und im apikalen Viertel schräg abgeschnitten.

Drei Exemplare gefangen am 20.VII.61, 24.VIII.61 und 23.VIII.61. Eine Paratype befindet sich in meiner Sammlung.

BESTIMMUNGSTABELLE DER *SAMPSONIUS*-ARTEN

1(2). Seitenrand des Absturzes nicht ausgepraägt. Am Beginn des Absturzes auf dem dritten Zwischenraume steht senkrecht ein dicker konischer Zapfen, auf dem vierten in der Mitte und kurz vor dem Ende ebenfalls ein doppelt so langer nach innen und vorn gebogener stumpfer Zahn. Körperlänge 8 mm ------*Sampsonius sexdentatus* Eggers

2(1). Seitenrand ausgeprägt. Die Bezahnung der Absturzfläche ist andere.

3(8). Auf dem Absturze jeder Flügeldecke unmittelbar vor dem Apikalrande befindet sich nur auf dem Nahtzwischenraume ein Zahn.

4(5). Der Zahn ist spitz, nach hinten und aussen gerichtet. Körperlänge 5,3 mm -------------*Sampsonius buculus* Schedl

5(4). Der Zahn ist als plattenförmiger stumpfer Fortsatz ausgebildet.

6(7). Die Firtsätze der geschlossenen Flügeldecken bilden ein gemeinschaftliches stumpfes Horn. Kleine Körnchen befinden sich nur auf Zwischenräumen 3,4,5. Körperlänge 3,2 mm ---------------------------*Sampsonius dampfi* Schedl

7(6). Beide Fortsätze der geschlossenen Flügeldecken stossen nicht zusammen zum gemeinschaftlichen Horn, sondern oben tief klaffen. Kleine Körnchen auf dem Absturze befinden sich auf Zwischenräumen 1–5. Am Anfange des sechsten Zwischenraumes am Beginne des Absturzes ein spitzes kleines Zähnchen. Körperlänge 3,4 mm ---------- ----------------------*Sampsonius costaricensis* sp. nov.

8(3). Die Zähne auf dem Absturze befinden sich nur auf dem zweiten Zwischenraume, zwei bis drei an der Zahl.

9(10). Auf dem zweiten Zwischenraume stehen drei gleichgrosse, kegelförmige Zähne. Körperlänge 5,5 mm -------------- ------------------------*Sampsonius conifer* (Hagedorn)

10(9). Auf dem zweiten Zwischenraume stehen zwei Zähne; der obere ist ein spitzer Kegelzahn, der untere ist stumpf. Körperlänge 5,3 mm. ------*Sampsonius quadrispinosis* Eggers

FAMILIE: PLATYPODIDAE

Bekannte Arten

13. *Platypus dejeani* Chap.
13.V.58–12 Ex (9 Männchen, 3 Weibchen); 2.VII.61–10 Ex. (6 M., 4 W.); 10.VII.61–10 Ex (8 M., 2 W.) in cocoa plantation; 10.VII.61–2 Ex. (1 M., 1 W.); 11.VII.61–10 Ex. (5 M., 5 W.); 12.VII.61–14 Ex. (5 M., 9 W.); 18.VII.61–7 Ex. (3 M., 4 W.); 20.VII.61–1 Ex. (1 M.); 21.VII.61–4 Ex. (3 M., 1 W.); 25.VII.61–1 Ex. (M.); 26.VII.61–7 Ex. (5 M., 2 W.); 28.VII. 61–5 Ex. (2 M., 3 W.); 29.VII.61–6 Ex. (4 M., 2 W.); 30.VII. 61–15 Ex. (7 M., 8 W.); 31. VII.61–11 Ex. (9 M., 2 W.); 4. VIII.61–19 Ex. (13 M., 6 W.); 8.VIII.61–1 Ex. (W.); 10.VIII. 61–4 Ex. (M.); 11.VIII. 61–2 Ex. (M.); 13.VIII.61–2 Ex. (1 M., 1 W.); 15.VIII.61–5 Ex. (3 M., 2 W.); 23.VIII.61–1 Ex. (M.); 24.VIII.61–4 Ex. (2 M., 2 W.); 26.VIII. 61–3 Ex. (1 M., 2 W.); 28.VIII.61–3 Ex. (M.).

14. *Platypus discicollis* Dej.
24.VIII.61–1 Ex. (W.).
Gemeldet aus Brasilien, Columbien, Bolivien, Guatemala und Fr. Guayana.

Das Exemplar hat Flügeldecken fein gleichmässig chargriniert und dadurch seidenglänzend. Die Borsten auf dem Halsschilde zwischen der Mittelfurche und dem Seitenrande stehen mehr weniger an der Grenzlinie der braunen und blassgelben Farbe.

15. *Platypus obtusus* Chap.
10.VII.61–1 Männchen. in cocoa plantation.
LaLola ist der nördlichste Fundort. Bis jetzt gemeldet aus Brasilien, Fr. Guayana und Columbien.

16. *Platypus perpusillus* Chap.
2.VII.61–2 Ex. (M.) ; 10.VII.61–1 Ex. (M.) ; in cocoa plantation.
Bekannt aus Brasilien, Venezuela und Fr. Guayana.

17. *Platypus pulchellus* Chap.
10.VII.61–1 Weibchen, in cocoa plantation; 12.VII.61–2 Weibchen; 17.VII.61–3 Ex. (1 M., 2 W.) ; 18.VII.61–1 M.; 20.VII. 61–1 M.; 29.VII.61–2 Ex. (1 M., 1 W.) ; 30.VII.61–1 M.; 31. VII.61–3 W.; 4. VIII.61–2 Ex. (1 M., 1 W.) ; 8.VIII.61–1 W.; 13.VIII.61–1 W.; 15.VIII.61–1 M.; 24.VIII.61–1 M.; 28.VIII. 61–1 W.

18. *Platypus rudifrons* Chap.
2.VII.61–1 Weibchen.
Bis jetzt bekannt aus Mexico und Argentinien.

19. *Platypus subitarius* Schedl
10.VII.61–1 Weibchen, in cocoa plantation; 24.VIII.61–1 Männchen.
Bekannt nur aus Brasilien.

20. *Tesserocerus dewalquei* Chap.
2.VII.61–1 Weibchen.
Bis jetzt bekannt nur aus Südamerika (Brasilien, Argentinien, Fr. Guayana, Bolivien und Peru).

Neue Arten und Gattungen

21. *Cenocephalus lalolaensis* sp. nov.
Weibchen (Taf. II. Fig. 1–3).
Länge 3,3 mm.
Langzylindrisch, Flügeldecken nach hinten kaum divergierend; rostbraun, auf dem Absturze angedunkelt; nur am Kopfe und auf dem Absturze deutlich behaart.

Kopf mit ziemlich stark eingedrückter Stirn, die Fläche des Eindruckes glänzend, nicht punktiert; beide Seiten des Eindruckes bis zur halben Augenhöhe mit dichter Haarfranse, die Haare am Ende leicht nach innen gebogen. Übriger Seitenrand kürzer behaart, ähnlich wie der zerstreut aber ziemlich stark punktierte Scheitel. Übergang von der Stirn zum Scheitel nicht stark hervortretend. Die dunkle Scheitellinie zieht sich nach unten bis zur Mitte des Stirneindruckes. Augen unregelmässig rundlich. Fühler mit dreigliederigen Geissel (nicht viergliederig!) und langeiförmigen Keule.

Halsschild viel länger als breit, glänzend, in der Länge flach gewölbt, Seiten (von oben betrachtet) in der Mitte deutlich eingebuchtet, die basale Hälfte kaum breiter als die vordere, Basalrand angerundet, zweibuchtig. Die Pleuren mit doppelter Grube zur Aufnahme der Schenkel und Schienen; der Rand der Grube bogig ausgeschweift, ohne eckige Vorsprünge. Auf der Scheibe, beiderseits der Mittellinie ein grosser mehr weniger dreieckiger Fleck aus ziemlich grossen Punkten, die Ecken des Fleckes abgerundet, die Basis eingebuchtet. Restliche Fläche fein punktuliert und ausserdem ziemlich zerstreut grob punktiert: die Punkte an der Halsschildbasis und an den Seiten stärker.

Flügeldecken (von der Seite gesehen) oben flach, der Absturz beginnt im letzten Viertel, die Fläche des Absturzes oben sanft abgewölbt, unten fast senkrecht. Basalrand im Bereiche der Zwischenräume 1–5 gekantet. Der dritte an der Basis stärker gewölbt und hier mit etwa 5 Querrunzeln welche weiter nach hinten in Körnchen übergehen; der fünfte mit 1–2 undeutlichen Querrunzeln. Die drei ersten Puntreihen schwach streifig vertieft, den Seiten zu werden die Punkte der Streifen immer schwächer, nur der neunte ist wiederum streifig vertieft. Zwischenräume der Scheibe schwach gewölbt, die seitlichen flach, alle hie und da mit einzelnen sehr feinen Pünktchen. Alle Zwischenräume kurz vor dem Absturze deutlich gekielt und weiter hinten gekörnt, auf den ungeraden Zwischenräumen gehen die Körnchen in Zähnchen über, auf dem dritten, siebenten und neunten sind sie am stärksten entwickelt: nach hinten nehmen die Zähnchen an Stärke zu. Auf dem steilen Abschnitte des Absturzes ist die Fläche glänzend, zertreut punktiert und gekörnt, im unteren Teile, beiderseits der Naht flach eingedrückt; der mittlere Teil des Hinterrandes glatt. In der Verlängerung des dritten Zwischenraumes zieht sich ein schwach gewölbter Streifen in der Richtung des grössten Zahnes am Hinterrande. Die Zähnchen und Körnchen auf dem Absturze tragen kurze, gekrümmte Haare.

Die Vorderschieben tragen auf der Aussenseite drei quere Leisten, die mittleren zwei und die hinteren nur eine Leiste.

Zwei Exemplare gefangen am 4.VIII.61. Die Paratype befindet sich in meiner Sammlung.

BESTIMMUNGSTABELLE DER *CENOCEPHALUS*-WEIBCHEN

1(4). Auf der Scheibe des Halsschildes beiderseits der Mittelfurche befindet sich ein Fleck aus zahlreichen Punkten gebildet.

2(3). Der Fleck ist rundlich. Körperlänge 5,3 mm Brasilien ---- ----------------------------*Cenocephalus thoracicus* Chap.

3(2). Der Fleck ist dreieckig. Körperlänge 3,3 mm. Costa Rica -- --------------------------*Cenocephalus lalolaensis* sp. nov.

4(1). Auf der Scheibe des Halsschildes, beiderseits der Mittelfurche, befindet sich kein Fleck aus zahlreichen Punkten.

5(6). In der Mitte der concaven Stirnfläche befindet sich eine quere kurze Leiste. Körperlänge 4,4 mm. Fr. Guayana -------- -----------------------------*Cenocephalus pusillus Schedl*

6(5). Die concave Stirnfläche ist glatt. Körperlänge 4 mm. Guayana -----------------*Cenocephalus pulchellus* Schedl

Costaroplatus gen. nov.

Eine Gattung, welche wegen des Baues der Unterlippe und der Fühler schwer in das System einzureihen ist. Vielleicht nach dem Finden des anderen Geschlechtes (Männchens) wird es erst möglich sein. Die Gattung wird auf Grund des einzigen weiblichen Exemplares gegründet.

Kopf ohne Bruch zwischen Stirn und Scheitel, dem Kopfe des *Tesserocerus*-Weibchens ähnlich; Augen unregelmässig rundlich. Fühler mit grossem Schafte, welcher sehr stark abgeplattet und schwach löffelartig ausgehöhlt ist; auf der Vorderseite und an den Rändern ist er ziemlich lang behaart. Beide Schäfte bedecken die Stirn bis zur Hälfte der Augenhöhe, ähnlich wie bei *Tesserocranulus* Schedl, aber im kleineren Masse (die erwähnte Gattung hat lange, unten genäherte Augen!). Geissel viergliederig, Glied 1 kurz kegelförmig, das 2. verkehrt kegelförmig, um die Hälfte kürzer als Glied 1., das dritte und vierte kurz, etwas breiter. Die Keule solid, unregelmässig länglich oval, nicht viel grösser als der Schaft.
Maxillen mit gesonderten Laden, die Tasterglieder stark abgeplattet, membranenartig. In der Unterlippe sind sowohl die Tasterträger wie auch die beiden ersten Glieder verwachsen, weshalb separat nur die letzten Glieder ausgebildet sind. Eine faltenartige Zunge ist auch zu bemerken. Durch diesem Bau wohl am meisten der *Crossotarsus*-Gattung genähert, bei welcher aber nur die Tasterträger zusammengewachsen sind, fehlt aber das zweite Stück, welches durch Zusammenwachseb der beiden ersten Glieder entstanden ist.

Halsschild Platypodiden-artig, ohne Poren oder Punktfleck, mit feiner Furche. Der Rand der Schenkelgruben nur hinten eckig, und hier mit einer fast halbkugeligen, tiefen Eindellung (ähnlich aber stärker als bei manchen *Crossotarsus*-Weibchen, z.B. *Cross nipponicus* Bldf.). Flügeldecken wie beim *Platypus*-Weibchen.

Die Vordertibien mit 6 Querleisten, die mittleren mit drei, die Hintertibien ohne derselben. Tarsen wie beim *Platypus*.

22. Genus-Type: *Costaroplatus shenefelti* sp. nov.
Weibchen (Taf. II. Fig. 4–8).
Länge: 4,4 mm.

Hell graubraun, Scheibe der Flügeldecken und die Unterseite etwas heller. Wegen sehr feinen Grundchagrinierung seidenglänzend. Behaarung kaum nennenswert, spärlich, kurz.

Stirn über dem schwarzen Clypeus beiderseits der Mitte länglich schwach eingedrückt, auf der Höhe der Augen in der Mitte stärker gewölbt und hier mit einem feinen, schwarzem Strich, welcher etwas über die Hälfte der Augenhöhe zieht. Die Scheitellinie sehr schmal. Stirn in der oberen Hälfte fein eingestochen punktiert, stärkere Punkte sind in beiden länglichen Vertiefungen über dem Clypeus.

Halsschild um ¼ länger als breit, in der basalen Hälfte etwas breiter als vorne, mit gut von oben sichtbaren Einbuchtungen der Schenkelgruben. Die Furche zart. Punktierung auf der Scheibe sehr spärlich und fein, stärker gegen die Seiten und Basis.

Flügeldecken fast zweimal so lang wie der Halsschild, hinter der Mitte kaum breiter als an der Basis, hinten fast quer breit abgerundet. Punktstreifen sehr fein, Punkte klein; der Nahtstreifen etwas eingedrückt. Die Basis des dritten Zwischenraumes erweitert und mit einigen Querrunzeln und Körnchen. Absturzfläche zweimal so breit wie hoch, kurz behaart mit Ausnahme eines schmalen Streifens unterhalb der Bruchlinie des Absturzes.

Holotype in der Sammlung der Universität Wisconsin.

CHANGING REGIONALIZATION OF SHEEP HUSBANDRY IN WISCONSIN

Stephen L. Stover

The Wisconsin dairy cow has gained such prominence that the state's other farm animals are often overlooked. This is understandable, for dairy cattle in 1960 accounted for about 63% of the income from livestock and livestock products in the state. In this paper, however, the focus turns from dairying to sheep-raising, at the present time not high in statistical importance. In 1960 it accounted for 3½ million dollars, about .35% of farm income from livestock.[1]

The procedure in this study in historical geography is to examine the sheep-raising industry at selected intervals in time and thus to develop a series of cross-sections centering on distribution maps based on county units. Emphasis is on evolving patterns as a means of understanding the place of sheep husbandry in the total picture.

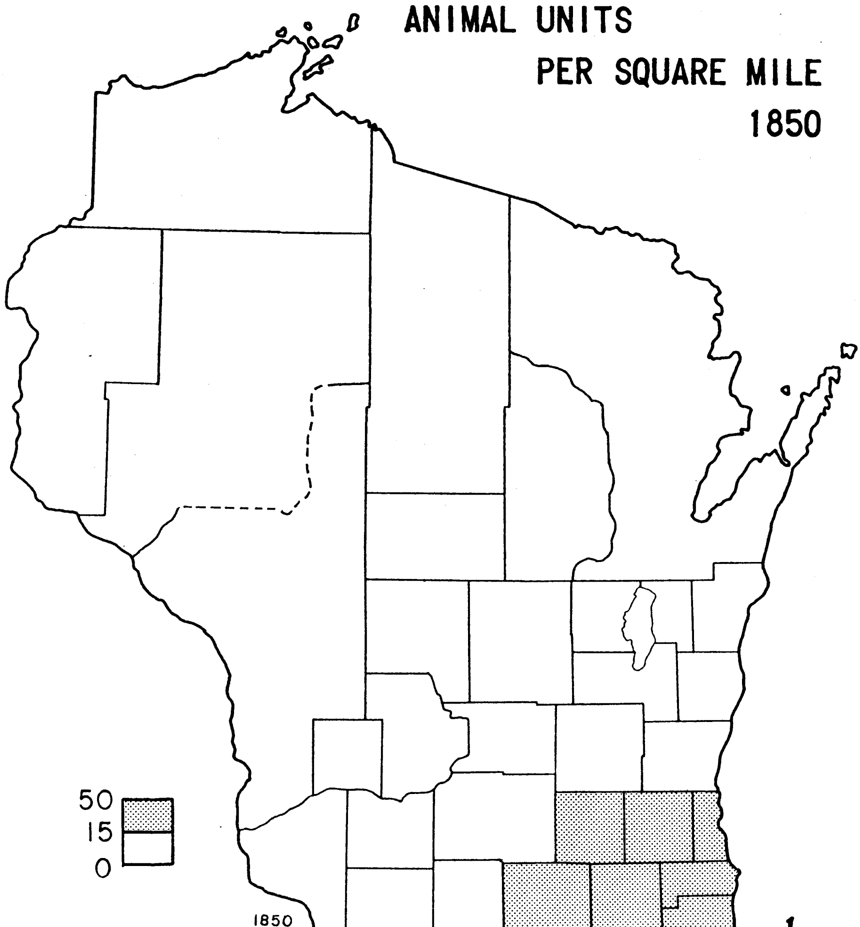
The first sheep in Wisconsin apparently were the seven head purchased at Mackinac and shipped to Green Bay in a barge about 1790. In the southeastern part of the territory, sheep were brought in—to Walworth County—around 1840, "after the wolves were mostly exterminated."[2]

Wisconsin's 3500 sheep in 1840 were concentrated in the southeast. Almost ¾ (73%) of them were in the six counties bordering Illinois. Milwaukee County, then including the area to become Waukesha County, reported the most, 798; no county averaged more than about 1 per square mile.[3] There was little emphasis on stock raising. Wheat was and continued to be the main source of income until about 1875 although in 1850 there were already reports of poor winter wheat crops with blame being placed on continuous cropping to wheat. The answer to the need for a change in emphasis was seen in more animal husbandry. Interest in swine-raising was growing, and a report from Jefferson county asserted: "The

[1] In 1960 the rest of Wisconsin farm income from livestock and livestock products was derived approximately as follows: cattle and calves 17%; hogs 12%; chickens and eggs 7%; turkeys 2%. Calculated from: Wisconsin State Department of Agriculture (WSDA), *Wisconsin Livestock, Dairy, and Poultry*, Special Bulletin 78 (Madison: 1961).

[2] An exception to the generalization that sheep could not endure frontier conditions was the wether reported to have strayed from Prairie du Chien in 1837 and to have survived two winters on its own before being discovered, killed, and eaten in the spring of 1839. Wisconsin State Agricultural Society (WSAS), *Transactions* (I: 1851) 146.

[3] United States Census (1840), 342 ff. For the state the average was about 11 sheep per hundred persons, the inhabitants numbering then about 31,000.



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substitution of sheep husbandry for exclusive wheat-growing will doubtless be found profitable on our best grass lands, if not in every part of the county." From Kenosha another correspondent wrote, "The wool-growing business seems to be the special order of the day among our most enterprising farmers . . ."[4]

Wisconsin farm animals, considered as animal units, were distributed in 1850 as shown in figure 1, a pattern confirming the con-

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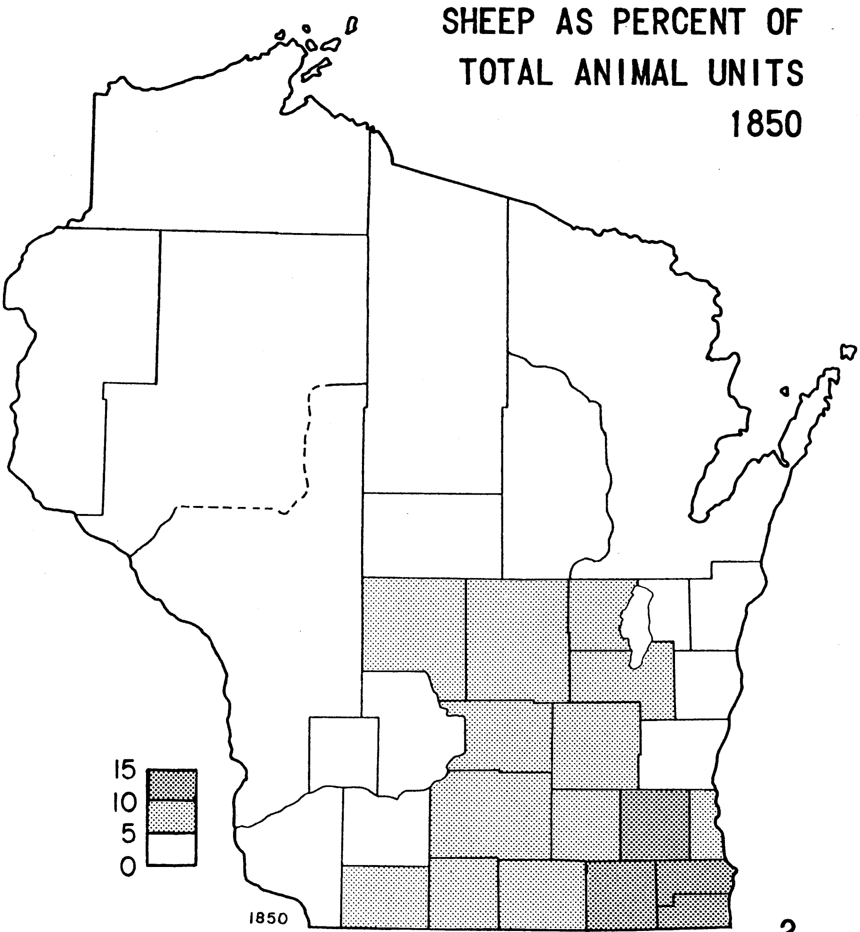
[4] WSAS, *Transactions*, I, 177. He reported further that there were "some very respectable dairies in this county," that their output was steadily increasing, and that he could see "no reason why Wisconsin should not become a cheese-exporting instead of a cheese-importing State. . ." One of the reported drawbacks to expansion of livestock raising and especially of dairying was the lack of cultivated grasses suitable for hay for fall and winter feeding. The answer, appearing in 1850, was clover and timothy. See *Ibid.*, 213, 225.



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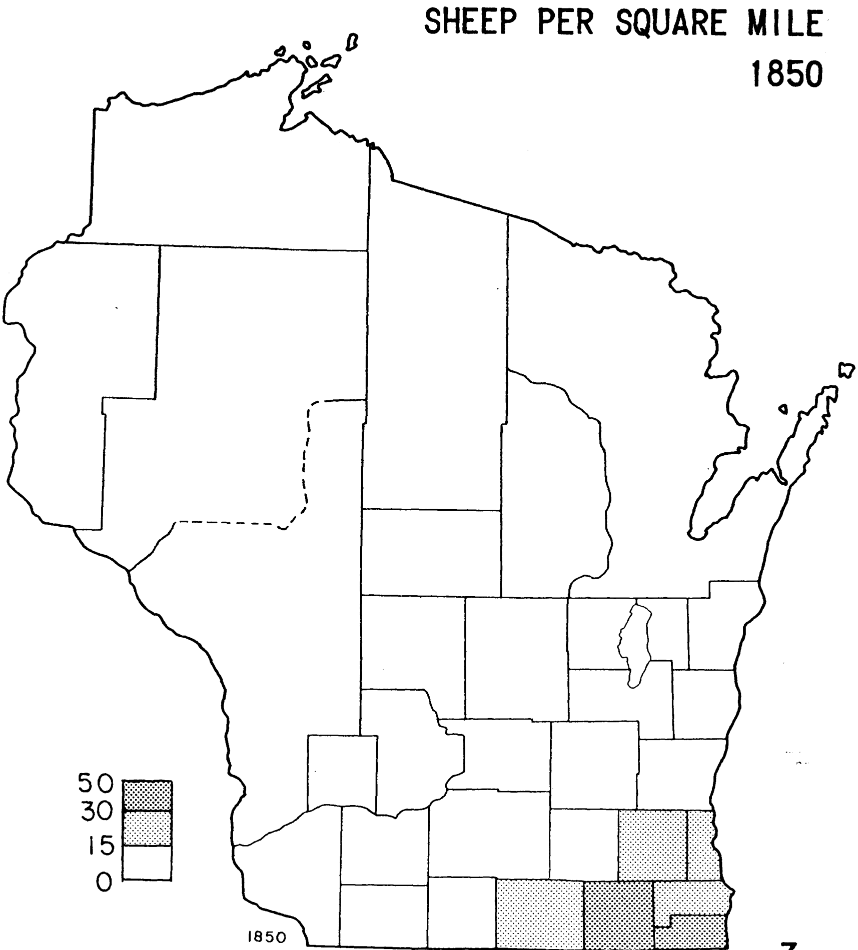
centration of agricultural settlement in the southeast.[5] Sheep, numerically a poor third to cattle and swine, were relatively most important in four southeastern counties, but even in these they comprised less than 15% of the animal units (figure 2). Highest in this regard was Walworth with 14½%, but 5–10% was more

[5] The term, "animal units," is used to equate different kinds of farm livestock on the basis of their feed requirements. In this study one mature cow is considered as the standard or one animal unit, and other livestock are equated to this standard as follows: one horse, five swine, seven sheep, seven goats. The general ratios employed in this study are those cited by Wellington D. Jones, "Ratios and Isopleth Maps in Regional Investigation of Agricultural Land Occupance," *Annals of the Association of American Geographers,* XX (December, 1930), 177–195.

typical elsewhere south of the Fox-Wisconsin line. In 1850 sheep were recorded on farms in 24 of the state's 30 counties, but in general they were still few and far between (figure 3). Only in the extreme southeast did they appear in significant numbers on a county level, Kenosha averaging 47 per square mile, followed by adjacent Walworth with 41.

Wool provided the primary incentive for keeping sheep since tastes then as now ran to beef and pork, and many people preferred wild game to mutton as a supplement. Wool, however, filled a real need for fibers, and as a cash crop it could easily be stored and shipped. Spinning at home was the early practice, but by 1850



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woolen factories had made their appearance.[6] Merinos usually were preferred though coarser-wooled breeds were also grown.[7] By 1850 some farmers could boast of flocks improved by imports of pure breds from Vermont, New York, or Ohio, even a few direct from Europe.[8] Improved stock meant heavier fleeces, but judged from the average yield per animal shorn (2.03# as compared to 8.3# in 1959), improved breeding had just begun in 1850.[9]

Turning from the state pattern to the county having the highest sheep density, we may direct our attention to Kenosha. Sheep there were most numerous in Pike (later re-named Somers) township, where the average was about 88 per square mile. Even here, however, farmers with sheep were the exception—61 of the town's 85 farms reported none at all. Half the flocks were small, containing fewer than 20 animals each, and the bulk of the town's 3165 sheep were kept in a few large flocks, of which there were seven over 200, the largest reporting 700. Kenosha's lowest average density was reported by the lakeshore town of Southport, where the 49 sheep were kept on three of the town's 28 farms.[10]

1870

During the next twenty years numbers of sheep along with other livestock reflected the state's growing population, which by

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[6] WSAS, *Wisconsin: Its Natural Resources and Industrial Progress* (Madison 1862), 45. See *Wisconsin and Iowa Farmer and Northwest Cultivator*, IV, No. 6 (1852). An advertisement describes a mill as "largest and best establishment in the State. Will make any kind of cloth desired for one half the product or at a charge of 25–38¢ per yard." The proprietor warranted his "heavy, well-twisted cloths to do twice the service of those bought in the Eastern market." See also John G. Gregory, editor, *Southeast Wisconsin: A History of Old Milwaukee County*, II (Chicago, 1932), 656 ff.

[7] Reuel Bryan Frost, *The Geography of the Distribution of Sheep in Wisconsin* (unpublished thesis, M. Ph.: Madison, 1928), 10. Frost describes southeast Wisconsin as a Merino stronghold as of 1855. Further indication of the preference for fine-wooled sheep is given by the entries in the State Agricultural Society's First Annual Cattle Show and Fair in 1851. There were 7 long-wools, 3 medium-wools, and 71 fine-wools. WSAS, *Transactions*, I, 54. Introduction of Merino sheep hastened the decline in the use of linen in Wisconsin although of more importance was the rapid growth of cotton culture and manufacturing. Methods were also devised to mix wool and cotton in a variety of fabrics. Fred L. Holmes, *Wisconsin: Stability, Progress, and Beauty*, (Chicago:1946), I, 484.

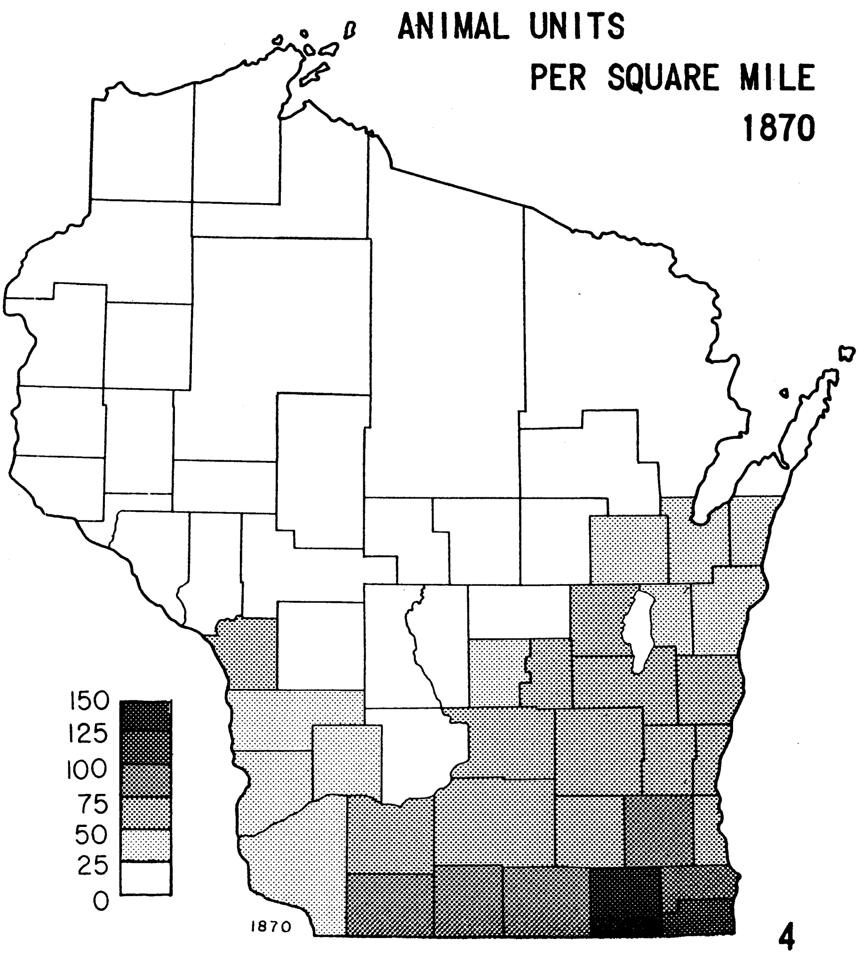
[8] N. B. Clapp, a prominent livestock farmer of Kenosha, raised several varieties of purebred sheep. He had bought Spanish Merino ewes in Vermont, and the original stock for his flock of 500 Saxony Merinos had come from Dutchess County, New York in 1844. WSAS, *Transactions*, I, 54. Joseph Schafer suggests that among Wisconsin farmers, sheep held the highest place among improved livestock at that time. Joseph Schafer, *A History of Agriculture in Wisconsin* (State Historical Society of Wisconsin: 1922), 115.

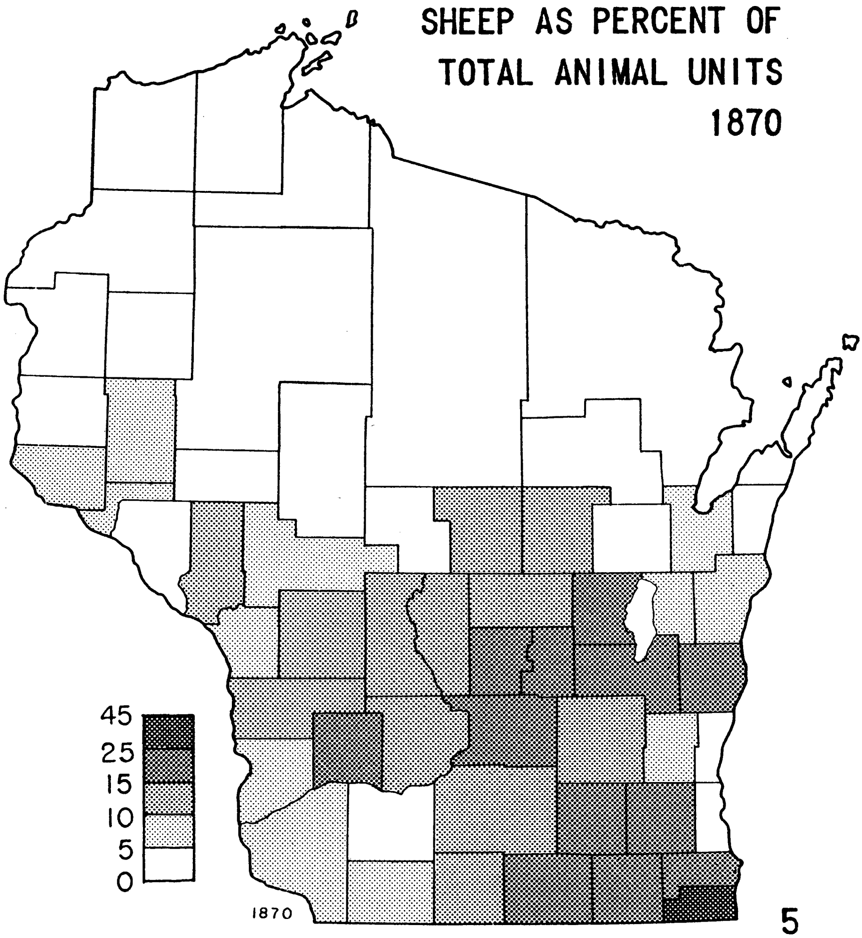
[9] Western Historical Association, *History of Walworth County, Wisconsin* (Chicago: 1882), 158.

[10] United States Census, 1850: Schedule 4 Mss. The farm with the flock of 700 was composed of approximately 1200 acres of which about 50% were unimproved. Its production in 1850 was: wheat, 3000 bushels; oats, 1500 bushels; corn, 250 bushels, Among farm livestock sheep were far and away the most important, but there were also 30 hogs, 16 milch cows, 8 working oxen, and eleven horses. When not otherwise specified, data on livestock numbers cited in following pages are from U.S. Census, appropriate year.

1870 reached 1.1 million. At that time there were 1.2 million animal units (figure 4), an increase of some 60% over 1850; whereas six counties were supporting 25 or more animal units per square mile in 1850, 21 counties had reached that average twenty years later. The pattern of distribution was basically unchanged although the southeast-northwest gradient was much more marked.

When the proportion of sheep among total animal units is considered, the change in distribution is more complex (figure 5). In 1870 the state had twelve counties with more than 15% of their animal units in sheep and one (Kenosha) with 26%. Though farm livestock were sparse beyond the Fox-Wisconsin line, a half-dozen counties in 1870 were reporting enough sheep to comprise 10% or

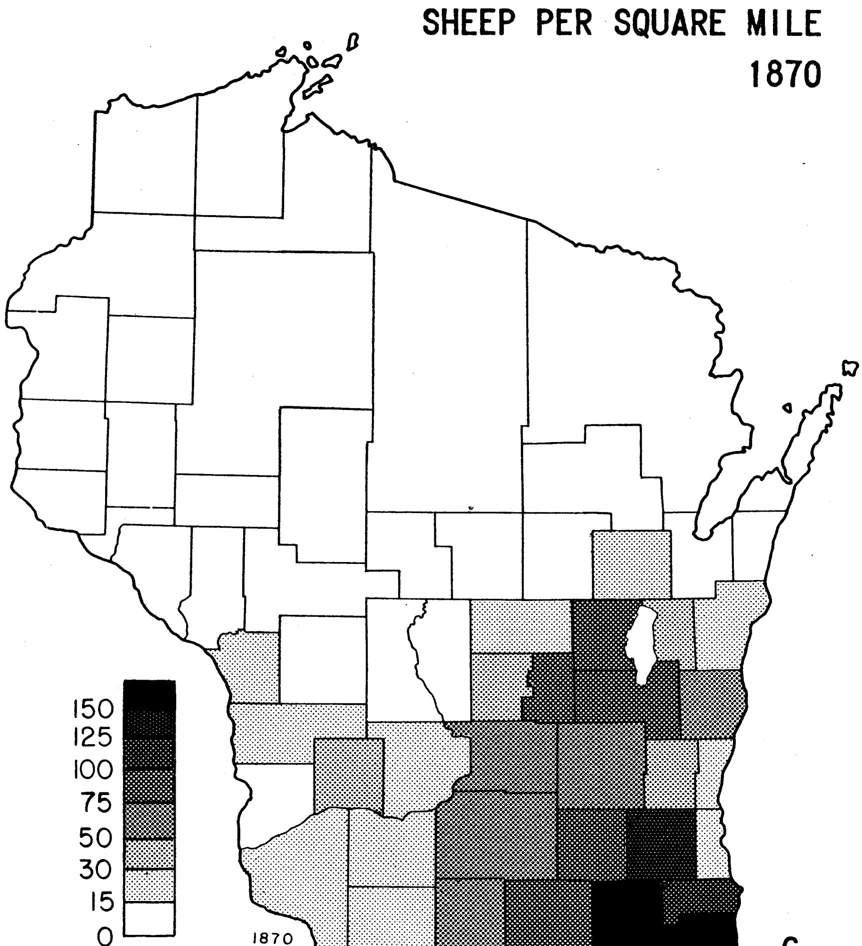




more of their animal units. Sheep numbers had reached their peak at about 2 million in 1868.[11] The war-bolstered wool market had weakened as southern cotton fields again became productive, and the price of wool between 1864 and 1867 fell from $1.05 to .29 per pound.[12] Discouraged sheep farmers—especially those specializing in fine wool—reduced their flocks, often by selling for shipment to western ranges. Mutton breeds (long and medium wools) were substituted for the fine wools by some farmers, while others

[11] Frost, 10. Wisconsin Crop and Livestock Reporting Service, *A Century of Wisconsin Agriculture, 1848–1948* (Madison, 1948) estimates almost 1,600,000 head in 1867, implies it was a peak year. 61.

[12] Milwaukee Chamber of Commerce (now Milwaukee Grain and Stock Exchange), *Report, 1867* (Milwaukee, 1868), 39.



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turned from both wool and mutton to take up the more dependable business of dairying.[13]

Figure 6 indicates the larger total sheep population in the state as compared to 1850, and the continued prominence of the south-east, where the leading county now averaged 181 sheep per square mile as opposed to 47 two decades before. In general, the average density, as expected, still fell away toward the northwest, but the appearance of a secondary center south and west of Lake Winne-

[13] Schafer, 126. During the war years cattle breeding had received less stimulus than had wool-growing and crop-raising. In fact the number of cattle in the state in 1866 had been approximatly 413,000, in the neighborhood of 25% as compared to 1860. WSAS, *Transactions,* VII (Madison, 1868), 41. See also Commissioner of Agriculture, *Report . . . for the Year 1869* (Washington, 1870), 537 ff.

bago had complicated the pattern somewhat. Significant numbers of sheep were beginning to appear north and west of the Wisconsin River, growing in importance somewhat faster than farm livestock as a group. At this time in Wisconsin quality of breeding stock was considerably above the level of 1850. With reference to Wisconsin the United States Commissioner of Agriculture reported in 1869: "Farmers hope to rival Vermont and Michigan in breeding fine horses and sheep, Kentucky in cattle, and perhaps New York in the dairy business . . . Cattle breeding has not received its proper share of attention, owing partly to the great interest concentrated in wool-growing."[14]

As was true in 1850 the distribution pattern for the state in 1870 emphasizes the southeastern counties with Kenosha again heading the list (181 sheep per square mile). The town (Pike) with the highest average density in 1850 had fallen to last place in the county while Bristol, one of the two lowest towns in 1850, reported an average of almost 300 sheep for each of its 36 square miles. The western and southwestern towns were prominent in both years.

Within Bristol Town ¾ (74%) of the farmers were now keeping sheep; only a small proportion belonged to large flocks. Thus the absolute rise in sheep numbers is associated with a higher proportion of farms keeping sheep and also with a rise in the number of medium-sized flocks. The most common flock size had now become 50–100 as opposed to 1–20 in 1850. For the state as a whole the impressive rise in sheep numbers as compared with 1850 was the result of a widespread shift into sheep-raising rather than merely an expansion of flocks on those farms where sheep-raising had been a specialty.

1900

The next cross section is that of 1900. At that time the number of stock sheep (1.1 million) was about the same as it had been thirty years before although the long-range downward trend was already taking shape. There had been a temporary upturn in the mid-1880's and another in the mid-90's, but each crest was somewhat lower than the one before, in spite of the efforts of those who insisted that sheep-raising was more profitable (both wool and mutton being for sale), less confining, and more conducive to soil fertility and weed destruction than was true for other types of farm production.[15]

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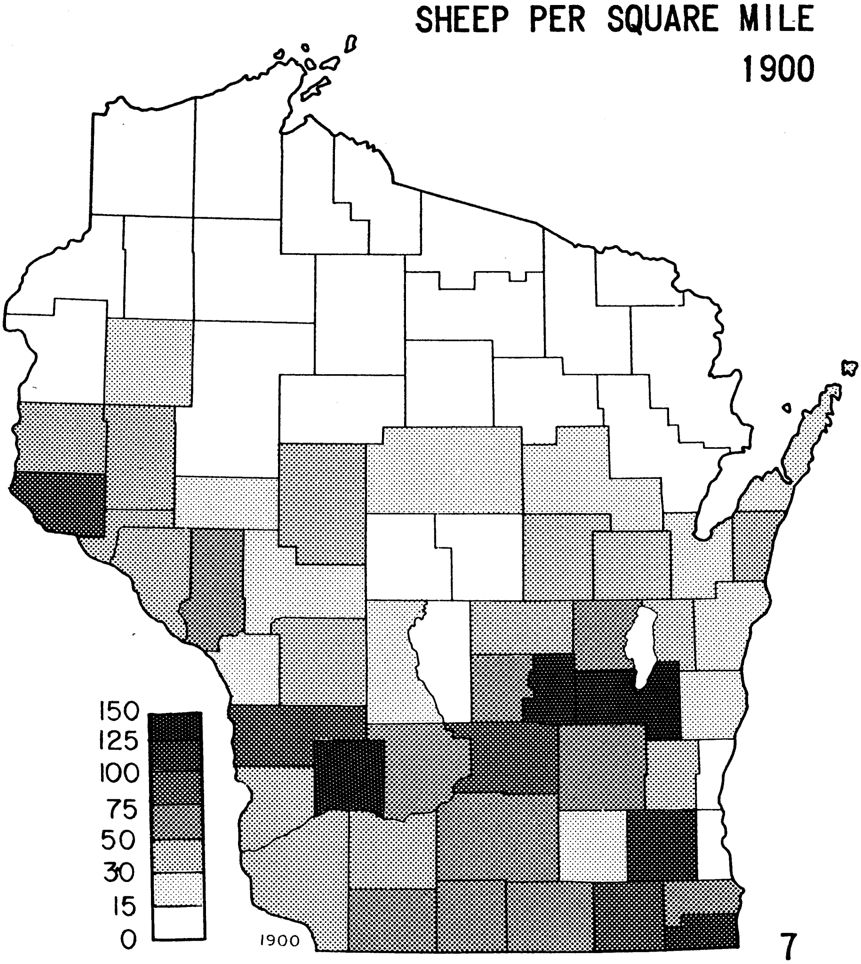
[14] Commissioner of Agriculture, *Report*, 537.

[15] United States Department of Agriculture (USDA), *Origins and Growth of Sheep Husbandry in the United States* (Washington: 1880), 10. It was suggested by William F. Renk, among others, that dairymen might do well to raise small flocks of sheep upon their farms. Wisconsin Live Stock Breeders Association, *Directory* (Madison: 1912), 58.

The pattern in 1900 shows a pronounced shift to the westward with the far southeast now overshadowed by two other areas—one farther north centering on Fond du Lac and Green Lake counties, and one north of the Wisconsin River in Richland county (figure 7). The center of gravity remained in south-central Wisconsin, but



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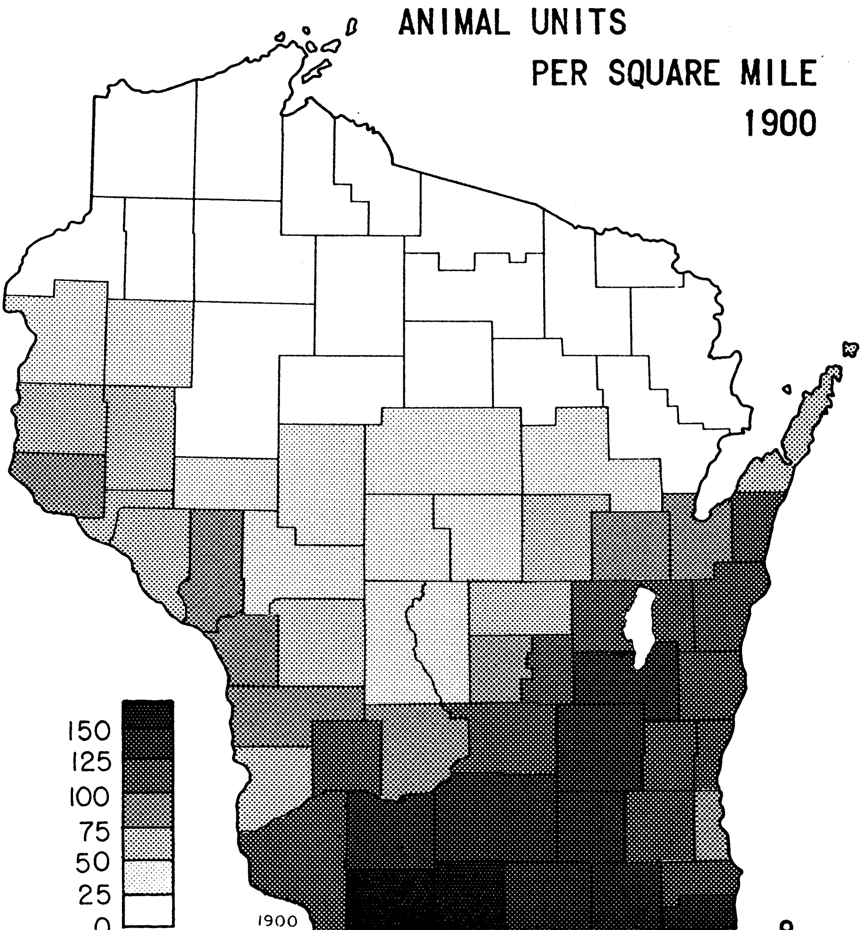
an extension of sheep-raising toward Green Bay and the Door
the Mississippi. The northern part of the state together with the
central counties of Adams, Wood, and Portage retained character-
Peninsula was more than balanced by growth of the industry along
istic low density, but the area with a density below 15 was not
noticeably smaller than it had been in 1870. Thus, although the

number of sheep in 1900 was about the same as it had been three decades before, they were now more widespread with leading counties not only farther northwest but also less densely populated with sheep. This section was not heavily populated by other types of farm livestock, as well, as figure 8 shows. The distribution pattern of animal units emphasizes the concentration of farm livestock in southern Wisconsin with an extension of high density counties to the northeast and a less impressive one to the northwest.

Comparison of figures 7 and 9 points up the fact that those counties with highest average densities of sheep and those where sheep rank highest in comparison to other livestock are not necessarily one and the same. Fond du Lac, for example, stands out in absolute



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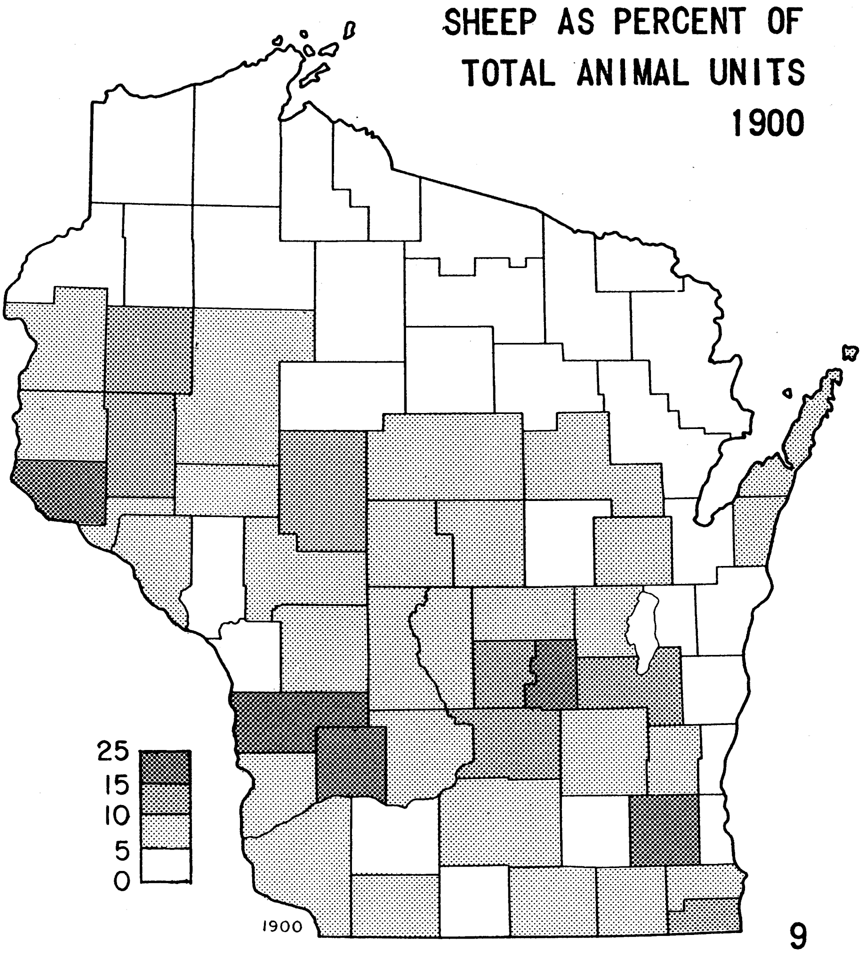
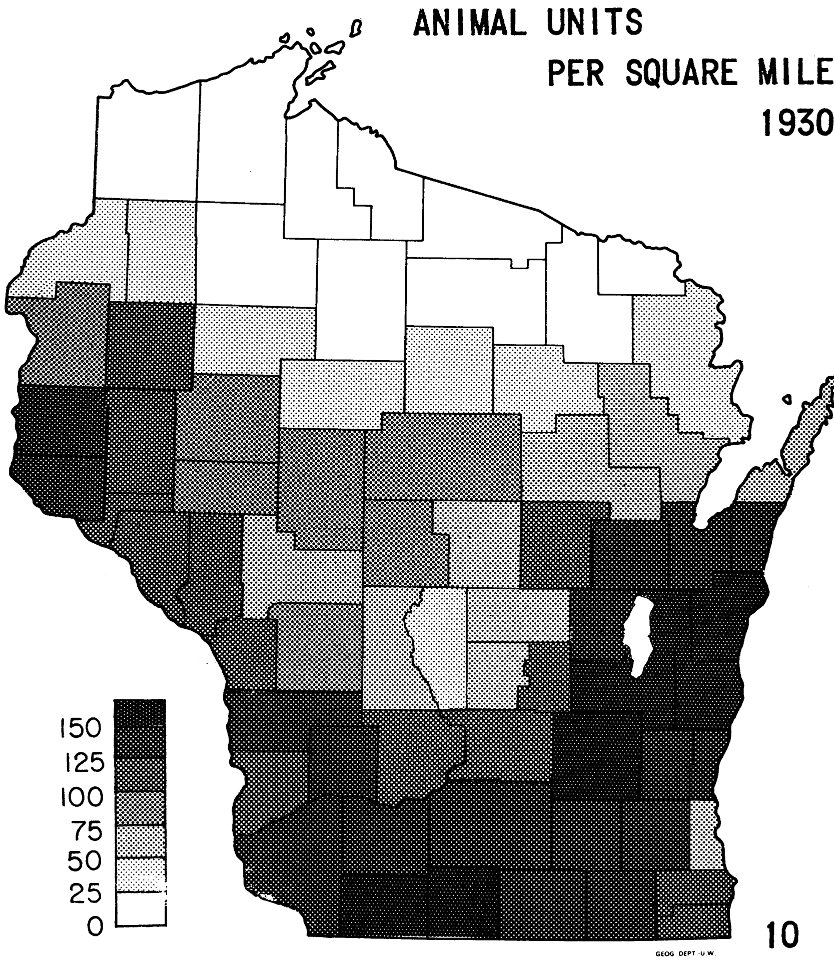


numbers of sheep, but it is not outstanding with reference to the proportion of sheep among its total farm livestock. In general, however, figure 9 reinforces the interpretation made from figure 7 and perhaps makes more noticeable the greater relative importance of western counties in 1900 as compared to 1870 as well as the continued low density in the north.[16]

[16] This low density in northern counties persisted despite efforts to interest potential settlers in moving into that part of the state. They were assured of cheap land, a drained soil, medium natural pasture, and a liberal supply of water with no wolves and no dogs to plague their flocks. They were further told that disease would be no problem since "Snuffles, internal worms, scab or foot rot are altogether unkown to the sheep; a condition that is highly indicative of the adaptation of the climate and soil for sheep life." John A. Craig, "Dairy and Sheep Farming at Superior," Wisconsin Agricultural Experiment Station (WAES) Bulletin 43, *Agricultural Horticultural and Livestock Features of a Portion of Wisconsin Tributary to Superior,* (1895), 47.



In 1900 there was increasing preference for dual purpose animals as opposed to fine wools. Arguments supporting this change in emphasis were: the growing population, the high cost of beef, the inferiority of pork, the demand for good mutton, and the increase in price of worsted wools as compared to fine wools.[17]

[17] USDA, *Origins*, 9. As the relative importance of Merinos went down, so too did interest in the Wisconsin Sheep Breeders and Wool Growers' Association, started in Whitewater, 1877; its last meeting was held in 1900. Western Historical Association, *Cyclopedia of Wisconsin* (Madison, 1906), 346. This was "the first breed association to be active in the state. It was a successor to the Wool Growers' Association which was organized at Oshkosh in 1866. In 1889 the Southeast Wisconsin Sheep and Wool Growers' Association was organized. Milo Milton Quaife, *Wisconsin, Its History and Its People.* (Chicago), 56. In 1904 the Wisconsin Sheep Breeders Association appeared. Its membership was largely breeders of Shropshires, a dual purpose breed popular with Wisconsin farmers.

The county leading in sheep density in 1900 was Richland with 146 per square mile. There the range was from 11 in Buena Vista township in the southeastern part of the county to 174 in Marshall in the northwest.

1930

In 1930 the total number of livestock units had reached 4½ million, up about 28% from 1900. Their distribution in terms of county averages per square mile (figure 10) was fairly similar to what they were shown to be in the preceding geographical cross section (figure 8). A northward extension of stock-raising was evident, but it was not simply a later edition of the 1900 pattern, for Adams county had now become the center of a low-density area bounded on the north by a statistical ridge some two counties wide. There were also changes farther to the south. Dodge county and four contiguous ones to the northeast had joined Lafayette and Green as the most outstanding in the state so that the "center of growth" appears noticeably northeastward. At the same time in the west and northwest increases were apparent also, especially in Pierce and St. Croix counties.

In this general rise in the livestock population between 1900 and 1930, sheep were not keeping pace. In 1900 they had been sufficiently important to comprise 5% or more of the animal units in 43 counties, but in 1930 no county could qualify. The nearest was Green Lake with 4.6%. It is not surprising then that the pattern is rather a faint one (figure 11).[18]

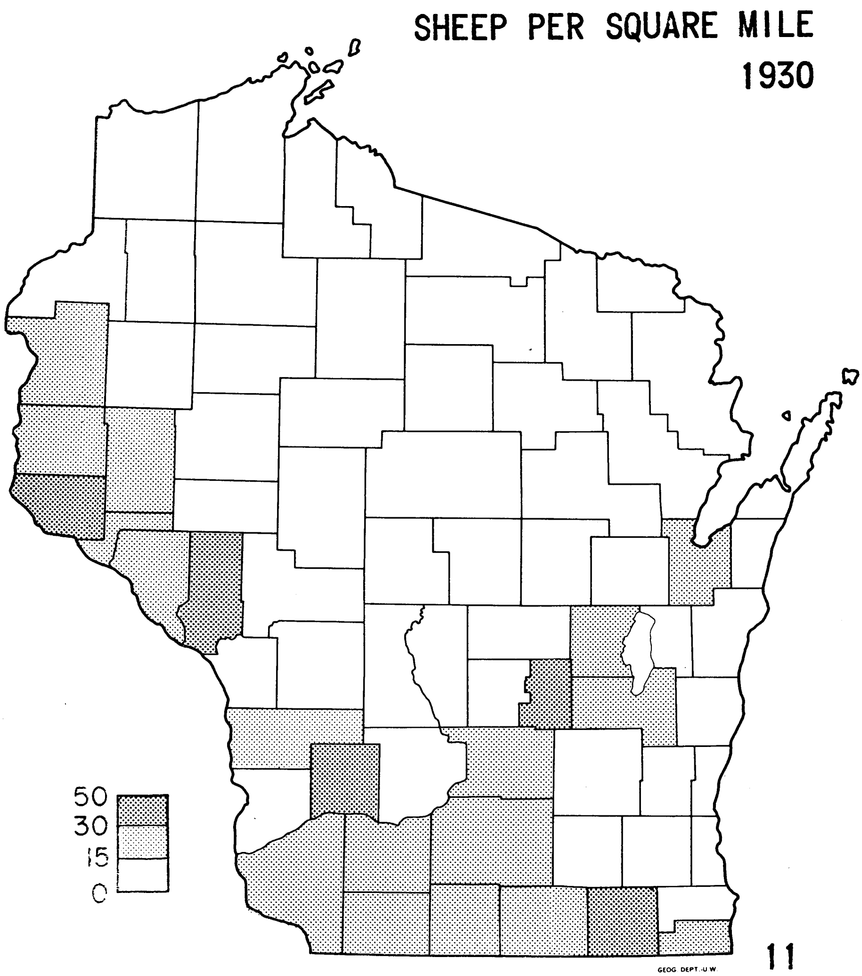
The leading county was again Richland, now one of five scattered counties with a density of thirty or more. The map in general suggests a shift to the westward as eastern and southeastern counties dropped below the threshhold for this study—i.e. b[illegible] 15 head per square mile. Richland's 24,000 sheep in 1930 were less than ⅓ the number in 1900 though distributed in a pattern roughly similar.

Medium-wool sheep had long since supplanted almost all of the pure Merinos in Wisconsin. Nevertheless, the wool clip remained consequential, and it was at this time that the Wisconsin Co-operative Wool Growers Association came into being.[19]

The practice of fattening lambs in feed lots was not new, but it had assumed a greater importance than in 1900, especially in those parts of southern Wisconsin where surpluses of corn and pea vines

[18] On these maps northern Wisconsin still does not show much evidence of the efforts directed toward stocking its vast acreage of cut-over land with sheep. During World War I the College of Agriculture had been active in aiding in the introduction of small flocks of breeding ewes into that part of the state. R. B. Pixley, *Wisconsin in the World War* (Milwaukee, 1919), 359–360. See also WAES Bulletin 306, *The Soils of Northwest Wisconsin,* (second edition, April, 1922).

[19] Wisconsin State Department of Agriculture and Markets, *Biennial Report,* 1929–30, 13.

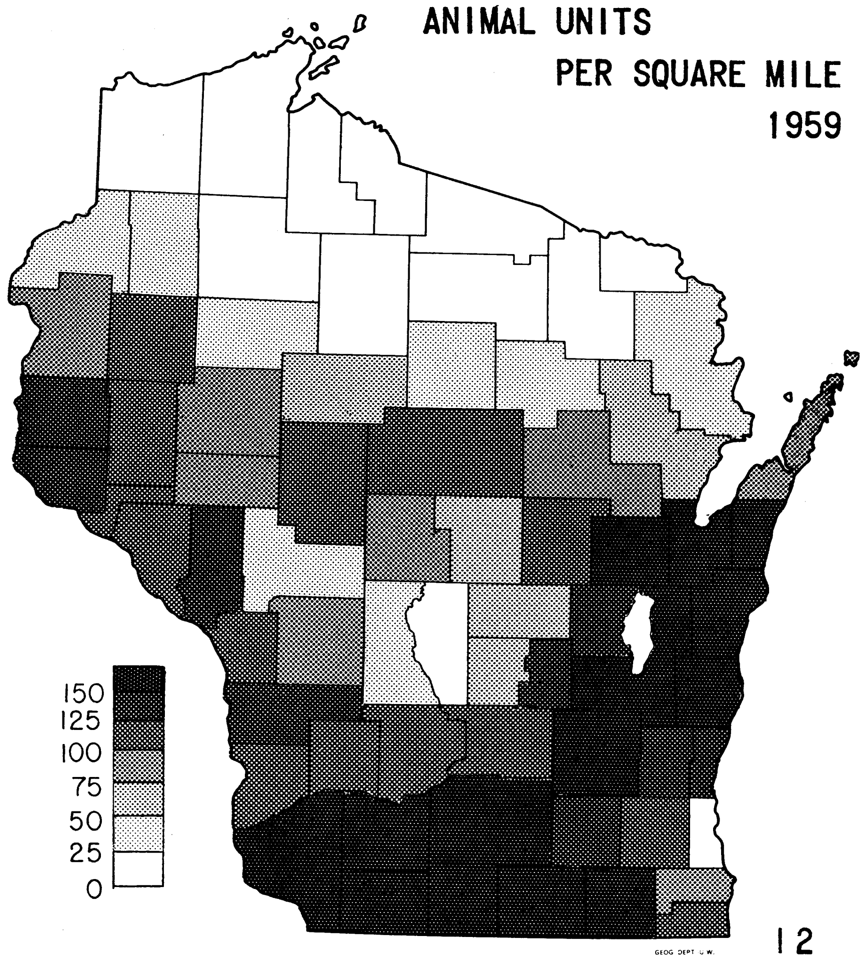


facilitated the practice. On feed in 1930 were approximately 500,000 lambs, about 30% of them shipped in from the western range. Few lambs on feed are included in the figures on which these maps were based because of the late enumeration date (April 1), but generally Wisconsin's western hills were prominent in the feeder lamb picture. This suggests a utilization of pasture on slopes difficult to crop while the more tillable surfaces were producing the winter feed.[20]

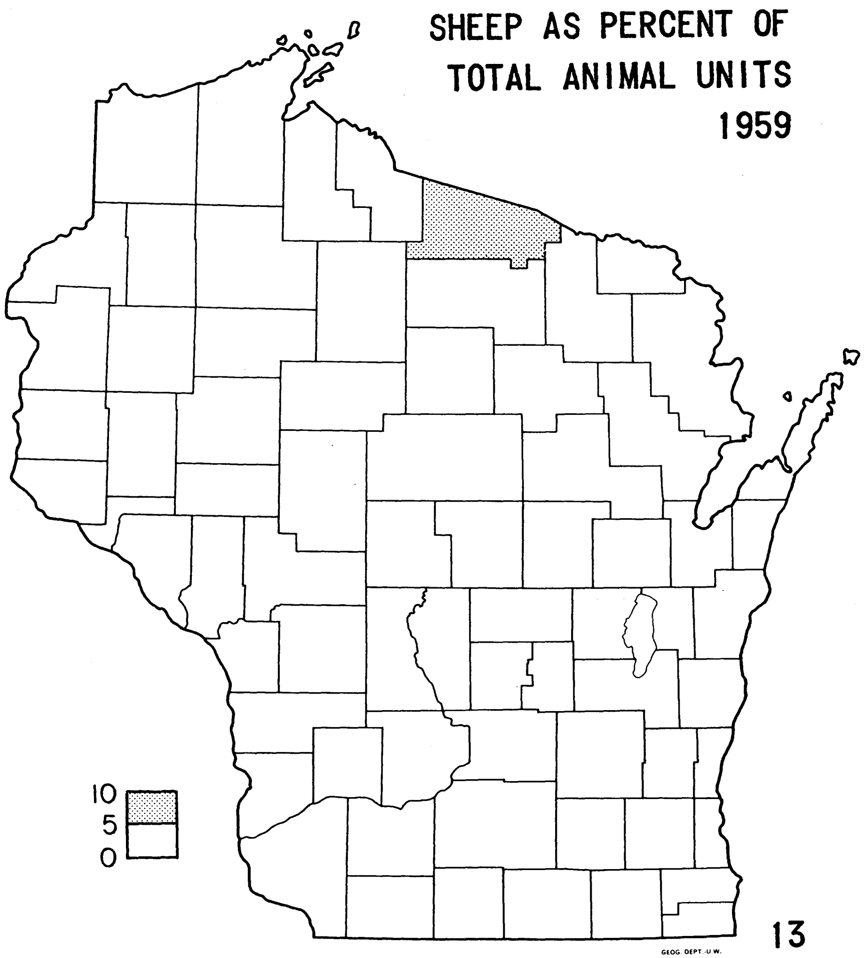
[20] See Frank Kleinheintz, "The Sheep Industry in Wisconsin," *Directory of the Wisconsin Livestock Breeders Association, 1924–25* (Madison: 1925), 25; and WAES, Bulletin 306, 28.

1959

In 1959 animal units numbered 4.7 million, an increase of about 4½% over the figure for 1930. The distribution of these farm animals (figure 12) was very little different from what it had been in

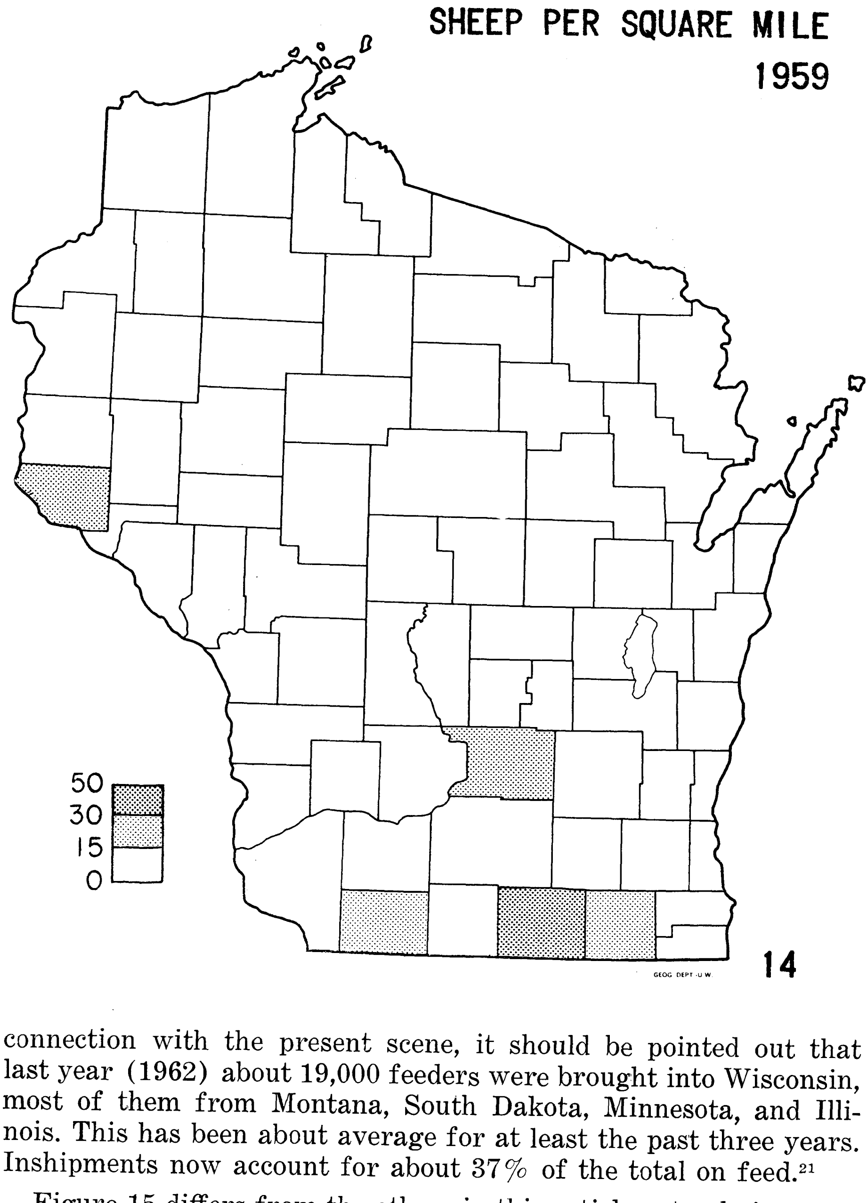


1930 (figure 10), but their concentration south and east of the Fox-Wisconsin line was somewhat more noticeable. The low-density area of northern counties was unchanged, but the paucity of livestock in the central sand plain and in Milwaukee county was even more pronounced.



The place occupied by sheep in this farm livestock picture had become minimal (figure 13). For the state as a whole it averaged about .9% and in only one county, Vilas, did it exceed 5%. Figure 14 shows three of the five leading counties to be in the south, one in the west, and one in the south-central part of the state. Rock county was the only one to exceed a density of 30. In 1930 it may be recalled, five counties had reached this level of density, Rock, however, not having been one of them.

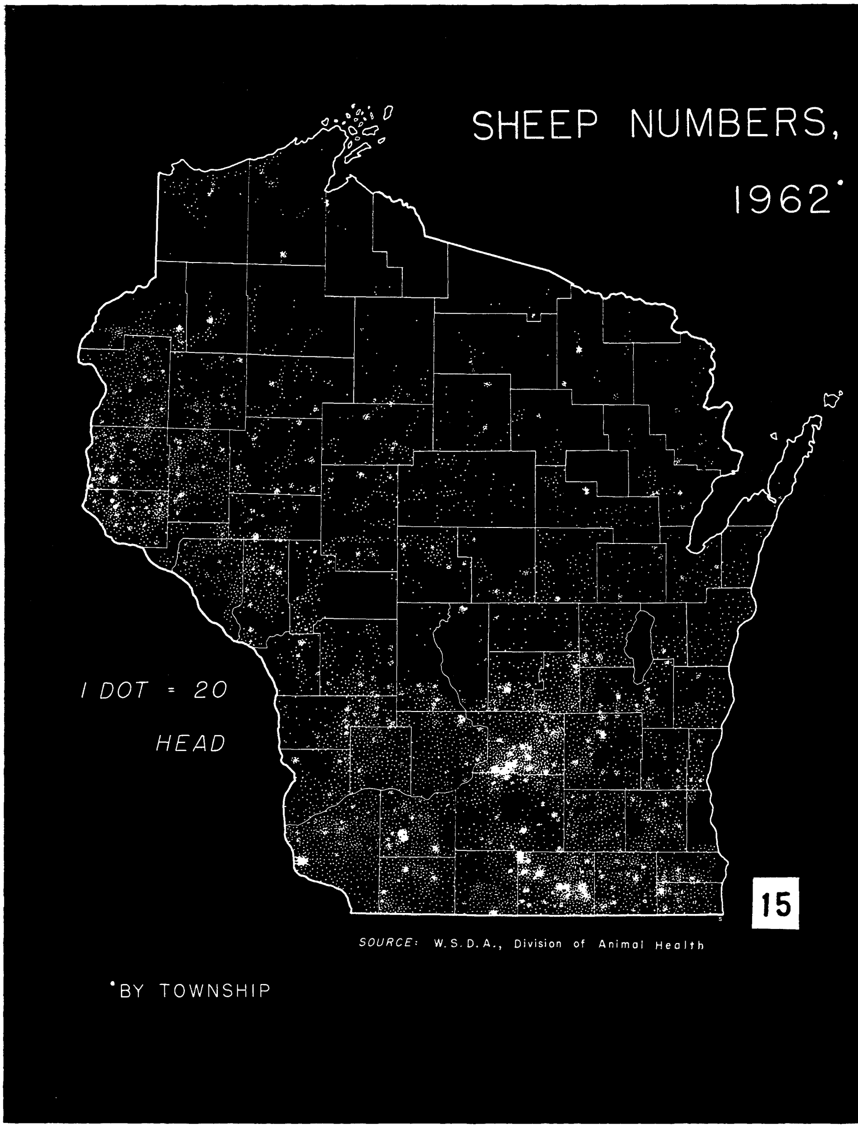
This paper has concerned itself primarily with changing patterns of distribution of stock sheep in the state. The story of feeder sheep is a separate one, mentioned only incidentally here, but in



connection with the present scene, it should be pointed out that last year (1962) about 19,000 feeders were brought into Wisconsin, most of them from Montana, South Dakota, Minnesota, and Illinois. This has been about average for at least the past three years. Inshipments now account for about 37% of the total on feed.[21]

Figure 15 differs from the others in this article not only in cartographic technique but also in the animals included. It is made from data collected in eary 1962 by the State Division of Animal Health

[21] Wisconsin Crop Reporting Service, *Sheep and Lambs on Feed, January 1, 1963*, January 16, 1963.



to determine the health status of all sheep in Wisconsin. The map shows their distribution by town and suggests again the concentration in the south, where feed gains are most likely to be available.

SUMMARY

Wisconsin's sheep husbandry began early and reached its peak numerically and relative to other livestock during the Civil War era. Since then, it has declined in both these respects. Its changing distribution patterns since 1850 show first a concentration in the southeast, followed by a spread northward and westward before retrenchment left the highest density counties once more in the south. Although these broad changes are a reflection of market conditions, a more full explanation would depend upon a detailed evaluation of a myriad human considerations along with terrain, climate, soils, and vegetation. During the period from which these cross-sections were taken, emphasis has changed from wool to fat-lamb production; continued careful management has brought higher quality of both meat and wool as well as greater yield per animal. Sheep husbandry is minor but still a going concern in Wisconsin agriculture.

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THE DOMESTIC TURKEY IN MEXICO AND CENTRAL AMERICA IN THE SIXTEENTH CENTURY

A. A. Schorger

The Spaniards used a number of names for the turkey *(Meleagris gallopavo)* and there is uncertain identification in some cases. We have *pavo, guanajo, gallina, gallina de la tierra, gallina de papada, gallo, gallipavo,* and *gallo de Indias*. Only *gallina de papada* is sufficiently descriptive of the turkey. The display of the turkey was so like that of the peafowl that the use of *pavo* was logical. Mexico and Central America contained several species of large gallinaceous birds sometimes called *pavos*. Oviedo[1] definitely included the curassow *(Crax)* among the *pavos*.

It is not certain when the turkey was first seen. Mártir[2] states that when Vincent Yañez Pinzón was at the Gulf of Paria, Venezuela, in 1500, the Indians gave him some fowls of the country *(pavos)* which differed from the peafowl in color. There were females to be taken to Spain for propagation and males to be eaten at the time. If the birds could be raised in quantity it is probable that they were turkeys. Eden assumes that they were turkeys for he has the marginal note: "Peacockes which we caule Turkye Cockes."[3] It is entirely possible that Columbus received turkeys in Honduras in 1502 during his fourth voyage. There being nothing of importance on a group of islands which he called the Gunajas, he landed at Point Caxinas (Cabo de Honduras) on August 14. Here the natives brought him native fowls, *gallinas de la tierra,* which were more savory than those of Spain.[4] It is believed that the Cuban name for the turkey, *guanajo,* was derived from the birds received by Columbus near the Guanajas. When Cortés arrived at Trujillo, Point Caxinas, in 1525, the natives gave him fish and turkeys, according to Diaz,[5] who is consistent in using *gallinas* for these fowls.

There is no doubt that the birds found by Cordoba, when he discovered Yucatan in 1517, were turkeys. Las Casas[6] came to Cuba in 1511 and lived in the New World for thirty-six years. He states that when members of the Córdoba expedition landed near Cape Catoche, the natives gave them two roasted turkeys *(gallinas)* as large as peafowls. At Campeche they received many fowls with a dewlap, or throat wattle *(gallinas de papada),* just as large and perhaps better than peafowls.

The handsome ocellated turkey *(Agriocharis ocellata)* of the Yucatan Peninsula does not appear to have received a distinguishing name by the early Spaniards. Landa[7] came to Yucatan in 1549. He states that the Mayas called Yucatan the land of the turkey and the deer *(Umil cu[t]z yetel ceh)*. The meaning is the same in Espinoza's[5] orthography, Yetelzeh y Vnunuýz. According to Seler[9] the Maya name of the ocellated turkey was *cutz*. Some modern names for this bird are *pavo de monte,* and *kuts,*[10] *guajalote de Yucatán, guajalote brilliante,* and *cũt.*[11] The ocellated turkey is represented frequently in the Mayan codices, the common turkey, rarely. All of the numerous "turkey" bones found at archeological sites in Yucatan have been referred to the ocellated turkey.[12] Pollock and Ray[13] found 1268 bones of the ocellated turkey, none of the common turkey, at the ruins of Mayapan, dating for the most part from the 13th to the 15th century A.D. This suggests that the Mayas did not have the domestic turkey until shortly before the Conquest. Supporting evidence is to be found in the relatively small numbers of turkeys reported by the discoverers. The ocellated turkey was not domesticated by the Mayas.

The expeditions of Cortés revealed that the domestic turkey was widely distributed. On July 10, 1519, he[14] wrote that many *gallinas,* like those of Tierra Firme and as large as peafowls, were raised by the coastal people from Cozumel to Veracruz. Turkeys were reported at nearly every town on his march to the city of Mexico. The Anonymous Conqueror[15] wrote that many turkeys were raised by the Mexicans; and Diaz refers frequently to the birds.

Some of the numbers of turkeys exacted as tribute are a strain on credulity. Ixtlilxochitl[16] states that about 1430, Netzahualcoyotzin, Lord of Texcoco, required 100 turkeys *(cocqs)* daily, or 36,500 yearly. Torquemada[17] reduces the number to 6,000 to 8,000 annually. According to Cook[18] every inhabitant, *"chicos y grandes,"* of Mizquiahuala had to contribute a turkey every twenty days. He estimated the population of the town to have been 7500 in 1519, so that the annual contribution would have been 137,000 turkeys. If we assume that only adults actually paid tribute and that they formed two-fifths of the population the annual conrtibution would still be 56,800 birds. It is difficult to believe that even this number could have been supplied. According to Torquemada,[17] 1400 to 1600 turkeys were consumed daily during the fiesta for the Tlaxcalan god, Camaxtli. The raptors and carnivores in Montezuma's menageries required daily large numbers of turkeys. Salazar[19] and Clavigero[20] state that 500 turkeys were required daily just to feed the raptors. Gomara[21] gives the same number and adds that 300 men were required to attend the aviary. Some turkeys were also fed to the carnivores.[14] If we, in addition, allow for the turkeys consumed by Montezuma's large entourage, the daily consumption may have been 1000 birds. In fulfilling the request of Cortés[14] for an estate, Montezuma provided 1500 turkeys. Mártir[2] was informed that the number was 1500, some of the birds being for propagation, others for the table.

The domestic animals of the Aztecs were limited to dogs, turkeys, ducks, and a few other birds. Turkeys formed the largest source of meat. The markets of the city of Mexico have been described by several writers. Cortés in his letter of 1520 states: "There is a street for game in which are sold all kinds of native birds such as turkeys, partridges, quails, wild ducks, . . ." Diaz[5] mentions hen and cock turkeys, rabbits, hares, deer, and other game. Eggs of turkeys, geese, and many other birds were also for sale in large amounts.[22] All transactions in the markets were by barter. The closest approach to money was the cocoa bean. Gomara[21] states that a turkey was exchanged for a bundle *(haz)* of maize. I have been unable to find a quantitative definition of *haz*. Motolinía[23] wrote that a turkey was worth three or four Spanish chickens. In 1628 a turkey or a Spanish chicken sold for a real in Yucatan.[8] According to Oviedo[1] a *pavo,* in this case a curassow, was worth a ducat, and sometimes a castellano or gold peso, worth a real in purchasing power in Spain. If he refers to the old gold Castilian castellano, which weighed 4.6 grams, a curassow was worth $5.65 in present United States dollars.

Little is known about the methods used in raising turkeys. Sahagun[24] states that the young were given maize in the form of mash, cooked pigweed *(bledo),* and other plants. The mother fed the poults worms and other things that she found. He has four plates showing the "domestic life" of the birds. The breeding female appears to have had a small coop provided for her.

The domestic turkey descended from the wild turkey of Mexico. At the time of the Conquest the domestic bird was only about one-half the size of the wild one. The degeneration may have been due to improper feeding, or to failure to select the best birds for breeding. About 1580 it was stated that the wild turkeys in the state of Puebla were much larger than the domestic ones.[25] This was not true of the turkeys kept in confinement by the Pueblos of New Mexico. They resembled closely the wild bird in size and color. One of the members of Coronado's Expedition was impressed by their size for he wrote that they were larger than those of New Spain.[26] Many species of wild birds undergo changes in color of the plumage by domestication. Sahagun[24] mentions that the Mexican turkeys were of various colors, white, black, red, and brown. Salazar[19] states: "This bird is white and blackish and has no other color." A

Franciscan friar wrote about 1538–39 on the customs of the people of Michoacan, and mentions that the Chichimecas made banners of white turkey feathers.[27]

The Aztec name for the turkey was *huexolotl*, or *mexolotl.* Molina[28] gives *quetzaltototl* as a synonym for *pavo*, but it is more properly applied to one of the trogons. Salazar[19] called the turkey *cuzcacahtl.* According to Sahagun,[24] the female, or the turkey in general, was called *totollin*, the male, *huexolotl.* The latter was subsequently corrupted to *guajalote*, or *guajolote*, by which name the turkey is commonly known in Mexico today.

Some of the Indian names for the turkey follow:

Cáhita or Yaqui, *cúvis.*[29]
Cocopa, *urút.*[30]
Maya of Yucatan, *tux, itux,* female; *ulum,* male.[9]
Opata, *chique.*[31]
Papago, *tóva.*[30]
Tarahumara, *tshīví,*[32] *siwí.*[33]
Zapotec, *pète hualache, pète zaa,* female; *pète nigola,* male.[9]
Mexicans of Durango, *cocino.*[32]
Central America, *guanajo, chumpìpe, huehuecho.*[34]

Isthmus of Tehuantepec:[35]

Zapotec, *toú.*
Nahuat, *totóli.*
Chontal, *lapump, tulú.*
Popoluca, *tu? nuk*
Mixe, *tutk*
Zoque, *túnuk*
Huave, *tu:l.*

When the turkey was domesticated in the area under consideration is unknown. There are good archeological data on the turkey in New Mexico. Here the bird was confined, if not domesticated, shortly after the birth of Christ. Two bones of the turkey were found at the ruins of Zaculeu, near Huehuetenango, Guatemala, in the earlist phase, Atzan, *c.* 700 A.D.[36] They were identified by Dr. Alexander Wetmore as those of the common turkey *(M. gallopavo).* Since this bird is not native to Guatemala, it must have been brought in from the north where it was probably domesticated at a considerably earlier time.

Food was of prime concern to the early Spanish explorers and travelers so that domestic turkeys are mentioned frequently. The cultivation of maize and the raising of turkeys went hand in hand. Many of the settlements where these birds were found can not be located due either to disappearance, change of name, or variation in spelling. No early reliable information on the occurrence of domestic turkeys in Mexico north of latitude 25° was found. The gap between this latitude and the United States boundary indicates that domestication took place independently in Mexico and the Southwest. The places where turkeys were raised are shown in Fig. 1. The latitudes and longitudes of existing towns have been

FIGURE 1. Localities where turkeys were raised in Mexico and Central America in the sixteenth century.

taken from the Gazetteers of the United States Board on Geographic Names. A very useful map of the early pueblos of southern Mexico is that of Barlow.[37] The position of many old places in central Mexico are given by Borah and Cook,[38] and the work of Lopez-Portillo[39] was helpful in locating pueblos in westcentral Mexico. The *Suma de Visitas*[40] is rich in references to turkeys paid as tribute in the middle of the sixteenth century. The distance in leagues, often only approximate, of a small pueblo from a main town is frequently given. The Spanish league was 2.63 miles.

Campeche. When the Spaniards landed at the pueblo of Campeche in 1517, the cacique entertained them at a feast in his palace where turkeys and other birds were served.[2, 41] At the same time many turkeys were seen at a farm at Champoton.[6] Dampier,[42] who was in Campeche in 1676, informs us that among the fowls of the country are "Quams (guans), Corresoes (curassows), Turkies." The turkeys at which he shot unsuccessfully were the ocellated.

Chiapas. During the Cortés expedition to Honduras the natives of a village near Chiapa brought turkeys and cherries. The caciques at the town of Gueyacala (Acala, twenty-three miles southeast of Tuxtla) sent twenty loads of Maize and some turkeys.[5] About 1625 turkeys were abundant at Chiapa.

Colima. In 1530, during the conquest of New Galicia, the cacique of Contlán appeared at Chiametla with many mantles and turkeys.[44] Ystlahuacán (Ixtlahuacán) contributed to the Spaniards 8 turkeys every month; Coatlán, 5 leagues from Colima, and Escayamoça, each contributed 24 turkeys annually; Malacatlán, 4 annually; Quiçilapa (Quezalapa) and Tequepa, each 36 annually; Tepacuneca (Petlazoneca), 12 annually; Teçitlan (Tecuicitlán), 48 annually; Tlacoloastla, 24 annually; Tecolapa, 30 annually; and Xocotlán, 24 annually.

Costa Rica. Significant evidence for the raising of turkeys in Costa Rica in pre-Columbian times is a turkey effigy jar shown by Lothrop.[45] The long frontal caruncle is clearly that of the common turkey. The jar was found at Bolson and is considered to be of local manufacture. There was a Mexican colony at the isthmus of Nicoya. The Mexicans had an extensive trade along the Pacific coast as far south as Panama where there was also a small colony. It is probable that the Mexican colonists brought turkeys with them but Lothrop[46] does not believe that these birds were raised south of the Nicoya peninsula.

Durango. Many turkeys were being raised at Nombre de Dios in 1608.[47]

Guanajuato. The middle of the 16th century, the inhabitants of Acanbaro (Acambaro) had turkeys, chickens, and quails.[48] Hardy[49] noted that turkeys were raised in abundance at San Francisco [del Rinçon] in 1825. He purchased a fine one for fifty cents.

Guatemala. Four turkeys were supplied to the Cortés expedition (1524–26) at Tayasal, located on an island in Lago Petén. At the pueblo of Tayca, 30 turkeys were found in four houses, and the following day the Spaniards came to a farm where there were turkeys. Sailing up the Rio Dulce, they came to Lago de Izabel where the inhabitants had many turkeys.[5] These birds were plentiful about 1636 at the pueblos of Guatemala, Mixco, and Rabinall (Rabinal).[43] For the campaign of 1694, Totonicapa (Totonicapán) and Gueguetenango (Huehuetenango) were each to contribute 800 turkeys. The Indians at Dolores killed turkeys and offered the blood to their idols. There were many turkeys at Lacandón, near present San Luis.[50]

Guerrero. Ayutla and neighboring towns contributed to Montezuma one turkey daily.[37] Under the Spanish regime Ayutla also provided one turkey daily; Acamistlauca (Acamixtlavaca), 2 daily and 15 in addition each month; Nochtepeque, 20 leagues from Mexico and 3 from Tasco (Taxco), one turkey daily; and Tetela [del Rio], one every 80 days.[40]

In 1579 chickens and turkeys were raised in abundance at Tzicaputzalco (Ixcapuzalco). The domestic animals at Alaustlan (Alauiztlan, Alahuixtlan) were small dogs, chickens, and turkeys. Ostuma (Oztoman) had an abundance of these fowls. Quatepeque (Coatépec de Guerrero, Cuatepeque, Cuautepec), Tlacotepeque (Tlacotépec de Guerrero), Utatlan (Utlatlan), Tetela, Cuetzala (Quezala), and Teloloapa (Teloloápan) raised chickens and turkeys in large numbers. The domestic birds at Tasco were Castilian chickens, turkeys, and doves.[51] There were both wild and tame turkeys at Asuchitlan (Ajuchitlan).[52]

Hidalgo. The contribution of turkeys to Montezuma by the pueblo of Mizquiahuala (Mizquiyauallan) has been mentioned.[18] The price of a turkey at Mizquiahuala in 1571 was two reals (1 peso = 8 reals).[53] Epaçoyucan (10 miles southeast of Paucha) also contributed turkeys to Montezuma.[37] Acatlan contributed to the Spaniards 4 turkeys and 4 quails *(quatro gallinas y quatro codornizes)* every 5 days; Tlacachique, 12 turkeys every 40 days; Tututepeque, one on every meat day; and Vauagasco, 30 chickens and turkeys every three months.[40]

In 1579 there were tame turkeys and chickens at Zimapán; turkeys, chickens, doves, and white geese at Axocupan (Axacuba); chickens, turkeys, quails, and hawks at Yetecomac; doves, turkeys, Castilian chickens, and quails at Tornacustla (Tulnacuchtla); turkeys and chickens at Tezcatepec (Texcatepec) and Tecpatepec. The inhabitants of Uexutla de Hidalgo (Huejutla, Huexotla, Huexutla) had no other birds than *gallinas,* which grow wild; and they raise turkeys *(gallinas de tierra)* which are like peafowls. At Atitalaquia, they ate the male turkeys which in Spain were called *gallopavos.* The females were kept for propagation as it was considered poor management to eat them.[51]

Honduras. When Cortés arrived at Trujillo in 1525, the inhabitants of the neighboring islands brought presents of fish and turkeys. While at this town some natives of Olancho (Guayapa) came to him complaining that the soldiers were stealing their turkeys.[5]

Jalisco. The province in 1530, according to Guzman,[54] was well supplied with turkeys. He states further that turkeys were abundant at the pueblo of Nuyano and at Chapala.[55] Tello[44] informs us that during the conquest of Nuevo Galicia, the cacique of Chola appeared at Chiametla with mantles and turkeys; that the latter were plentiful at Tonolán (Tonolá); and that in 1536 the natives of Purificación were raising turkeys and other birds in quantity. Lopez-Portillo[39] cites the statement of Gonzalo López that the valley at Cuitzeo was supplied with an abundance of provisions such as turkeys, deer, hares, and some fruit. The inhabitants of Cuynan has turkeys. The same statement is made by Samáno[56] for a valley near Chapala. An unknown writer informs us: "At the end of two days of travel we arrived at the province of Tonalá and when we came in sight there appeared certain peaceful Indians with turkeys in hand saying that the lady *(señora)* of this province was peaceful and in her house."[57]

Acatitlán contributed to the Spaniards 3 turkeys annually; Cuyseo (Cuitzeo) and Poçintlán (Poncitlán) together, 20 turkeys every two months; Cuistlán, one every 5 days; Yztlan (Ixtlán), 5 annually; Mechinango, 20 annually; Cuyutan (Coyutlán), Miztlan (Mixtlán), and Acatitlán, some turkeys; Mizquiticacan (Mexticacán), 2 per week; Nuchistlán, 2 every two months; Ocotlán, one every Sunday; Ocotique (Ocotic), one every week; Tetitlán, 5 every 4 months, Tequeçistlán (Tesixtan), one every 5 days; Tlacotlán (Tlacotán), 2 every 5 days; and Tlaxomulco (Tlajomulco), one every week.[40]

Mexico. According to Alvarado Tezozomoc,[58] the Aztec nobleman, 600 turkeys were provided for the people from Huejotzingo, Cholula, and Tlaxcala who came to Mexico to attend the funeral rites of King Axayacatl, the middle of the 15th century. When messengers came from King Ahuitzotl regarding a victory over Cuextlan and other pueblos, the people of Chalco, Xochimilco, Tabuca, and Aculhuacan (Culuican), to celebrate the success, brought especially birds, *huexolome*, i.e. turkeys *(gallipavos)* and *cihuatototolin* or peahens *(pavas)*, wild turkeys *(gallinas del monte)*, and doves. It is difficult to determine if the names of the birds have suffered from translation from the Aztec. Apparently the people brought male and female domestic turkeys, and wild ones.

Each Indian at Atenco contributed to Montezuma one turkey every 20 days.[37] According to Gamio,[59] prior to the conquest, Teotihuacán contributed 62 turkeys annually, and 14 in addition from time to time. In 1543 Domingo Hernández, a resident of Xochimilco and judge for the Viceroy, fixed the tribute at turkeys daily.

Due to a protest in 1552, Fray Diego Rengifo reduced the number to 7 every 80 days.

In 1950, when Cortés neared Tecoco, the houses were found to be filled with turkeys and dogs which the Tlaxcalans carried off[5] The Humboldt fragments record a sale of turkeys at Chalco in 1564. Plate XX of Seler[53] shows the heads of 61 turkeys paid as tribute at some unknown locality. Tomson, [60] in 1555, found "Guiny-cockes" cheap in the city of Mexico. When Hawks[61] was in the city in 1572, he noted that there were "Guiny cocks and hennes," old English names for turkeys. A turkey cost $0.75 to $1.00 in 1822.[62]

Tepechpa (Tepexpan) and Tecama each contributed to the Spaniards 4 turkeys daily; Tequecistlan (Tequisistlan), one daily; Taxcaltitlan (Texcaltitlán), 2 daily. Tepepulco raised turkeys in quantity; and Cuauhquilpan, 3 leagues from Pachuca and about 10 from the city of Mexico, raised both chickens and turkeys. In 1580 turkeys were eaten in Tamazcaltepec.[40, 51]

Michoacan. Guzman[54] wrote on July 8, 1530, that the inhabitants of the province had an abundance of maize and turkeys *(aves de tierra)*. The unnamed Franciscan friar,[27] writing of the customs in Michoacan, mentions turkeys frequently. He states that the Tarascans did not eat turkeys but raised them for their feathers to decorate their gods. One of the caciques had 80 royal eagles and smaller ones in cages which were sometimes fed turkeys. Before the arrival of the Spaniards, one of the priests dreamed that people came bringing horses. They slept in the temples and the many turkeys that they brought made the buildings dirty. At a place called Quangaceo, near Metalcingo, Cristoval de Olí requested and received presents of rich mantles, turkeys, and eggs. The Spaniards were in the town for six months during which time they were provided with bread, turkeys, eggs, and fish. On account of fear of the Spaniards, the inhabitants of Hiripan and Tangaxoan abandoned their towns leaving the dogs, parrots, and turkeys. The cacique of Yzipamuca ordered his people to kill and eat all the dogs, parrots, and turkeys since they were to remain there only five days.

In the latter part of the 16th century, Aquila contributed 48 turkeys annually; Estopila (Estapilla), Teçuatlan, and Yluistlan ((Yhuitlán), each, 24 annually. The latitudes and longitudes given by Borah and Cook[38] would place Estopila and Yluistlan in the Pacific Ocean. Apapapalán contributed 36 turkeys annually; Comanja, 2 daily; Necotlán, 10 every 20 days; Pomaro, 28 annually.[40] Tarequato raised well turkeys and chickens, while Yurirapundaro had chickens and a few turkeys. Chilchota, and Oran, subject to Chilchota, raised chickens and turkeys in quantity. Tasaguararo also raised turkeys. Chocandiran had both wild and domestic turkeys.[48]

Morelos. In 1579, Teputztlan, 12 leagues from the city of Mexico had wild and domestic turkeys. The inhabitants of Ocopetlayuca ate turkeys.[51]

Nayarit. When Guzman passed through Jalisco, he found the people on the side of a mountain. Eventually they came down and gave him turkeys and other foods.[63] The province of Aztatlan had an abundance of provisions, turkeys, and a multitude of all kinds of fishes. The Spaniards often took the name of a pueblo for a province. While Guzman was at Azatlan (Aztatlan) there came lords of the province of Chiametla (Chametla), 20 leagues distant, bringing many turkeys, chili, and fish.[57] This would place Aztatlan on or near the Acaponeta River. The map in Lopez-Portillo[39] locates Aztatlan close to this stream. The Antonio Garcia y Cubas map (1863) has Etzatlan south of Acaponeta on a branch of the Acaponeta River. Regarding the Rio Hastatlan (Aztatlan, now Acaponeta river) it was said: "Here they found so great a supply of food, turkeys *(gallinas de Mexico)*, maize, ducks, and other birds that it was a strange thing to see."

Five leagues from Chametla was a province called Cazala where turkeys and maize were found.[65] The inhabitants of Tepic had turkeys in 1531. Tzenticpac (Teimoac) provided much maize and turkeys. Honey and turkeys were also furnished by Tzapotzinco (Izapotzinco).[44] The latter part of the 16th century Apetatuca contributed 16 turkeys every Easter; Cuyacán, 3 every four months; Tepique (Tepic), 6 every 3 months; Camotlán, 5 every week; Xalxocotlan (Jalcocotlan), 10 yearly; and Xala (Jala), one every week.[40]

Nicaragua. Pedrarías Dávila arrived at Darien in 1514 and organized Tierra Firme, consisting of most of Panama, Costa Rica, and part of Nicaragua. Andagoya[66] states that there was no game in the provinces except birds, consisting of two kinds of *pavas,* pheasants (chachalacas), and doves. If his *pavas* were game birds, they must have been curassows and not turkeys. Córdoba conquered the Rivas area in 1524 and founded the towns of Leon and Grenada. The inhabitants, according to Andagoya, had an abundance of maize, grapes, turkeys *(gallinas de aquella tierra)*, and small dogs which they ate.

Gil González Dávila explored northward along the Pacific Coast in 1522 and arrived in the Department of Rivas, between Lake Nicaragua and the coast. The cacique Diriajen came to his camp with 500 men each carrying one or two male or female turkeys *(pavo o' pava)*. No other bird than the domestic turkey could have been supplied so abundantly. Here was a Mexican (Nahuatl) colony and it is to be expected that it would have turkeys. Oviedo[67] adds that in settling a marriage contract, the Indians killed large turkeys *(gallinas)*, which are like peafowls *(pavos)*, but better than those of Spain. The supplying of turkeys by the cacique "Dirigen" was first mentioned by Mártir.[2]

Benzoni[68] was in Central America from 1541–1556. He reported that in Nicaragua there was to be found a kind of peacock that had been brought to Europe and called Indian fowl. In the New World it was to be found elsewhere only in Guatemala, Cape Fonduri, Mexico, and on the shores of New Spain. The Mexican language was the most important one in Nicaragua, and in this tongue, he adds, fowls were *totoli,* the Mexican word for the turkey hen being *totolin.* About 1635 Gage[35] found turkeys to be ordinary meat in Nicaragua.

Oaxaca. There is little information on the turkey prior to the middle of the 16th century when it was being raised in quantity. Coquitlan contributed 3 turkeys weekly; Chiomesuchitl, 17 every 20 days; Camotlán, 12 yearly; Çimatlan (Zimatlán) and Cuyutepeque (Coyotepec), one daily; Gueytepeque (Huitepec), 10 every 80 days; La Chichina, 20 annually; Necotepeque, 10 every 80 days; Totolapa (Totolapan), 12 every 80 days and 2 every 10 days; Xaltepeque (Tlazoltepec), 40 every 100 days; Ticatepeque (Ticatepec), 40 yearly; Tlaquaçintepeque (Tlacuatzintepec), 20 every 80 days; and Vepanapa (Huapanapa), 120 yearly.[40]

Iztepexi contributed turkeys to Montezuma and later raised both chickens and turkeys. At Texupa (Tejupan), the chiefs ate turkeys at their fiestas. Turkeys and chickens were raised at Chinantla, and the people of Macuilsúchil (Macuilxóchitl) and Treutitlan (Teotilán) de Valle raised these fowls in their homes. The inhabitants of Teticpac formerly paid tribute to Montezuma with turkeys, hares, rabbits, deer, and honey, and subsequently raised turkeys and chickens for commerce. Coatlán sacrificed dogs, turkeys, and quails, and Tlacolula, dogs, turkeys, and Indians. Turkeys and chickens were raised in quantity by Mitla and Taliztaca (Tlaliztaca, Tlalixtac). Guaxilotitlan (Huajolotitlan, Huitzo) raised Castilian chickens, turkeys, and pigs in large numbers. At Puerto de Guatulco, there were bred many native birds called chachalacas which are like Castilian chickens. One statement reads: "ay muchas palomas torcazas y codornizes y 'chachalacas,' que son como gallinas de Castilla, y gallos e gallinas de la tierra; codos estos generos son aues monteses, y demas desto crian entrellos muchas aues de castilla e de la tierra domesticas." Elsewhere are mentioned "chachalacas y gallos y gallinas que son de la generaçion de las domesticas de la tierra."[69] Since chachalacas are mentioned specifically, "gallos y gallinas" can refer only to turkeys, or possibly to the curassow or crested guan; however neither of the latter species would have been raised in numbers.

Puebla. During the conquest the caciques of Cholula sent turkeys and bread. The pueblos of Tepeaca, Quacholae, and Tecamachalco (Tepemaxalco) had plenty of turkeys and little dogs. When Guatomac was made king of Mexico, he sent his armies to raid the pueblos of Guacachula (Huaquechula) and Ozucar where they robbed the people of turkeys and other possessions.[5]

About 1580, the inhabitants of Guachinango (Huachinango) contributed a turkey or its equivalent every five days.[40] Xonotla (Jonatla), as did Tetela, had a great quantity of domestic turkeys.[25]

Quintana Roo. During the Cordóba expedition of 1517, the Spaniards while near Cape Catoche, were given two turkeys.[6] Two years later, on the island of Cozumel, turkeys were found in the houses abandoned by the natives, and Pedro de Alvarado ordered that 40 of the birds be taken.[5]

Sinaloa. At Chametla, a pueblo and province on the Baluarte River, the Spaniards during the Guzman expedition, found many provisions and many turkeys which did not exist farther on. Nevertheless it was subsequently stated that the provinces of Huxitipa and Panuco abounded in fruits, deer and other animals, and that there were many turkeys.[64] Lopez-Portillo[39] shows the pueblo of Chiametla on the Acoponeta River on one map, and on another map on the Baluarte River, on which stream lies modern Chametla. According to Obregón,[70] the province of Chiametla had an abundance of provisions consisting of maize, beans and turkeys, and many cattle which had multiplied from those left by Coronado. The inhabitants presented many turkeys to Diego de Ibarra.

Regarding the pueblo of Actlan, province of Chiametla, it is stated: "And gave a great quantity of turkeys and some fish, and leaving in peace said province he returned bringing with him the son of the lord with about 150 men all laden with turkeys from which the [Spanish] people took no little consolation because there had been many sick ones."[65]

The pueblo of Piastla (Piaxtha), according to Guzman,[55] was well supplied with all kinds of provisions except turkeys of which were found only three or four males. Quinota, a short distance northeast of modern Quila, had abundant provisions, but only a few turkeys were found. Near Pascua there were many large turkeys but nothing else. Regarding a pueblo near the mouth of the Rio Culucan, he wrote: "There were not many turkeys there because they ate them, knowing that we were coming, since there was a pueblo where I found four turkeys dead and plucked."

Some turkeys, many parrots, and some falcons in cages were found at Pochotla, a pueblo above Piaxtla on the Piaxtla River. There was much to eat in Culiacan, one item consisting of "a turkey as large and tough as a he-goat."[65] In 1534 the inhabitants of Culiacan, according to Tello,[44] had many turkeys and Castilian chickens. Another writer states that the province of Culiacan had only a few turkeys, but there was "no lack of mosquitos."[57]

Sonora. No early account of the keeping of turkeys in Sonora was found. An unknown Jesuit, writing in 1763, stated that in some places in Sonora there were domesticated turkeys.[31] Sonora was defined as the area north of the Yaqui River, west of the Sierra Madre Mountains, and south of the Gila River in Arizona.

Tabasco. At the mouth of the Grijalva River in 1518 and 1519, according to Diaz,[5] the Indians brought to the Spaniards cooked fish and turkeys. He mentions several pueblos where turkeys were obtained during the expedition of Cortés to Honduras. I have relied for the location of the towns on the map in Maudslay's[71] translation of Diaz. Turkeys were obtained at an unknown pueblo on the Rio Usumacinta at approximately 17°40′N, 91°30′W. Cortés built a bridge across the Rio San Pedro at approximately 17°20′N, 91°10′W. Here Diaz arrived with maize and 80 turkeys that the soldiers appropriated. The following evening he went out and returned with 20 turkeys for Cortés. Evidently the source of supply was not more than six miles from the bridge. The Indians at Gueyacala, a pueblo up stream, brought maize and some turkeys. In some of the houses they found many cooked cock and hen turkeys *(gallos de papada y gallinas)*.

The natives of the Rio Tabasco (Grijalva) brought to Cortés, during his expedition of 1519, eight dark turkeys neither smaller nor less tasty than peafowls.[2] Cortés,[14] writing in the same year, says that some Indians in a canoe brought certain *gallinas* and a little maize. At the port of San Antonio, near the mouth of the Rio Grijalva, Grijalva[72] informs us that in 1518 the Indians brought cotton mantles and turkeys. These birds, according to Dampier, were raised in 1676 in the towns along the Tabasco River. Of one of them he wrote: "They feed abundance of Turkies, Ducks, and Dunghill Fowls, of which the Padre has an exact account; and is very strict in gathering his Tithe :and they dare not kill any except they have his Leave for it."[42] Turkeys were also raised along the Chiltepec and Dos Bocas Rivers.

Tlaxcala. According to Mártir[2] the city of Tlaxcala contained a great number of fat birds lke peafowls, which were raised in place of Spanish chickens. Cortés[14] wrote that in 1520 the place was well supplied with bread, turkeys, game, and fish.

Veracruz. The people of Cempoala (30 miles north of Veracruz) gave turkeys as tribute to the predecessors of Montezuma.[37] When Grijalva[72] was at the Isla de los Sacrificios, near Veracruz, the Indians brought cakes and turkey pies. Diaz,[5] who accompanied the expedition, mentions that at the mouth of the Rio de Banderas (Jamapa) the Indians brought turkeys and maize bread. Turkeys were also supplied at the port of San Juan de Ulúa (Veracruz). Alvarado raided the pueblos adjacent to Costastan (Cotaxtla) and brought back turkeys. These birds were also sent by the cacique of Cempoala. When the survivors of the DeSoto expendition arrived at Pánuco in 1543, they were well supplied with turkeys by the inhabitants. All the way from Pánuco to the great city of Mestitam, when a turkey was requested of an Indian, he would give four.[73]

About 1580 Nanaguautla (Nanahuatla) furnished 60 turkeys yearly.[40] Tlacotalpan had deer, and raised turkeys and chickens; Xalapa (Jalapa), a great quantity of hens which are called turkeys in Castile *(gallinas, que en Castilla dizen gallibabos,* also called *papagallos);* Veracruz, numerous turkeys in many large flocks.[25] When Gage[43] landed at Veracruz, apparently in 1635, the inhabitants gave a dinner for the fleet for which "Turkey-cocks and Hens were prodigally lavished." During the first two days of his journey to Mexico City, turkeys were plentiful in the small towns where he lodged.

Yucatan. The people of Zamailco (Samahil), in 1549, were required to pay an annual tribute of 400 fowls, either turkeys or Castilian chickens.[7] Numerous occasions are mentioned by Ponce[74] when he was given turkeys. About 1635 Gage[43] found turkeys abundant in Yucatan.

Zacetacas. In 1580 Suchipila (Juchipila) contributed five turkeys monthly.[51]

Place Names

State or Country	Town	Latitude and Longitude
Colima	Chiametla	19°17′N, 104°10′W
	Coatlán	19°13′N, 103°56′W
	Contlán	19° 3′N, 104°12′W
	Escayamoça	18°59′N, 103°55′W
	Malacatlán	19° 5′N, 103°44′W
	Teçitlan	19°10′N, 104° 0′W
	Tecolapa	19° 3′N, 103°50′W
	Tepaçuneca	18°45′N, 103°50′W
	Tequepa	18°52′N, 103°58′W
	Tlacoloastla	19°23′N, 104° 3′W
	Quiçilapa	19°15′N, 103°50′W
	Xocotlán	18°50′N, 103°50′W
	Ystlahuacan	19° 2′N, 103°45′W
Durango	Nombre de Dios	23°51′N, 104°15′W
Guanajuato	Acanbaro	20° 2′N, 100°43′W
Guatemala	Dolores	16°32′N, 89°28′W
	Gueguetenango	15°19′N, 91°28′W
	Mixco	14°37′N, 90°38′W
	Rabinall	15° 6′N, 90°18′W
	San Luis	16°13′N, 89°25′W
	Totonicapa	14°55′N, 91°20′W
Guerrero	Acamistlauca	18°34′N, 99°33′W
	Asuchitlan	18°10′N, 100°29′W
	Alaustlan	18°34′N, 100° 2′W
	Ayutla	16°50′N, 99°14′W
	Cuetzala	18° 6′N, 99°50′W
	Nochtepeque	18°38′N, 99°42′W
	Ostuma	18°20′N, 100°12′W
	Quatepeque	16°42′N, 99° 4′W
	Tasco	18°33′N, 99°38′W
	Teloloapa	18°21′N, 99°52′W
	Tetela	17°58′N, 100° 7′W
	Tlacotepeque	17°46′N, 99°59′W
	Tzicaputzalco	18°35′N, 99°56′W
	Utatlan	18°15′N, 99°20′W
Hidalgo	Acatlan	20° 9′N, 98°26′W
	Atitalaquia	20° 4′N, 99°13′W
	Axocupan	20° 5′N, 99° 6′W
	Mizquiahuala	20°14′N, 99°13′W
	Tecpatepec	20°14′N, 99° 5′W
	Tezcatepec	20°16′N, 99°15′W
	Tlacachique	20°10′N, 99° 0′W
	Tornacustla	20°10′N, 98°52′W
	Tututepeque	20°25′N, 98°17′W
	Uexutla de Hidalgo	21° 8′N, 98°25′W
	Vauagasco	21°15′N, 98°37′W
	Yetecomac	20°12′N, 99° 1′W
	Zimapán	20°45′N, 99°21′W
Honduras	Olancho	14°45′N, 86°52′W
Jalisco	Acatitlán	20°32′N, 104°29′W
	Chapala	20°17′N, 103°12′W
	Chola	19°45′N, 105°19′W
	Cuistlán	20°47′N, 103°20′W
	Cuitzeo	20°18′N, 102°48′W

PLACE NAMES—Continued

STATE OR COUNTRY	TOWN	LATITUDE AND LONGITUDE
Jalisco—Cont.		
	Cuynan	20°30′N, 103° 0′W App.
	Cuyutlan	19°42′N, 104°31′W
	Mechinango	20°35′N, 104°25′W
	Mizquiticacan	21°14′N, 102°44′W
	Miztlan	20°29′N, 104°20′W
	Nuchistlán	20°38′N, 103°27′W
	Ocotique	21° 3′N, 103° 4′W
	Ocotlan	20°40′N, 103°27′W
	Poçintlán	20°22′N, 102°56′W
	Purificación	19°43′N, 104°38′W
	Tequeçistlán	20°47′N, 103°27′W
	Tetitlán	19°55′N, 105°10′W
	Tlacotlán	20°47′N, 103°12′W
	Tlaxomulco	20°28′N, 103°27′W
	Tonolán	20°38′N, 103°14′W
	Yztlan	20°37′N, 103°27′W
Mexico	Aculhuacan	19°20′N, 99°11′W
	Atenco	19°32′N, 98°54′W
	Chalco	19°15′N, 98°54′W
	Cuauhquilpan	19°50′N, 98°55′W App.
	Tabuca	19°26′N, 99°13′W
	Tamazcaltepec	19° 2′N, 100° 3′W
	Taxcaltitlan	18°53′N, 99°54′W
	Tecama	19°43′N, 98°58′W
	Tecoco	19°32′N, 98°54′W
	Teotihuacán	19°42′N, 98°50′W
	Tepechpa	19°37′N, 98°56′W
	Tepepulco	19°50′N, 98°30′W
	Tequecistlan	19°37′N, 98°58′W
	Xochimilco	19°15′N, 99°10′W
Michoacan	Apapapalán	18°57′N, 103°17′W
	Aquila	18°40′N, 102°32′W
	Chilchota	19°47′N, 102° 3′W
	Chocandiran	19°53′N, 101°20′W
	Comanja	19°42′N, 101°42′W
	Estopila	18°59′N, 103°31′W
	Metalcingo	19°12′N, 101° 1′W
	Necotlán	19°38′N, 101°17′W
	Pomaro	18°20′N, 103°14′W
	Tarequato	19°52′N, 102°32′W
	Teçuatlan	18°38′N, 103°30′W App.
	Yluistlan	18°34′N, 103°27′W App.
	Yurirapundaro	20° 5′N, 101°30′W
Morelos	Ocopetlayuca	18°55′N, 98°38′W
	Tepúztlan	19° 0′N, 99° 2′W App.
Nayarit	Apetatuca	20°55′N, 105° 0′W
	Aztatlan	22°10′N, 105°20′W App.
	Camotlán	20°58′N, 104°40′W
	Cuyacán	21°35′N, 104°55′W
	Jalisco	21°27′N, 104°54′W
	Tepic	21°31′N, 104°53′W
	Tzapotzinco	21°32′N, 104°57′W
	Tzenticpac	21°45′N, 105° 2′W
	Xala	21° 8′N, 104°27′W
	Xalxocotlan	21°27′N, 105° 8′W
Oaxaca	Camotlán	17°30′N, 96°10′W
	Chinantla	17°45′N, 96°24′W
	Chiomesuchitl	17°16′N, 96°29′W

PLACE NAMES—Continued

STATE OR COUNTRY	TOWN	LATITUDE AND LONGITUDE
Oaxaca—Cont.		
	Çimatlan	16°50'N, 96°47'W
	Coatlán	16°12'N, 96°46'W
	Coquitlan	16°33'N, 96°20'W
	Cuyutepeque	16°57'N, 96°43'W
	Guaxilotitlan	17°13'N, 96°50'W
	Gueytepeque	17°13'N, 96° 7'W
	Iztepexi	17°15'N, 96°34'W
	La Chichina	17°28'N, 96°18'W
	Macuilsúchil	17° 2'N, 96°32'W
	Mitla	16°56'N, 96°23'W
	Puerto de Guatulco	15°51'N, 96°19'W
	Taliztaca	17° 5'N, 96°40'W
	Teticpac	16°56'N, 96°37'W
	Texupa	17°39'N, 97°28'W
	Tlacolula	16°56'N, 96°28'W
	Tlaquaçintepeque	17°48'N, 96°33'W
	Totolapa	16°42'N, 96°18'W
	Treutitlan de Valle	17° 3'N, 96°31'W
	Vepanapa	18° 8'N, 97°40'W
	Xaltepeque	16°52'N, 95°47'W
Puebla	Cholula	19° 5'N, 98°18'W
	Guacachula	18°45'N, 98°33'W
	Guachinango	20°12'N, 98° 3'W
	Ozucar	18°37'N, 98°27'W
	Quacholac	18°57'N, 97°38'W
	Tecamachalco	18°52'N, 97°43'W
	Tepeaca	18°58'N, 97°55'W
	Tetela	18°52'N, 98°10'W
	Xonotla	20° 3'N, 97°35'W
Sinaloa	Panuco	23°25'N, 105°55'W
	Piastla	23°51'N, 106°39'W
	Quila	24°23'N, 107°13'W
Veracruz	Costastan	18°50'N, 96°23'W
	Nanaguautla	21° 7'N, 98°37'W
	Panuco	22° 3'N, 98°10'W
	Tlacotalpan	18°37'N, 95°40'W
	Xalapa	19°32'N, 96°55'W
Yucatan	Zamailco	20°50'N, 89°55'W
Zacetacas	Suchipila	21°55'N, 103° 8'W

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THE ZENDA METEORITE

William F. Read

The Allyn Palmer family operates a 174-acre farm located half a mile west of Zenda in Walworth County, Wisconsin. In the spring of 1955, Mr. Palmer, while plowing, noticed an unusual-looking dark, heavy rock and brought it back to the house. Some time later his eldest son Jon took the rock to school and gave it to some boys who were members of the local astronomy club. The boys showed it to Dr. G. P. Kuiper at Yerkes Observatory. Suspecting that it might be a meteorite, Dr. Kuiper bought the specimen and forwarded it for positive identification to Dr. H. H. Nininger of the American Meteorite Museum at Sedona, Arizona. Dr. Nininger cut a small slice from one end, determined that this was in fact an iron meteorite, and returned the main mass to Dr. Kuiper. The writer purchased the main mass from Dr. Kuiper in March, 1960.

The original total weight was near 3.7 kg. As received by the writer, the main mass weighed 3623 g. It has since been cut into two pieces weighing 2791 g and 770 g. Dr. Nininger retained the slice which he had cut off and later sold it, along with the bulk of his collection, to Arizona State University. This slice weighs 60 g.

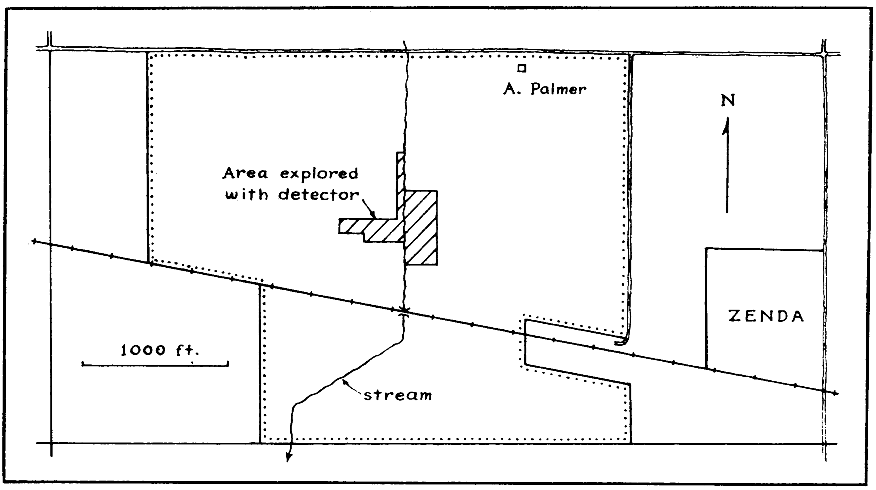

FIGURE 1. South half of Sect. 28, T 1 N, R 17 E. Stippled line is the Palmer farm boundary. The meteorite is believed to have been found in the east half of the area explored with a metal detector.

Mr. Palmer does not recall exactly where on his property he found the meteorite. Figure 1 shows the farm boundaries. Certainly the specimen came from north of the railroad tracks, and probably from east of the stream in the area which the writer later explored (unsuccessfully) with a metal detector. If so, the coordinates of the fall are Lat. 42° 30′ 48″; Long. 88° 29′ 22″. This is gently rolling farm country on the south slope of the Darien moraine of the Delavan ice lobe.

External Form

The Zenda meteorite evidently fell many years ago. A brilliant fireball is reported to have burst over Zenda the evening of February 5, 1917, (Frost, 1917) but is it doubtful that this was the source of the present meteorite. Rusting has destroyed the original fusion crust with its ablational detail. How much rust had accumulated we cannot tell since much was doubtless dislodged by farm machinery. The thickest remaining accumulation (Fig. 3) is about ¼ inch.

The overall form at present is roughly wedge-shaped. The narrow end (Fig. 2) tapers between fairly flat surfaces; the broad end is more irregular. Shallow depressions, circular to irregular in plan and up to 2 inches in diameter, occur equally on all sides. The conspicuous notch which appears on the upper left margin of the upper photograph in Figure 2 is caused by an unusually deep depression which has cut into the edge between two surfaces. Probably these depressions are ablational in origin though they have doubtless been modified by weathering.

A narrow, deep cleft may be seen parallel to the lower right margin of the upper photograph, Figure 2. This marks the former position of a thin, flat sheet of troilite, remnants of which are still visible. The black spot in the upper right corner of the lower photogroph is a hole leading into the cleft.

Some evidences of human tampering are present. The squarish projection shown on the upper right margin of the lower photograph, Figure 2, has been flattened off with a file. One inch, and again four inches, to the left of the projection, shallow notches cut with a hacksaw may be seen.

Composition and Structure

Two etched sections through the Zenda meteorite are shown in Figure 3. Octahedral structure is immediately evident. The narrower kamacite bands have a width of about .6 mm., making this a "medium" octahedrite.

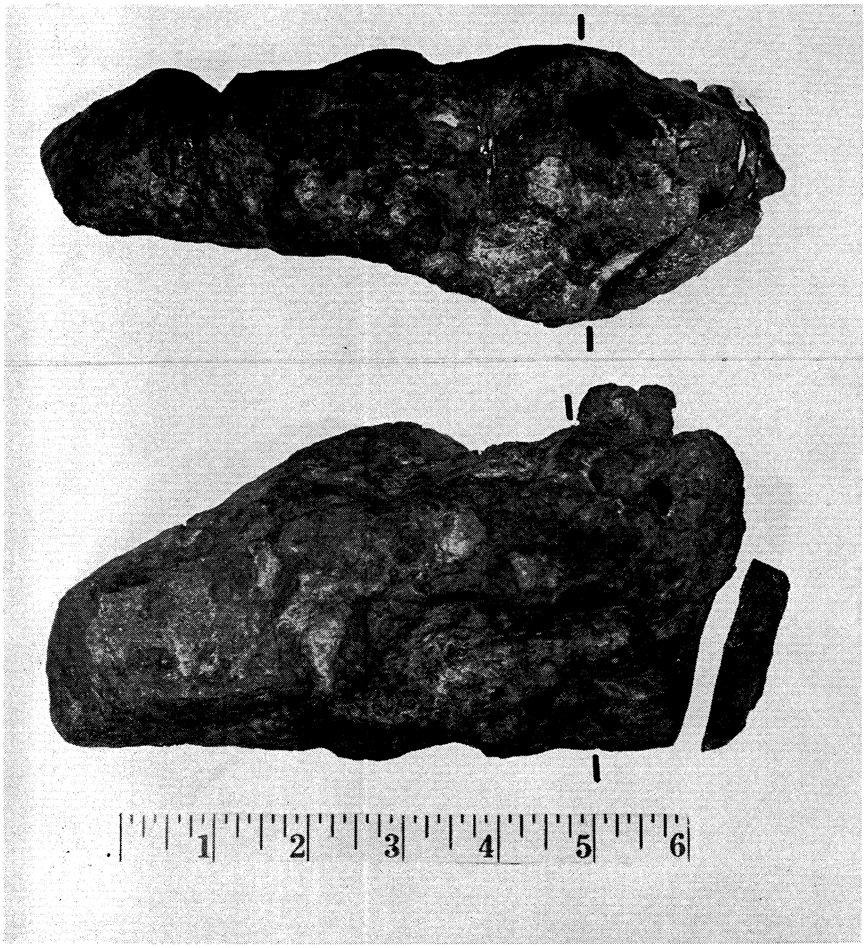

FIGURE 2. Two views of the Zenda meteorite. The upper photograph looks down toward the top edge of the specimen as shown below. In the lower photograph, the end piece belonging to Arizona State University has been restored to its approximate original position. Short, heavy lines indicate the location of the section cut by the writer.

On the larger surface, the right one third shows a different pattern of bands from the left two thirds. This is attributed to twinning, the boundary between the two contrasting parts being a composition surface. Since one set of kamacite bands (i.e., one of the octahedral directions) is common to both parts, the twin is assumed to be of the "spinel" type.

The kamacite bands are somewhat swollen between intersections. Many of them shown conspicuous Neumann lines. Also, many are divided into rounded or polygonal grains separated by fine furrows

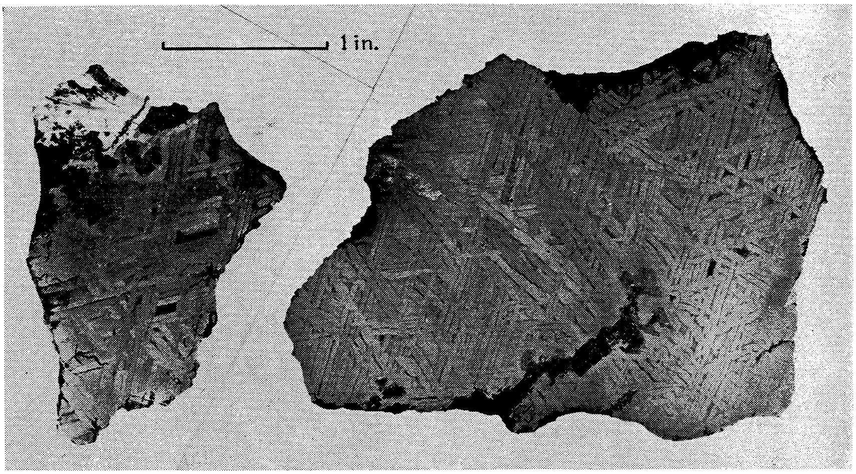

FIGURE 3. Etched sections through the Zenda meteorite. Left hand section cut by H. H. Nininger. Light area at the top is a curved surface. Note limonite "worms" due to presence of lawrencite. Right hand section cut by W. F. Read.

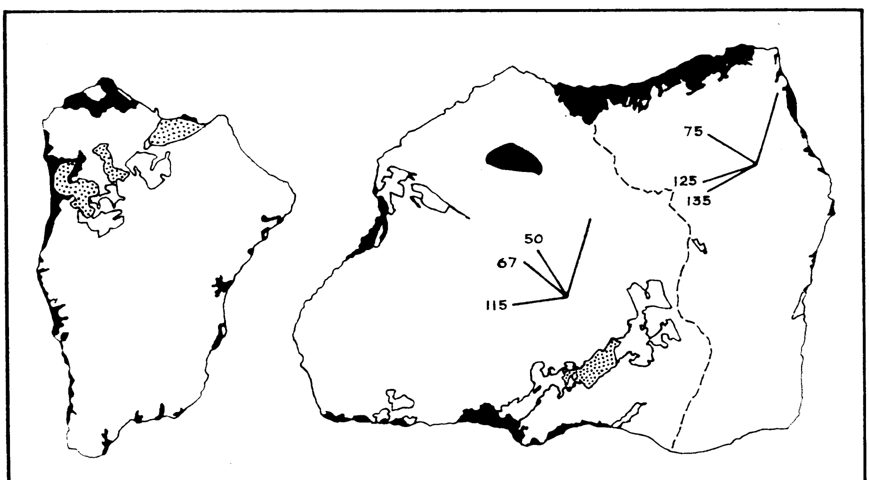

FIGURE 4. Tracings from photographs of etched surfaces shown in Figure 3—black: oxidation, white enclosed areas: schreibersite, dotted: troilite. Dashed line indicates composition surface between two parts of twin. Radiant diagrams show angles between kamacite bands limited to one part of twin and those shared in common (longer line).

on the etched surface. Neumann lines cross these furrows without deflection. Minute euhedral schreibersite crystals (rhabdites) are abundant as inclusions. "Swathing" kamacite surrounds the more conspicuous patches of schreibersite and troilite (Fig. 4).

Taenite lamellae are fairly uniformly developed around the kamacite plates. For some reason, they etched to a golden color on the surface cut by the writer—hence appear dark in the photograph, Figure 3. They have the usual silvery appearance on the surface cut by Dr. Nininger. Variations in width are pronounced. In some places, the taenite is about one fifth as wide as adjoining kamacite bands. Elsewhere it narrows down to a hair line or may be entirely lacking. Some sections of the taenite lamellae are replaced locally by schreibersite.

Plessite fields occupy perhaps 20 percent of the total area of a cut surface. Most show a grilled structure, with pronounced variation in the coarseness of the grill. Some are apparently structureless. Small, irregular inclusions of schreibersite may be present. A few plessite fields show partial replacement by a brittle, brownish-metallic mineral which resembles troilite but leaves no mark on a sulfur print.

The conspicuous included patches of schreibersite and troilite shown in Figure 4 are of considerable interest. Dark speckles which appear within and near them in the photographs, Figure 3, are crystals of pyroxene (black), olivine (pale brown to greenish), and graphite (grey) in approximately equal proportions. These crystals tend to be clustered together, leaving certain portions of the inclusion—most commonly the extremities—relatively clear. From the fact that the silicates and graphite occur outside the inclusions, though never very far outside, one gets the impression that nickel-iron has encroached on (replaced) the schreibersite and troilite, leaving less digestible silicates and graphite stranded beyond their original matrix. Replacement is also suggested by the presence of small spongy masses of kamacite inside the phosphide and sulfide.

No crystals of silicate or graphite are seen in the wedge-shaped mass of troilite which cuts into the upper edge of the smaller surface as shown in Figure 4. This is in line with the prominent cleft mentioned in the description of external form; hence, the troilite here belongs to a flat sheet, not an irregular patch. Unlike the troilite of the patches it fractures along parallel planes (possibly the 0001 parting) and may be a single crystal. The curved margin adjoining to the right (Fig. 4) was apparently one wall of a second mass of "sheet" troilite running at right angles to the first. The edge of the specimen is here formed by a strip of swathing kamacite.

ACKNOWLEDGEMENTS

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CHAUTAUQUA AND THE WISCONSIN IDEA

Melvin H. Miller

The purpose of this paper is to reconstruct America's only university-conducted circuit Chautauqua. The University of Wisconsin operated such a Chautauqua from 1915 to 1917 and in so doing demonstrated that bold leadership in adult education which was to become known as "The Wisconsin Idea."[1]

A Chautauqua conducted by a university is not only interesting but significant. To understand that significance one must look briefly at the phenomenon known as the Chautauqua movement.

Circuit Chautauqua was a lusty child whose father was the lyceum movement and whose mother was Lake Chautauqua. As with most children this one was a fascinating composite of good and bad, a child who grew up to have tremendous popularity for a brief time and then to die suddenly—while its less spectacular but hardier parents lived on.

Lyceum had grown up in New England in the early 1800's. At first it was a non-commercial community affair in which lectures and talks were given by local members or by visitors from other town lyceums. In 1868, James Redpath organized the first commercial lecture bureau to solve the difficulties of bringing professional lecturer and audience together. The lecture bureau flourished and thus provided two basic ingredients upon which circuit Chautauqua could eventually draw: organization and a pool of talent.

Mother Chautauqua grew up on the shores of Lake Chautauqua at Fair Point, New York. Rooted deep in the religious revival of the early nineteenth century, she was born of the Methodist camp meeting and the American Sunday School movement. Starting in 1874, Lake Chautauqua became a full-fledged summer school, one of the first in the United States. By 1900 more than two hundred courses were being offered in eight academic and special schools, housed in permanent buildings.[2] She brought to circuit Chautauqua its essentially moral and religious flavor, its earnestness and its bucolic nature.

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[1] It is unfortunate that this pioneer experiment is not chronicled even in the University's official records. *The Biennial Reports of the University Regents* during this period only mention Chautaqua. Merle Curti and Vernon Carstensen's *The University of Wisconsin;* a History, 1845–1925, mentions it only briefly. Frederick M. Rosentreter's *The Boundaries of the Campus,* A History of the University of Wisconsin Extension Division, 1885–1945, does not mention it at all. It has been necessary, therefore, to turn to the contemporary press of the day and this, along with bits and pieces of scattered reports, makes it possible to reconstruct, at least in part, this unique episode.

[2] John S. Noffsinger, *Correspondence Schools, Lyceums and Chautauquas* (New York, 1926), p. 109.

There were several off-spring who helped to spread the Chautauqua idea. One of these was the Chautauqua Literary and Scientific Circle, usually known as the C.L.S.C., forerunner of the correspondence course and dedicated to home study and consistent and serious planned reading. A half-million earnest readers have kept the idea alive to this day.

Still another child was the permanent Chautauqua Assembly, patterned after Lake Chautauqua, two hundred of which sprang up over the country.

In 1904, the last and most colorful member of the Chautauqua family was born and the one most Americans remember—the circuit or traveling Chautauqua—an idea that was to carry the big brown tents to every corner of the land and to bring an amalgam of knowledge and entertainment to one out of every eleven men, women and children in the United States sometime during every calendar year.[3]

Since the Midwest was Chautauqua's stronghold, we might expect that Wisconsin played a role in its development and this is true. Permanent Chautauqua Assemblies, such as the one at Monona Bay, were active as early as the 1880's.[4] The C.L.S.C. had chapters at Appleton, Darlington, Dartford (now Green Lake), Elkhorn, Milwaukee, Waupun, Eau Claire, Sparta and Cheboygan as well as many individual enrollees.[5] There is little doubt that attics all over Wisconsin hold dusty copies of George B. Adams' *Growth of the French Nation* or J. P. McGaffey's *A Survey of Greek Civilization.*

Finally, the tents of the commercial circuit Chautauqua dotted the landscape of Wisconsin for more than twenty years yet no Wisconsin historian has done more than glance in that direction.[6]

II

Our concern in this paper is with Chautauqua as it was conducted by the University of Wisconsin. What makes a university-run Chautauqua significant lies in the relationship of education to Chautauqua—a relationship which has always puzzled critics and historians. Was Chautauqua, as Sinclair Lewis once stated, "noth-

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[3] F. C. Bray, "Chautauqua Fifty Years Young," *Review of Reviews,* LXX (July, 1924), 71–76.

[4] The cash book for the Monona Bay Assembly shows numerous entries for monies paid to lecturers in the 1880's. An entry for July 25, 1893, shows the sum of $200.00 paid to Russell H. Conwell, author of the Classic "Acres of Diamonds" speech, State Historical Library MSS 34BX.

[5] Harrison John Thornton, "Chautauqua and the Midwest," *Wisconsin Magazine of History,* XXXIII (December, 1949), 155.

[6] The subject bibliography of Wisconsin history published by the State Historical Society of Wisconsin lists no items on the subject. Thornton's article, which only indirectly involves Wisconsin Chautauqua, is the only such article in the *Wisconsin Magazine of History.*

ing but wind and chaff and the heavy laughter of yokels?"[7] or was it an embodiment of the original idea defined by Bishop John H. Vincent: "Self-improvement in all our faculties, for all, through all time, a people's idea, a progressive idea, a millenial idea?"[8] With its talent ranging from Billy Sunday to Herbert Hoover and from the Swiss Bell Ringers to Galli-Curci, was it truly a "People's University" or was it a kind of sanctioned circus?

Wisconsin's answer was clear. Both lyceum and Chautauqua offered great educational opportunity and the University set about to demonstrate that potential in its extension offerings.

There was precedent for the development of a university-sponsored Chautauqua at Wisconsin. Gould's recent book demonstrates the relationship between Lake Chautauqua and the universities. This relationship was strongest first at the newly-formed University of Chicago under William Rainey Harper, but with his death in 1906, leadership in adult education passed to the University of Wisconsin.[9] Says Creese: "If one were thoroughly acquainted with the experience of these two universities he would know almost the whole story of university extension in this country."[10]

As with the commercial agencies, the foundation for Chautauqua was laid by the lyceum movement. Wisconsin was one of four state universities to carry on a university-sponsored lyceum program sharing its lyceum talent with Minnesota and North Dakota.[11]

By 1909, John J. Pettijohn was reporting to Dean Reber of the Wisconsin Extension Division that, "these commercial lecture and entertainment courses usually called lyceum courses will provide an avenue through which the University may bring its valuable information, its culture, and its inspiration to the people of the state and furthermore *I believe these lyceum courses are in themselves of sufficient educational, recreational and spiritual value to be worthy of institutionalizing by public taxation.*" [Italics in the original] Pettijohn stated a few years later that upon this 1909 report was built the beginnings of the University lyceum.[12]

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[7] George S. Dalgety, "Chautauqua's Contribution to American Life," *Current History* XXXIV (April, 1931), 59.

[8] Gregory Mason, "Chautauqua, its Technique," *American Mercury,* I (March, 1924), 274.

[9] Joseph E. Gould, *The Chautauqua Movement* (State University of New York, 1961).

[10] James Creese, *The Extension of University Teaching* (New York, 1941) p. 40. Creese noted that four prominent Lake Chautauqua members moved on to the universities and were responsible for much of extension development there. Those moving to Chicago, besides Harper, included Frederick Starr, Chautauqua Registrar, who became Professor of Anthropology; and George Vincent, Vice President of Lake Chautauqua and Manager of the Chautauqua Press, who was made Professor of Sociology. To Wisconsin in 1892 went Richard T. Ely as Professor of Political Economy. His strong leadership was to continue there until 1925.

[11] Noffsinger, p. 133.

[12] As reported by Pettijohn in a speech "University Extension Lyceum" delivered before the International Lyceum Association Convention in Chicago, September 17, 1913. The speech was published in pamphlet form.

By 1913 Pettijohn could report in an address before the International Lyceum Convention, that the University of Wisconsin had provided in the past year over four hundred lyceum lectures and over two hundred dates filled by concert companies. Said he: "When education is the guiding motive, instead of dividends, the lyceum and Chautauqua will step up in line with libraries, art galleries and museums. It will form part of our great expanding educational system."[13]

Pettijohn resigned that same year and was replaced by Paul H. Voelker. Voelker not only expanded the lyceum service by using non-university talent, but saw the opportunity for a university-conducted Chautauqua. After all, the administrative structure was already in existence. The lyceum programs were being scheduled by six extension districts throughout the state.[14] If lyceum was successful in the winter, wasn't Chautauqua, as someone once said, merely lyceum in the light pongee of summer?

So the Chautauqua began. Its aim, according to the Report of the Board of Regents was "to satisfy the growing demand among all classes in America for education in connection with recreational opportunities."[15] The first circuit, in the summer of 1915, was to include twenty towns.

The district representatives had done a good job of promotion and the local newspapers looked forward eagerly to what was called, "Wisconsin Week." Said an editorial in the *Evansville Review* for May 20, 1915: "We in Wisconsin ought to be glad that our great University has entered the Chautauqua field. It is one of the best things it ever did." In Bayfield the *Bayfield Progress* looked forward to a "feast of good things" and proclaimed itself "The Chautauqua City of Chequamegon Bay."[16] In Ripon the editor of the *Weekly Press* after complaining that a great many had nearly choked trying to pronounce the name Chautauqua, proclaimed it "good for the blues and will drive away any grouch."[17] And said the editor of the *Bloomer Advance* in the wonderful prose of the small town editor: "Most of the towns and cities in the better parts of Wisconsin will this year have Chautauqua, the people's university and recreation period, combined in one great jollification."[18]

The newspapers stressed over and over again that University Chautauqua was a non-profit operation and thus it could bring

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[13] Ibid.

[14] "With the opening of the year 1912–1913, the placing of lecture and entertainment courses was transferred to the districts." *Biennial Report of the University Regents, 1914–1916*. The districts included Milwaukee, Oshkosh, La Crosse, Superior, Wausau and Eau Claire.

[15] *Biennial Report,* 1914–1916, p. 191.

[16] *Bayfield Progress,* December 17, 1914; July 22, 1915.

[17] *Ripon Weekly Press,* July 1, 1915.

[18] *Bloomer Advance,* June 10, 1915.

better talent at lower cost than had been possible with the commercial kind.

The arrangements were similar for all the communities. Each town paid the University one thousand dollars for the program. For this payment the University sent a large-sized tent seating 1200, with platform, chairs and electric lamps, a smaller tent to enclose the two; a corps of four workers who remained in the community for six days and gave platform talks, conducted round table discussions, lead in community singing, displayed educational motion pictures and told the children stories and taught them games.

In addition, the University provided two popular programs every day for six days, each program preceded by a musical or literary prelude. Each community was amply supplied with advertising matter. It was originally estimated that it would require 26 days to give the six-day program in 21 towns. (One town later dropped out.)

This arrangement meant that seven tents and similar sets of equipment were required since it took one day to transport and set up the gear. Thus the Chautauqua would leap-frog its way around the state for as one community ended its program each day, a new Chautauqua opened someplace else. This was the basic principle of the commercial circuit Chautauqua, of course, and it was this circuit idea which made the peripatetic university economically possible.

A look at the program for that 1915 Chautauqua reveals that its talent was almost identical with one of the better six-day commercial circuits.

One is surprised to find only one University of Wisconsin lecturer featured although certainly an outstanding one. While Chautauqua programs were not given to the use of litotes, in the brochures sent out by the Extension Division, William H. Kiekhoefer, then Assistant Professor of Political Economy, was billed as "A typical American." One other Madisonian was on the list of lecturers. He, too, was well-known for his speaking. This was Reverend Father H. C. Hengell, the Irish pastor of University St. Paul's Chapel in Madison. Other lecturers were standard attractions on the commercial circuits. One of these was Dr. William Forbush, organizer of the Knights of King Arthur, called the largest boy fraternity in the world. Forbush's topic was "The Boy Problem."[19]

Other speakers included Congressman James Manahan of Minnesota, who had served during the preceding term in the U. S.

[19] The Boy Scout movement was incorporated in this country, February 9, 1910, and received much of its imputus from the Chautauqua movement. See my article "The Chautauqua in Lansing," *Michigan History*, XL (September, 1956), 268.

House of Representatives; William Bruce Leffingwell, a travel lecturer, who showed slides and talked about "Seeing America First" and Edwin W. Lanham, billed as "sometimes a historian, sometimes a poet, sometimes a scientist, often a humorist, but always an orator." Finally there was Lincoln Wirt, the former Territorial Superintendent of Public Instruction in Alaska, and a long time Chautauqua and lyceum lecturer.

These speakers were supplemented, for parts of the tour, by Congressman William H. "Alfalfa Bill" Murray of Oklahoma speaking on "The Philosophy of the Plow" and on several occasions by Wisconsin's Robert LaFollette giving his famous lecture on popular government. In addition Dean Louis Reber and Paul Voelker from the Extension Division would visit the Chautauqua from time to time.

Providing entertainment was Thatcher's Symphony Orchestra of twenty pieces.[20] Others included a dramatic company of five members, a male quartet complete with readings and the inevitable Swiss bells, and the Tuskegee Institute Singers, a group of eight students from that institution and billed as the best Negro singers in the world. (It was worth the cost of a season ticket, said the advertising copy, to hear them singing, "The Watermelon Hanging on the Vine.")

Two reels of motion pictures were shown after the lecture each night. *The Evansville Review* said of these: "It is quite a relief to see no one pushed off a cliff or something." Instead, reported that newspaper somewhat vaguely: "Scenes of birds—various and unusual birds of all sorts, doing all sorts of things."[21]

The circuit began in Madison on July 1, the first Chautauqua Madison had had since the days of the Monona Assembly. The big tent was set up in front of the Historical Society library. President Van Hise came down to tell the audience, "I shall never be content until the University becomes a beneficient influence to every family in the state." George Vincent, President of the University of Minnesota, also spoke. "Alfalfa Bill" Murray told this audience, "Preparedness is the surest protection against war." Even with these famous names, though, bad weather and the great number of attractions going on in the University community put attendance far below expectations.[22]

The first week had its share of troubles. In La Crosse, where the Chautauqua opened on July 4th, wind and rain collapsed the big tent just an hour before the afternoon performance was to begin. The program moved over to the smaller exhibition tent and

[20] "The biggest that has ever come to Bloomer." *Bloomer Advance,* July 22, 1915.
[21] *Evansville Review,* July 15, 1915.
[22] *Wisconsin State Journal,* July 2, 1915.

the show went on. The first speaker noting the torrential downpour going on outside said, "I have been asked to make a dry speech to offset the weather." Professor Kiekhoefer hopped up on a chair, which he noted was the smallest platform he had ever spoken from, and opened his remarks like this: "I am going to lecture to you on "The Springs of Happiness" and I'll wager that there is no place in Copeland Park where you would be happier than you are right here." And if the stringed instruments of the orchestra sounded a little strange in the damp weather—well, that was Chautauqua—university of otherwise.

And so the Chautauqua went—to such towns as Tomah and what is now Wisconsin Rapids, to Stevens Point, Ripon and Antigo, to Ladysmith and Bloomer and Rice Lake, to Bayfield and Superior, and down again to Delevan and Racine and Evansville.

As with the commercial Chautauqua, it was best received in the smaller, more isolated areas. Typical was Bayfield, a village on the shores of Lake Superior, where University Chautauqua played from July 17 to July 22, 1915. Twenty citizens had underwritten the thousand dollar cost and had set up a number of committees to get ready. One hundred rooms had been made available and arrangements had been made to meet all trains and boats. Two hundred fifty children had registered for the morning games and organized play. Catering systems had been set up in the court house to handle the overflow crowds. The cost of the three meals was one dollar per day.

The Chautauqua opened on Sunday morning with Union services, two speakers and a chorus of fifty voices including singers from Ashland and Washburn.

Next day Professor Kiekhoefer told the packed tent that: "It is not enough to say this will be the last great war; to effect that end some kind of international organization must be established." In another lecture entitled, "Crusades of Today" he suggested these topics as being crusades he was for: Peace, Women's Suffrage, Eugenics, Temperance and the Labor Movement. Those crusades he was against included Commercialism, Progressivism and Socialism. Paul F. Voelker, who had appeared the previous winter on Bayfield's lyceum program, came up from Madison to talk on "Joan of Arc." The *Bayfield Progress* reported that he held his audience spellbound.[23]

By week's end the Chautauqua was over and the local headline on July 22 read: "First Chautauqua a Grand Success." The editor said the entertainment furnished was of sterling quality and reported plans to make Bayfield a permanent Chautauqua city.

[23] *Bayfield Progress*, July 22, 1915.

The University Chautauqua returned to Bayfield in 1916 as it did to twenty-one other towns in the state. The Mayor proclaimed it Chautauqua Week and in spite of intense heat and a storm on Saturday night (weather was always the bane of Chautauqua) the thousand dollar guarantee was met. The Chief of Police kept tabs on the number of autos parked in front of the main tent during the week and reported with satisfaction that a total of 247 cars brought passengers to the Chautauqua from the adjoining county and from cities and villages to the south. The highest total for any one performance was Sunday afternoon when thirty-five cars stood outside the big tent all at the same time.[24]

Featured on the 1916 University Chautauqua were twenty-five members of the University of Wisconsin band. The band had spent the previous summer at the San Francisco World's Fair in what the brochures referred to as "successful competition with Sousa and other great bandsmen." In Bayfield the band arrived late after a harrowing and hungry ride from Superior but the results were apparently worth it, for said the editor rather breathlessly: "It [the concert] was just wonderfully fine, unsurpassably superb."[25]

Speakers for this year were drawn almost entirely from commercial talent. They included Herbert S. Bigelow, city reformer from Cincinnati, Gabriel Maguire of Boston, who had spent many years in Central Africa as a missionary, and Burt L. Newkirk of the University of Minnesota, who lectured on the gyroscope. Newkirk was representative of the popular science type of lecturer beginning to appear on the circuits. The wife of the State Superintendent of Schools, Mrs. C. P. Cary, spoke on the exceptional child. Besides the band other musical events included the Milton College Glee Club and Professor and Mrs. Von Geltch on the violin and piano.

Although successful in Bayfield, reception in the twenty-one other towns of the 1916 season was uneven. Along with the usual difficulties of heat and storms and equipment delays experienced by all Chautauquas, new problems were beginning to appear. The papers were full of war news. Typical was Tomah, where Company "K" was ready to leave for Mexico. Those who stayed home were finding other things to do. The Tomah *Monitor-Herald* for June 16, 1916 had a full-page advertisement for a Maxwell touring car which could be purchased at the Central Hardware Company for $655. The Unique Theater was showing three reels of "What Dorris Did" for just ten cents.

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[24] *Bayfield Progress,* July 25, 1916.

[25] *Bayfield Progress,* July 18, 1916.

In Evansville, which claimed the oldest lyceum course in the state dating from 1882, a commercial Redpath Chautauqua took the place of University Chautauqua in 1916.[26]

In Delevan, the Delevan Assembly brought Wisconsin Week Chautauqua to its Eighteenth Assembly season in 1915 but tried an entirely new program in 1916 entitled, "Walworth County Community Week" which, while elaborately planned, proved no more successful.[27]

University Chautauqua was just about over. The summer of 1917 saw a modified program of Chautauqua constructed around "patriotic inspiration and instruction with reference to the war emergencies"[28] but this was the last year. An item in the Extension Division's Biennial Report published on July 1, 1918, gives this terse account: "The results [of Chautauqua] were quite satisfactory but the financial outlay was so great, considering the small number of communities that were reached, that it was felt that the general community betterment was not far-reaching enough to justify the time, money, and energy expended."[29]

III

In retrospect, University Chautauqua was a daring idea, quite in keeping with the leadership in extension work for which the University of Wisconsin was becoming so well known. Its similarity to commercial Chautauqua provides us with tangible evidence that at least at one university, educators saw in the circuit Chautauqua an educationally worthwhile venture and a force for good in the life of the small towns. At the same time that similarity to the circuits provided the seeds for its own destruction for, even though it was a non-profit university service, the cost of using commercial talent and the limited one-month season brought the price of a season ticket to $1.50 to $2.00. This was the standard price for a similar-length Chautauqua on the commercial circuits. The University could not hope to compete against the large, well-entrenched circuits on their own terms and it is doubtful if Wisconsin could have continued to sponsor Chautauqua for very long even if the war had not come along.

But the war did come and by 1917 the University and particularly the Extension Division was deeply involved in the war effort. More than one-third of the Extension staff had gone to war and those who were left were busy in the activities of the Red Cross, Liberty Bond drives, instruction at military camps and in conduct-

[26] *Evansville Review,* July 30, 1916.
[27] *Delevan Enterprise,* July 15, 1916.
[28] *Biennial Report,* 1916–1918, p. 183.
[29] *Biennial Report,* 1916–1918, p. 200.

ing correspondence school study programs for enlisted men. There was simply no time for Chautauqua.

University Chautauqua's justification and its epitaph was provided, fittingly enough, by Dean Lighty of the Extension Division, in his 1918 report to President Van Hise. Said he:

> In the last decade, University Extension teaching has undergone as profound a change and transformation as has occurred in any field of education in our own times. No longer . . . is this a movement only 'for the promotion of university teaching' . . . but something distinct and of itself, and possessed of a body of text materials and of teaching techniques of its own, and destined independent development. It is, therefore, no longer a mere transfer of intramural teaching into an extramural setting. It is not a substitute. In fact it is no longer the extension of university teaching but it has become extension teaching—a distinct instrument of the democracy of our times.[30]

[30] *Biennial Report*, 1916–1918, p. 177–178.

DISTRIBUTION AND ACCUMULATION OF COPPER FOLLOWING COPPER SULFATE APPLICATION ON LAKES

C. Joseph Antonie and Wayne H. Osness

Copper sulfate has been used for the control of algae for many years. In 1904, Moore and Kellerman[9] carried on studies to determine the dosages of copper sulfate for the control of offending types of algae. As early as 1918, copper sulfate was experimentally applied to Madison, Wisconsin, lakes for the control of algae. In 1925, Domogalla[3] began an extensive treatment program on Lake Monona and between May and September used 49,363 kilograms of commercial copper sulfate. Since this time through 1959, approximately .77 million kilograms of copper sulfate ($CuSo_45H_2O$) have been applied to Lake Monona making it the most heavily treated lake reported in the literature. (Table 1).

Numerous studies have detailed the immediate effect of copper sulfate treatment. Woodbury, Palmer and Walton[15] found that copper sulfate added to distilled water in a concentration of 1.5 ppm would kill largemouth black bass; however, in a duplicate experiment by Nichols[11], using Lake Mendota water with an alkalinity of about 170 ppm, the toxicity limit was found to be about 200 ppm of commercial copper sulfate. Nichols noted that Lake Mendota water used in the experiments dropped from pH 8.0 to pH 6.8 after the addition of 200 ppm of copper sulfate crystals. In similar treatment of distilled water the pH dropped to 5.6. Using these data, Nichols indicated that much of the copper sulfate added to lake water of notable alkalinity is precipitated as a basic copper compound. Since the alkalinity is principally due to the calcium and magnesium carbonates, it is reasonable to believe that the principal copper precipitate is in a carbonate or bicarbonate form.

Nichols further studied the distribution of the precipitated copper and found the greater concentration in the profundal region. The top layer of mud contained more copper than did deeper strata, but penetration was noted to a depth of 1.23 meters. The highest reported concentration was 1063 ppm in 1947 which is somewhat less than the 9000 ppm toxicity limit to certain types of bottom dwelling organisms reported by Machenthun[6] in 1952. Since 1947 approximately 27,300 additional kilograms of copper sulfate have been added to Lake Monona and with the passing of time continued seepage could increase the concentrations reported

TABLE 1. KILOGRAMS OF COPPER SULFATE APPLIED TO DANE COUNTY LAKES

YEAR	MENDOTA	MONONA
1925	....	30,600
1926	....	34,100
1927	....	40,200
1928	....	41,500
1929	....	37,500
1930	....	40,800
1931	....	45,500
1932	....	41,800
1933	....	39,100
1934	....	45,600
1935	....	40,800
1936	....	34,500
1937	....	37,100
1938	....	31,200
1939	....	26,600
1940	....	30,600
1941	....	26,700
1942	....	26,900
1943	....	31,200
1944	....	31,700
1945	....	6,880
1946	2,810	15,370
1947	185	3,610
1948	417	3,040
1949	0	703
1950	0	11,140
1951	313	5,570
1952	0	2,880
1953	58	2,220
1954	0	0
1955	0	413
1956	0	986
1957	0	0
1958	0	0
1959	0	0

by Nichols. No determinations have since been made to ascertain whether the copper concentration is increasing or decreasing in the bottom muds due to prolonged treatment.

This study was initiated to determine the present concentration and distribution of copper in the bottom muds of Lake Monona to determine the soluble copper concentration following treatment and the effect of time on this concentration.

Procedure. To determine the copper concentration after an elapse of time since the last application of copper sulfate, the top 2.5 cm of lake mud was compared to an inch layer 15 cm to 17.5 cm below the top. This was done to avoid the top 10 cm layer of mud that may be subjected to constant mixing. Thus, by using the 15 cm to 17.5 cm much layer it is assumed that this was deposited mud and not a mixture similar in content to the top 2.5 cm. The operation was carried out by careful use of an Ekman dredge with only the two layers mentioned taken as samples.

Sampling points (Figure 1) were chosen in a definite series in the same section of the lake to show the accumulative effect on

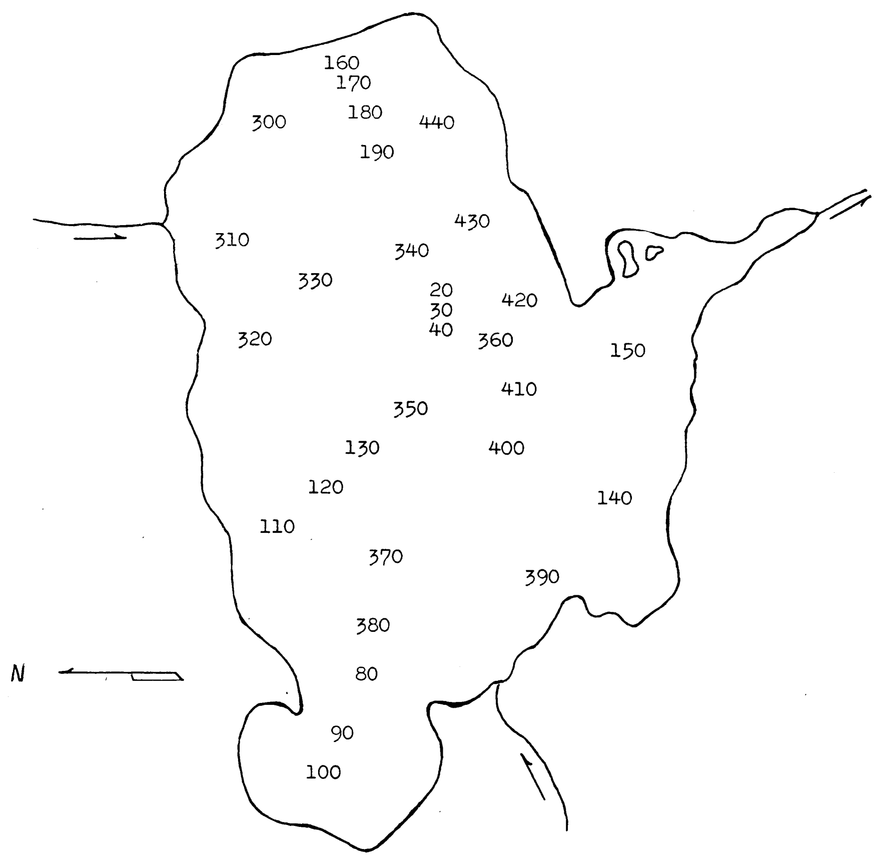

FIGURE 1.

different depths as well as in the deepest areas. None of the sampling points were located close to the shoreline because of the deposits of sand and gravel in those areas.

Three similar samples were taken from Lake Mendota to be used as controls since Lake Mendota has been treated only slightly (Table I) and the residual copper could be assumed to be similar.

Copper Determination. One gram of the finely divided dry mud was weighed on an analytical balance and transferred to a 300 ml. Kjeldahl flask. Twenty ml. of concentrated sulfuric acid were added and the mixture heated almost to the boiling point of the sulfuric acid. The sample was then digested until nearly colorless. This operation took about 3–4 hours. The sample was then cooled and 100 ml. of distilled water added. The insoluble residue was removed by filtering and the sample collected in another 300 ml. Kjeldahl flask. The clear, pale yellow filtrate was then treated with 2 ml. of 30% hydrogen peroxide. This mixture was then digested until entirely colorless. The digest was cooled and 50 ml. of distilled water added. The sample was neutralized with concentrated ammonium hydroxide using a piece of litmus paper as an indicator. After neutralization, the sample was again filtered to remove the iron which was precipitated as the hydroxide after the addition of the base. The sample was collected and stoppered in a 250 ml. Erlenmeyer flask until final treatment.

The sample containing the digested copper was transferred to a 500 ml. separatory funnel and 5 ml. of alkaline ammonium citrate (80 ml. of concentrated ammonium hydroxide and 420 ml. of distilled water are used to dissolve 20 grams of ammonium citrate) and 5 ml. of sodium diethyldithiocarbamate (5% of the reagent dissolved in distilled water) were added and the entire contents thoroughly mixed. The copper carbamate color usually developed rapidly, but five minutes were allowed before extraction to make sure the formation was complete. Ten ml. of amyl acetate were added to extract the color, and the separatory funnel was used to separate the layers. A second 10 ml. portion was added to obtain all of the color present in the sample and also to bring the total extraction to exactly 20 ml.

A portion of the extraction was placed in a photometer where the light transmission was compared to that of distilled water, which was given a reading of 100%. The amount of color present was compared to that of a known standard and the amount of copper in the unknown sample computed. In cases were a large amount of copper was present, it was necessary to dilute the extraction to 40 ml. to get an accurate reading on the photometer scale, the reading was then doubled to get the copper content. The copper content was computed in milligrams per gram and then multiplied by 1000 to determine the milligrams of copper per kilogram of dry mud sample (or ppm). Table II and III give the data that were obtained in this analysis.

Discussion of Results. As shown in Table II the amount of copper present in the top layer of mud was consistently less than that in the layer buried 15 cm deeper in the bottom of the lake. There were only four exceptions in the thirty samples. Two of these had little more than the natural copper in them (samples 140 and 150). This is explained by the fact that they were taken from the region of the lake close to the outlet of the Yahara River and carrying it downstream. The other two samples (80 and 100) were taken from areas of shallow depth near an area of greater depth. This too, may cause a scouring effect. The average copper concentration including all samples is 327 ppm in the top inch of bottom mud compared to 440 ppm in the 15 to 17.5 cm layer. Eight of the samples were reanalyzed to check accuracy of the procedure. It was found that the error averaged less than 5 ppm which is an error of about one percent.

Evidence that the copper content is less in the upper region would suggest that the constant settling of silt into the deeper areas of the lake would in time cover up the heavy concentrations of copper that were deposited at the time of application. This covering up or "healing" process would not be complete for quite a number of years, however, the trend is most apparent. Since bottom organisms inhabiting the upper limits of the mud are an important link in the food web, it seems it would be but a matter of time before they would be living in an environment with a gradual decrease in amount of artificial copper. The data also indicate that, after many years of copper sulfate application, the greatest concentration of copper is found in the lake muds of the profundal region. The resulting covering-up process tends to take place more rapidly in this area.

TABLE 2. TOTAL COPPER CONTENT IN THE BOTTOM MUDS OF LAKE MONONA AT VARIOUS DEPTHS (Table Samples number Ending in 0 is the Top 2.5 cm Portion and the Sample Numbers Ending in 1 is the 15 to 17.5 cm Deep Portion)

Sample No.	Depth	ppm Cu	Sample No.	Depth	ppm Cu	Sample No.	Depth	ppm Cu
20	70	406	150	10	113	350	34	502
21	70	470	151	10	62	351	34	588
30	74	396	160	30	250	360	32	492
31	74	450	161	30	384	361	32	528
40	70	368	170	35	296	370	38	443
41	70	456	171	35	474	371	38	464
90	20	322	180	40	284	380	18	527
81	20	318	181	40	290	381	18	732
90	8	420	190	45	220	390	15	331
91	8	550	191	45	528	391	15	487
100	5	256	300	35	231	400	20	112
101	5	196	301	35	252	401	20	145
110	30	274	310	48	315	410	15	308
111	30	530	311	48	383	411	15	539
120	50	328	320	51	367	420	12	165
121	50	480	321	51	470	421	12	180
130	55	330	330	47	389	430	31	383
131	55	660	331	47	612	431	31	438
140	15	147	340	43	482	440	42	362
141	15	97	341	43	699	441	42	742

Average: 0 numbered samples—327.
1 numbered samples—440.

TABLE 3. TOTAL COPPER CONTENT IN THE BOTTOM MUDS OF LAKE MENDOTA AT VARIOUS DEPTHS (The Sample Number Ending in 0 is the Top 2.5 cm Portion and the Sample Number Ending in 1 is the 15 to 17.5 cm Inch Deep Portion)

SAMPLE MO.	DEPTH	PPM CU
50	82	138
51	82	104
60	83	123
61	83	53
70	82	250
71	82	112

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NATURAL LAW AS CHAUCER'S ETHICAL ABSOLUTE

Gareth W. Dunleavy

This essay advances overlooked sources for Chaucer's exposure to the *lawe of kinde*[1] defined today as a "standard of right independent and supreme over the will of man," a law both autonomous and spontaneous that proclaims "in every time and place . . . a right course of action, one eternal, immutable."[2] It will argue that allusions to natural law particularly in the General Prologue of the *Canterbury Tales* reflect the impact of this doctrine on Chaucer. Consequently, the evidence here will support the probability that the poet was one of those "that weren of lawe expert and curious."[3]

This juridical and theological concept, a legacy from the classical and medieval eras, is alive in English law, in the post-war jurisprudence of West Germany and elsewhere on the Continent.[4] Natural law enjoys a life of its own in *Black's Law Dictionary* and survives somewhat tenuously in the United Nations' *Draft Declaration of Rights and Duties of States*.[5] As in Chaucer's time, it enjoys protected status as one of the pair of commandments on which "hang all the Law and the Prophets" and by St. Paul's pronouncement in *Romans* II, 14–15, that those having not the law, are a "law unto themselves" if they do naturally those things contained

[1] *A New English Dictionary on Historical Principles*, ed. J. A. H. Murray (Oxford, 1901). For a discussion of the relationship of the Law of Nature to the term and concept *natura* in its mediaeval context, see C. S. Lewis, *Studies in Words* (Cambridge, 1960), pp. 58–62. Lewis writes: "On the one hand, if *nature* is thought of mainly as the real (opposed to convention and legal fiction) and the laws of *nature* as those which enjoin what is really good and forbid what is really bad (as opposed to the pseudo-duties which bad governments praise and reward or the real virtues which they forbid and punish), then of course 'the law of *nature*' is conceived as an absolute moral standard against which the laws of all nations must be judged and to which they ought to conform."

[2] F. M. Taylor, "The Law of Nature," *Annals of the American Academy of Political and Social Science*, I (1890), 560, 577.

[3] J. M. Manly, *Some New Light on Chaucer* (New York, 1926), pp. 7–18. Cited hereafter as 'Manly.' See D. S. Bland, "Chaucer and the Inns of Court: A Re-examination," *English Studies*, XXXIII (1952), 3–4; R. J. Schoeck, "A Legal Reading of Chaucer's *Hous of Fame*," *University of Toronto Quarterly*, XXIII (1953–54), 185–192, suggests that Chaucer "wrote his *Hous of Fame* for one of the ritualistic functions of the Inner Temple." See also, the same author's "Gerard Legh, Herald," *Notes and Queries*, CC (1955), p. 140.

[4] On the strong link between "natural law" and the term "natural justice" as applied in English courts of the nineteenth and twentieth centuries, see H. H. Marshall, *Natural Justice* (London, 1959), pp. 6–20. Gottfried Dietze, "Natural Law in the Modern European Constitutions," *Natural Law Forum*, I (1956), 73–91; also, Frieherr von der Heydte, "Natural Law Tendencies in Contemporary German Jurisprudence," *Natural Law Forum*, I, 115–121.

[5] *The Law of Nations*, ed. H. W. Briggs, 2nd ed. (New York, 1952), pp. 15–16. The Draft Declaration "appears to reflect the natural law approach of inherent (basic) rights of states. . . ."

in the law. Anthropologists and sociologists define natural law as "supernatural intuitionalism" and a force "not subject to objective determination," while at the same time being forced to admit it as a cultural fact and a determinative force in the law systems of primitive societies.[6] Over forty years ago, Justice Holmes criticized for their naïveté those jurists who believed in natural law.[7] Today, however, Chroust writes that no criticism "can ever succeed in denying the immemorial merits and ideological importance of Natural Law, which are to be found in the sublime meaning of its honest quest for an enduring ultimate in a world perennially contingent and confusingly relative."[8]

The Middle Ages is marked by a continuing effort to reduce the antithesis between positive law typified by "givenness" and natural law, the law that ought to be, uncritical in one sense yet admirable in that it holds consistently to "an ultimate principle of fitness with regard to the nature of man as a rational and social being which is or ought to be, the justification of every form of positive law."[9] The literature and thought of Greece, largely devoted to the dignity of man, gave rise to natural law and its stress on moral principles derived from the nature of man and the need for translating those principles into positive law. The idea of positive laws founded on natural-law morality was taken up by the Roman Jurists and then assimilated into Christian thought.[10] From the fifth through the tenth centuries the Greek and Roman concept of natural law survived in glosses and etymologies such as those of Bishop Isidore of Seville.[11] At the outset of the *Decretum* of Gratian (c. 1143) natural law is identified with the law of God, for the church did not remain aloof to Aristotle, Cicero and Justinian—important figures in the rediscovery of classical learning during the "lesser Renaissance" of the twelfth century.[12] Gratian stated: "Natural law is the law common to all peoples, in that it is

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[6] E. A. Hoebel, *The Law of Primitive Man* (Cambridge, Mass., 1954), p. 5. See also Jacques Ellul, *The Theological Foundation of Law,* trans. M. Wieser (Garden City, 1960), pp. 27–28.

[7] O. W. Holmes, "Natural Law," *Harvard Law Review,* XXXII (1918–19), p. 41. See *The Mind and Faith of Justice Holmes,* ed. M. Lerner (Boston, 1943), p. 369. Nevertheless, in S. Pacific Co. vs. Jensen, Holmes refers to a "higher law," a "brooding omnipresence in the sky."

[8] A. H. Chroust, "On the Nature of Natural Law," *Interpretations of Modern Legal Philosophies,* ed. Paul Sayre (New York, 1947), p. 80. Cited as 'Chroust.'

[9] F. Pollock, "The History of the Law of Nature: A Preliminary Study," *Journal of the Society of Comparative Legislation,* II (1900), 418. Cited as 'Pollock.'

[10] See J. Leclerq, "Suggestions for Clarifying Natural Law," *Natural Law Forum,* II (1957), particularly pp. 66–73. Cited as 'Leclerq.'

[11] See *Etymologiae,* V, 4, in *Patrologiae Cursus Completus,* ed. J. P. Migne (Paris, 1850), LXXXII, Col. 199. Also, P. Vinogradoff, *Roman Law in Medieval Europe* (Oxford, 1929), p. 37. Cited as 'Vinogradoff." See O. Lottin, *Le Droit Naturel,* 2nd ed. (Bruges, 1931), pp. 9–11. Cited as 'Lottin.' As early as 1159, John of Salisbury in his political treatise, *Polycraticus* IV, 7, reflected the medieval tradition of natural law doctrine as yet unaffected by new contact with Aristotle's *Politics.* See *Joannis Saresberiensis Opera Omnia,* ed. J. A. Giles (Oxford, 1848), III, p. 241.

[12] Pollock, 422.

everywhere held by the instinct of nature, not by any enactment: as for instance, the union of man and woman, the generation and rearing of children, the common possession of all things and the one liberty of all men, the acquisition of those things which are taken from air and sky and sea; also the restitution of an article given in trust or money loaned, and the repelling of force with force. For this, or whatever is similar to this, is never considered unjust, but natural and equitable."[13]

Chaucer's first mention of *Jurisprudentia perennis* appears in the *Book of the Duchess:*

And in this book were written fables
That clerkes had in olde tyme,
And other poets, put in rime
To rede, and for to be in minde,
While men loved the lawe of kinde. (*B D* 52–56)[14]

Chaucer's "clerkes" and "poets" include Homer, whose heroes were accorded the hospitality and protection due suppliants, thus pleasing Zeus (however, this moral duty was not performed for Ulysses at the hands of Circe in *Bo* IV, m. 3). Although there is no proof that Chaucer knew his work, Sophocles had made the conflict between moral law, the idea of the "really right" and positive law, the law of the political ruler, the basis for the *Antigone.* Antigone cries of "Unwritten laws, eternal in the heavens, Not of today or yesterday are these, but live from everlasting, and from whence they spring, none knoweth."[15]

Whether "twenty bookes . . . of Aristotle and his philosophie" lay at Chaucer's own "beddes heed" is problematical, but in one of the Clerk's books lay this definition of the *lawe of kinde:* "Now there are two kinds of laws, particular and general. By particular laws I mean those established by each people in reference to themselves, which again are divided into written and unwritten; by general laws I mean those based upon nature. In fact, there is a general idea of just and unjust in accordance with nature, as all men in a manner divine, even if there is neither communication nor agreement between them." *(Rhetoric* I, 1373b 2)[16]

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[13] *Decretum Gratiana* (Paris, 1601), *Distinctiones* I, c. 7. Translation is by E. Lewis in *Medieval Political Ideas* (New York, 1954), I, 33. Cited as 'Lewis.' See M. Villey, "Le Droit Naturel chez Gratien," *Studia Gratiana,* III (1954), 85–99.

[14] All citations from Chaucer in text are from *The Works of Geoffrey Chaucer,* ed. F. N. Robinson, 2nd ed. (Cambridge, Mass., 1957).

[15] *An Anthology of Greek Drama,* ed. C. A. Robinson, Jr. (New York, 1949), p. 115. See Leclerq, pp. 76–77: "When Antigone opposes the rights of conscience to the tyrant's decree and speaks of eternal laws, she is talking of moral laws."

[16] Aristotle, *The Art of Rhetoric,* trans. John H. Freese (London, 1926), pp. 139–141. See Max Shellens, "Aristotle on Natural Law," *Natural Law Forum,* IV (1959), p. 81: "The aim of the *Rhetoric* in regard to natural law, is to show that the term natural law is in vogue and that from a certain point of view it is considered an advantage to make use of its emotional appeal . . . . No judgment is passed on natural law. He merely introduces us to a catchword without discussing its moral significance." Shellens points out that the *Magna Moralia* and *Nicomachean Ethics* go deeper than this.

The Franklin's "Marcus Tullius Scithero" had written in *Tusculan Disputations* of a "divine power" and a *"divine nature"* which has its basis not in laws and decrees.[17] In the *Republic* (III, xxii, 33) Plato stresses the universality of law since it is based upon the common nature of men. Its eternal and immutable aspects stem from its endorsement by God. This doctrine—the *jus naturae* of the Roman jurists—later was incorporated into canon law, the body of legal rules administered by the ecclesiastical courts, as indicated in the above citation from the *Decretum.*[18] Of the trio of illustrious third-century Roman jurists, Chaucer mentions only the name of Papinian "that had ben long tyme ful myghty amonges hem of the court" *(Bo* III, pr. 5). Of the remaining pair, Gaius and Ulpian, the latter contributed the most in the way of natural law theory to the massive compilation of law sponsored by that same Justinian "eke, that made lawes."[19]

Chaucer's rendering of Boethius from Trivet's commentaries and a French source probably did not appear until shortly after 1380, but the *De Consolatione Philosophiae* had helped to preserve the classical concept of the law of nature since the sixth century A.D. Chaucer was far more than a sedulous copyist or indifferent translator of the *Boece.* He read that "verray good is naturely iplauntyd in the hertes of men, but the myswandrynge errour mysledeth hem into false goodes" *(Bo* III, pr. 2). He had perhaps been influenced to "techyn his soule that it hath, by naturel principles kyndeliche yhyd withynne itself, al the trouthe the which he ymagineth to ben in thinges withoute" (*Bo* III, m. 11).[20] Contemplative reading of the *Boece* helped shape Chaucer's view of the law of nature just as it aided the canonists and schoolmen of the twelfth, thirteenth, and fourteenth centuries in their task of reconciling the moral authority of the classical philosophers with the temporal authority proclaimed in Justinian's compilation. These scholars provided an "identification of the law of nature with the law of God revealed in human reason."[21]

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[17] *A Documentary History of Primitivism and Related Ideas,* eds. A. L. Lovejoy and G. Boas (Baltimore, 1935), I, 256. Cited as 'Lovejoy.'

[18] See M. Radin, *Handbook of Roman Law* (St. Paul, 1927), pp. 70–73; also A. P. d' Entreves, *Natural Law* (London, 1951), p. 19 and G. Tellenbach, *Church, State and Christian Society,* trans. R. Bennett (Oxford, 1940), p. 23.

[19] *The Commentaries of Gaius and Rules of Ulpian* trans. J. T. Abdy and B. Walker (Cambridge, 1876), p. 1. Also, *The Digest of Justinian,* trans. C. H. Munro (Cambridge, 1904), I, p. 5. See E. Levy, "Natural Law in Roman Thought" *Studia et Documenta Historiae et Juris,* XV (1949), 1–23.

[20] Cf. also *Bo* III, m. 11, lls. 38–43; *Bo* V, pr. 2, lls. 10–15.

[21] H. S. Maine, *Ancient Law,* new ed. (London, 1930), pp. 120–121. On the Italian school of Post-Glossators of the fourteenth century, see R. Sohm, *The Institutes, A Text-Book of the History and System of Roman Private Law,* trans. J. C. Ledlie, 2nd ed. (Oxford, 1901), pp. 144–46, 151–55. In seats at Perugia, Pavia and Padua, the Post-Glossators forged a body of national Italian law similar to the national Italian literature created by Dante, Petrarch and Boccaccio. Their jurisprudence was a philosophical one "permeated by an idea which dates far back into antiquity, the idea, namely, of a Law of Nature. . . ."

In an early commentary (1170) on the *Decretum,* Rufinus holds that natural law is restricted to human beings rather than all animals.[22] At the hands of ecclesiastical jurists it became a law to which Chaucer's Troilus was subject, but not the 'proude Bayard" who was subject only to "horses lawe" *(Tr* I, 223–224). St. Thomas Aquinas posits an eternal law and the participation of this eternal law in rational creatures is called natural law *(S. T.* q. 91, 2).[23] He construes as the first precept of natural law that "good is to be done and followed, and evil is to be avoided. And upon this are based all other precepts of the natural law." For Aquinas "all virtuous acts are prescribed in the law of nature, for each man's reason dictates to him that he should act virtuously" *(S. T.* q. 94, 2).[24] in his *De Regimine Principium,* Aegidius Romanus, a student of Aquinas, wrote of man's natural desire for "existence and the good" while shunning "non-existence and the bad," emphasizing that "other laws, whether natural or civil, originate in this and are based on this."[25] Fourteenth century canonists worked to integrate natural law idealism into canon law as Gratian had done in the *Decretum.* Thus, when Chaucer writes in the *Troilus* (I, 236–238): "For evere it was, and evere it shal byfalle,/ That Love is he that alle thing may bynde,/ For may no man fordon the lawe of kynde"/ he reflects not only his debt to the *De Consolatione* of Boethius, but also his church's recognition of classical natural law doctrine. Also, he reduces the distance between his Christian readers and the pagan Troilus, Criseyde, and Pandarus appreciably more than might at first appear.[26] However, we must examine the *Canterbury Tales,* particularly the General Prologue and the Parson's Tale, to see Chaucer's most skillful use of allusions to the *lawe of kinde.*[27]

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[22] Lewis, 37.

[23] *S. Thomae Aquino Summa Theologiae* (Ottawa, 1941), II, 1210a–1210b. See also J. Bryce, *Studies in the History of Jurisprudence* (New York, 1901), II, 595. The capstone for the work of the canonists and schoolmen in this respect is perhaps to be seen in *Tres Libri Codicis* of the Italian Post-Glossator, Lucas de Penna (d. 1390). Natural law is identified with divine law and becomes therefore the direct expression and manifestation of the divine will. Cf. W. Ullman, *The Medieval Idea of Law as Represented by Lucas de Penna* (London, 1946), p. 46.

[24] *Summa Theologiae,* II, 1225a–1225b. Leclerq writes (p. 68) that St. Thomas relates all laws, eternal, natural, positive divine law and positive human law to a single definition and "emphasizes more what unites them than what distinguishes them." Also, (p. 79): In his definition of the law, "St. Thomas draws his inspiration indirectly from Roman law and directly from the canonists, who themselves followed Roman law."

[25] Lewis, 69.

[26] See M. W. Bloomfield, "Distance and Predestination in *Troilus and Criseyde,*" *PMLA,* LXXII (1957), p. 19.

[27] Mel* 2770–75 particularly "This is to seyn, that nature deffendeth and forbedeth by right that no man make hymself riche unto the harm of another persone." On natural law and its relation to private property see B. Tierney, *Medieval Poor Law* (Berkeley and Los Angeles, 1959), pp. 28–33. See also *Pars T* 336; 526, "For soothly, nature dryveth us to loven oure freendes . . . ," 865, 920, "This is verray mariage, that was establissed by God, er that synne bigan, whan natureel lawe was in his right poynt in paradys."

Before moving to the *Tales,* two additional important sources of Chaucer's exposure to the law of nature must be mentioned. If the poet spent the years 1361–67 at the Inner Temple,[28] into his hands may have come definitions of natural law appearing in law-books such as Bracton's *De Legibus Angliae* and its subsequent epitomes, *Fleta,* and the Norman-French *Britton.* Unlike Glanvill, Bracton had incorporated large portions of Roman law into his text, carefully copying Azo of Bologna's glosses and explications of the *Institutes* and *Code* of Justinian. Bracton follows Azo very closely in his account of the law of nature, but "omits enough to show that he has not come in sight of those problems which Azo had to face when he endeavoured to give a precise meaning to the term *jus naturale.*"[29] Whereas canonists and canon law were not always popular in England, the study of Roman law had never been discontinued[30] and the definition of the law of nature adapted from Azo by Bracton was transmitted from one juridical writer to another close to Chaucer's time. For example, Fortescue, himself a Sergeant of the Law, stresses in *De Laudibus Legum Angliae* (1468–71) that the "laws of England, in those points which they sanction by reason of the law of nature, are neither better nor worse in their judgements than are all laws of other nations in like cases. For as Aristotle said, in the fifth book of the *Ethics,* 'Natural Law is that which has the same force among all men'."[31] In Pecock's *Repressor* (c. 1455) where the clergy is defended against the attacks of the Lollards, we read that it is "natural resoun . . . and not Holi Scripture [that] is the ground of alle the seid gouernauncis, deedis, vertues, and trouthis."[32] Despite incom-

[28] Robinson, xxv and Manly, p. 28. See n. 3, above. In this connection note Chaucer's reference to Giovanni da Lignaco (1310–1383) in the *Clerk's Prologue*, II: 34–35. Lignaco was professor of canon law at Bologna. Well-paid, popular and influential, he may have been known to Chaucer through arch-deacons who had gone to Bologna from England to study canon law. See A. S. Cook, "Chaucer's 'Linian'," *Romanic Review,* VIII (1917), 353–382.

[29] *Bracton and Azo,* ed. F. W. Maitland [Selden Society] (London, 1895), VIII, 32–33. Cf. also C. Guterbock, *Bracton and His Relation to the Roman Law,* trans. B. Coxe (Philadelphia, 1866), pp. 49, 53, 64. On Bracton's acquaintance with Roman law see T. F. T. Plucknett, *Early English Legal Literature* (Cambridge, 1958), pp. 47–48. Cited as 'Plucknett.'

[30] Vinogradoff, 98. Also see S. Kuttner and E. Rathbone, "Anglo-Norman Canonists of the Twelfth Century," *Traditio,* VII (1949–51), 279–358 for evidence of "the existence in its own right of an Anglo-Norman school of canonists toward the turn of the twelfth century." On the introduction of Roman law to England see F. C. von Savigny, *Geschichte des Romischen Rechts im Mittelalter* (Heidelberg, 1834), I, 167–171. John Wyclif in his *De officio regis* (c. 1379), favors the study of English rather than Roman law by the clergy, although he is aware of the argument that there is "more subtle reasoning and more justice in Roman civilianship . . . [and] that it must needs be studied if the canon law is to be understood." See F. W. Maitland, "Wyclif on English and Roman Law," in *The Collected Papers of Frederic William Maitland,* ed. H. A. L. Fisher (Cambridge, 1911), III. pp. 50–51.

[31] Sir John Fortescue, *De Laudibus Legum Anglie,* ed. S. B. Chrimes (Cambridge, 1942), p. 39.

[32] *The Repressor of Over Much Blaming of the Clergy,* ed. C. Babington [Rolls] (London, 1860), I, 13.

plete knowledge concerning the Inns of Court in the thirteenth and fourteenth centuries, it is likely that the student met natural law tradition in the cases and writs recited by his teachers.[33]

There is also firm reason to believe that Chaucer met the natural law in the ethic of the dockside and trade fair known as law merchant. As the son of a wine merchant whose grandfather and step-grandfather had also been wholesale vintners and customs officers of the king,[34] Chaucer probably knew of law merchant long before he assumed duties after June 12, 1374 as a controller of the customs and subsidy of wool, woolfells, and hides in the city of London.[35] In addition to this post, held until December, 1386, he served with seven missions to France, Flanders and Italy—one of these involving the negotiation of a commercial treaty with Genoa that would designate a port in England with special privileges for Genoese merchants.[36] The Venetian and Genoese with eastern goods, the Italian with silks, velvet and glass, the Flemish weaver, the Spanish iron merchant, the Gascon with wine from France, Spain and Greece, the fur and amber traders from the Hanse towns as well as the three chapmen in Surry "riche, and therto sadde and trewe" were men of substance and status in medieval society.[37] To them and to public officials like Chaucer the *lawe of kinde* reflected in the law merchant was a cosmopolitan and efficacious means of insuring justice in disputes arising from transactions. To these men who "seken lond and see . . . for wynnynges," these "riche merchauntz, ful of wele been"[38] with whom Chaucer associated, the law merchant prevailed.[39] At the Merchant's Middleburgh and Orewelle, the Shipman's Dartmouth and Bordeaux (the Wife of Bath's Ypres being a singular exception) the law merchant preserved in a practicable form the essence of natural law. Like Roman law the law merchant was concerned with what was *aequum et bonum* and "what was agreeable to mores or the usages

[33] On some of the regrettably "unsolved mysteries of the thirteenth and fourteenth centuries" regarding the Inns of Court, see *Pension Book of Clement's Inn*, ed. C. Carr [Selden Society] (London, 1960), xvi-xxi. See also Plucknett, p. 114. On the persistent natural law tradition in England that extends from canon law and scholastic thinking (through Fortescue and St. Germain) to Hobbes and Locke, see Z. Epstein's review of H. Thieme's *Das Naturrecht und die Europäische Privatrechtsgeschichte* (Besel, 1 54) in *Natural Law Forum*, II (1957), p. 151.

[34] Manly, 21, 27.

[35] *Ibid.* 31–33.

[36] *Ibid.*, 32.

[37] T. A. Knott, "Chaucer's Anonymous Merchant," *Philological Quarterly*, I (1922), 1–16. Also Robinson, 657.

[38] *Prol MLT*, lls. 122–133. See E. Carus-Wilson, *Medieval Merchant Venturers* (London, 1954), pp. 239–264, for the extent of the English woolen trade in the fourteenth century.

[39] P. W. Thayer, "Comparative Law and the Law Merchant," *Brooklyn Law Review*, VI (1936–37), 41. ". . . The English Statute of the Staple [1358] expressly provided that justice was to be done [merchant strangers] according to the law merchant and not according to common law or the special customs of any town."

of honest and honorable people."[40] Like canon law the law merchant emphasized natural law concepts of "equity and good faith and the binding force of a simple promise."[41] The merchant of Chaucer's time once his goods had "comth . . . sauf unto the londe" thus had recourse to a law that was versatile, expandable, and adaptable —a law of custom.[42]

Law merchant decisions were rendered quickly through necessity. The *Little Red Book of Bristol* (c. 1344) contains the phrase "quod celerius deliberat se ipsam."[43] Quick justice is prescribed in a judicial definition of the law merchant given in 1473 where the alien merchant "is not held to sue according to the law of the land to abide a trial by 12 men and other solemnities of the law of the land; but he ought to sue here and [his suit] will be determined according to the law of Nature, in the Chancery, and he ought to sue there from hour to hour and from day [to day] because of the speed of the merchants etc."[44]

The law merchant was characterized also by a spirit of equity; the merchant whose grievance was settled at a staple, fair or piepowder court[45] could be sure that his fellow merchants serving as court members were not particularly litigious-minded men.[46] They arrived at prompt decisions based on plain justice and good faith with a disregard for abstruse technicalities that would have shocked the Manciple's "heep of lerned men" who belonged to the Temple.

Most important, the law merchant was international in character and hence true to that tradition of the law of nature. Staple and fair courts were composed of laymen who might perform their duty at Antwerp one month and find themselves sitting at St. Ives or Ipswich six months later.[47] For a dozen years Chaucer associated

[40] A. T. Carter, "The Early History of the Law Merchant in England," *The Law Quarterly Review*, XVII (1901), 240. Cited as 'Carter.'

[41] W. Mitchell, *An Essay on the Early History of the Law Merchant* (Cambridge, 1904), p. 158. Cited as 'Mitchell.'

[42] Mitchell, 10–12. Cf. also *The Little Red Book of Bristol*, ed. F. B. Bickley (Bristol, 1900), I. 60. Cited as 'Bickley." The force of custom in the law merchant is acknowledged here: ". . . set apponitur adhuc le affidauit propter antiquam consuetudinem."

[43] Bickley, I, 58.

[44] *Select Cases Concerning the Law Merchant*, ed. H. Hall [Selden Society] (London, 1930), 46, lxxxv-lxxxvi.

[45] See *Glossarium mediae et infimae Latinitatis*, ed. C. D. DuCange (Paris, 1845), V, 172. Also *The Black Book of the Admiralty*, ed. T. Twiss [Rolls] (London, 1873), II, 23 for entry regarding the piepowder court at Ipswich which dealt with "the plees be twixe straunge folk that man clepeth pypoudrous." See *Select Cases Concerning the Law Merchant*, ed. C. Gross [Selden Society] (London, 1908), I, 107–109. Also T. E. Scrutton, *The Influence of Roman Law on the Law of England* (Cambridge, 1885), p. 177. Gross's treatment of the piepowder court remains the best. See "The Court of Piepowder," *The Quarterly Journal of Economics*, XX (1906), 231–249. The institution was extant in the seventeenth and eighteenth centuries. Jonson refers to it in *Bartholomew Fair* and Defoe mentions "pyepowder courts" in the *Tour Through Great Britain* first published in 1724.

[46] Bickley, I, 70.

[47] Carter, 235.

with international merchants—men for the most part dealing in "marchandise . . . that oon is honest and leveful" according to the Parson; "as God had ordeyned that a regne or a contree is suffisaunt to hymself, thanne is it honest and leveful that of habundaunce of this contree, that men helpe another contree that is moore nedy" *(Pars T* 776–777). And Chaucer knew merchants to be of many types. There was the shrewd risk-taker depicted in the General Prologue "sownynge alwey th'encrees of his wynnyng;" the shipman's merchant of St. Denys who was ready to settle *all* debts according to tally;[48] the "marchant [who] deliteth hym moost in chaffare that he hath moost avantage of."[49] Among such men Chaucer had observed the practical application of natural law principles in the settling of disputes quickly and fairly in England and on the Continent. During his civil career Chaucer saw a law possessing the minimum "givenness" exerting maximum force in behalf of equity and fairness in transactions among men of power and prestige in the secular world.[50]

In ironic contrast to the merchants and their relatively informal judicial procedures based on natural law, stand certain characters of the Prologue to the *Canterbury Tales.* Both the Friar and the Summoner are members of a group whose daily lives were governed by canon law, a form of positive law that incorporates natural law idealism. Yet had either the Friar or the Summoner planned it, they could not have flouted natural law precept more completely.[51] Neither the Friar's instincts nor his reason dictated to him that he should act virtuously. On the contrary he thwarts the purpose and function of marriage as set forth at the head of the *Decretum* in the basest way. He makes personal gain at the expense of widows, and exploits the institution of the "love day" *(Gen Prol* 258) for his own profit.[52] It is here in his characterization of the Friar that Chaucer points up the extent of that worthy's

[48] Debt by tally was a contract according to the law merchant. Cf. *Gen Prol* 570. Note that the Man of Law has heard his tale from a merchant and merchants are in its background. See Mary Eliason, "The Peasant and the Lawyer," *Studies in Philology,* 48 (1951), pp. 525–26.

[49] *Pars T* 850.

[50] For the limited extent to which the law merchant was positive law see W. Holdsworth, *A History of English Law,* 7th ed. rev. (London, 1956). I, 527–28; also Carter, 234–35.

[51] Cf. Pollock, 423, who points out that the essence of Gratian's opening definition is that "the Law of Nature is nothing else than the Golden Rule comprised in the Law and the Gospels which bids us to do as we would be done by and forbids the contrary." The binding force of Gratian's definition for canon law long after the *Decretum* itself had been superseded seems obvious. On the acceptance of canon law by English courts Christian, see F. W. Maitland, *Roman Canon Law in the Church of England* (London, 1898), pp. 1–4.

[52] J. W. Spargo, "Chaucer's Love-Days," *Speculum,* XV (1940), 36–56. According to J. W. Bennett, "The Mediaeval Loveday," *Speculum,* XXXIII (1958), 370: "The fundamental weakness of the mediaeval institution lay in the canon law principle, 'Hoc enim ad officium Praelati spectat ut discordantes sive Clericos sive Laicos magis ad pacem quam ad Judicium coerceant.' There can never be any lasting peace without justice."

departure from natural law ideals. A cleric like the Parson could be expected to refrain from further corrupting the "love day," with its emphasis on natural law attributes of good faith, honesty and out-of-court arbitration. It is doubly ironic that the Friar whose calling is governed by laws tempered with natural law idealism not only breaks those laws but joins in the debasement of a judicial process that invokes the spirit of the *lawe of kinde.*

The Summoner, a petty officer of an ecclesiastical court, has the duty of administering canonical justice from the same body of positive law that ostensibly commands obedience of the Friar. However, the Summoner's own unethical operations, his amusing repeated shrilling of the legal tag "Questio quid iuris"[53] allow Chaucer to supply more than a hint of the corruption besetting at least one ecclesiastical court.[54] It is the Parson, he who "Cristes gospel trewely wolde preche" *(Gen Prol* 481), who restores faith in the ecclesiastics, for he shows a strict and literal acceptance of the Golden Rule and the Decalogue.[55]

At least two other members of the party, the Sergeant and the Franklin, are directly associated with positive law—secular not canon. However, law is chiefly decision, statute, and case to Chaucer's Sergeant. Chaucer has us understand this holder of "pleyn commissioun" to be a walking legal lexicon with an extraordinary retentive memory and the talent for exploiting it for his own best interest. Thus had he used the law to earn himself many "fees and robes" and with them, social status close to that held by the Knight. Although the Franklin exhibits openhanded hospitality in the oldest natural law tradition, his legal learning was primarily that needed for the conduct of his duties as a "shirreve" and "contour." He draws on this learning in the telling of his tale "much of the dramatic force of which relies on legal perceptions, and the recitation of which is couched at times in semi-legal language,"[56] but the Franklin does not seem the type to hold himself strictly to natural law ideas.

It is worth noting that the two most complete Christians whom Chaucer presents in the Prologue (aside from the Parson) lead their lives according to the *lawe of kinde.* In a day when man-made laws of chivalry are close to becoming superannuated, the Knight independently adheres to the natural law concept of "trouthe and honour" translated to mean "sense of honor, honorable dealing."[57]

[53] J. W. Spargo, "Questio Quid Iuris," *Modern Language Notes,* LXII (1947), 121.
[54] For an analysis of one Court Christian and the apparitors who "acted as a kind of ecclesiastical gestapo," see B. L. Woodcock, *Medieval Ecclesiastical Courts in the Diocese of Canterbury* (London, 1952), pp. 49, 112.
[55] Cf. fn. 27.
[56] R. Blenner-Hassett, "Autobiographical Aspects of Chaucer's Franklin," *Speculum,* XXVIII (1953), 793.
[57] Robinson, 652.

Moreover, we learn of the Knight:

> He nevere yet no vileynye ne sayde
> In al his lyf unto no maner wight. (*Gen Prol* 70–71)

Closely related to the knight and to the Parson by his ideal Christian conduct and by blood is the Plowman, whom Chaucer depicts in the lines:

> God loved he beste with al his hoole herte
> At alle tymes, thogh him gamed or smerte,
> And thanne his neighbor right as hymselve.
> (*Gen Prol* 533–35)

There is irony in the fact that the Knight and the Plowman live in honesty and charity in contrast to the ecclesiastics whose vocation is governed in part by natural law idealism.

Other echoes of the *lawe of kinde* appear in the Chaucer canon, as in the *Parliament of Fowls* where nature appears before the birds' assembly as the "vicaire of the almyghty Lord" to implement in a benign way her "Ryghtful ordenaunce" that birds and beasts must choose their mates and rear their young.[58] The sorting out and interpreting of all the poet's allusions to natural law calls for fuller study, but the evidence developed so far suggests that for Chaucer the *lawe of kinde* was more than a theological commonplace, or a dusty inheritance from the Alfredian *Boethius* lingering on in *Cursor Mundi.* In the *Boece,* in the law merchant of the wharfside, and possibly, in dialogues between teacher and pupil at the Inner Temple, Chaucer recognized the *lawe of kinde* as the counter-balance to the extremes of materialism and covetousness reached by certain members of the Canterbury party and their contemporaries.

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[58] J. A. W. Bennett, *The Parlement of Foules* (Oxford, 1957), pp. 131–132. On this aspect of the *lawe of kinde* in Gower and Langland, see pp. 207–209.

THE COMMEMORATIVE PROPHECY OF *HYPERION*

Karl Kroeber

The question which I suspect to underlie most of the objections to *Hyperion* is this: can a sophisticated reader care about Apollo and Hyperion? I believe much of Keats's art is directed to making a virtue out of this apparent difficulty. Because we do not care about Apollo and Hyperion *per se*, we are free to respond to their situation with an appropriate ambivalence. This freedom is not available, for example, to readers of *Paradise Lost*. The meaning of the conflict between the Olympians and the Titans must be dramatically created by the poet, who cannot rely on his readers' allegiance to traditional attitudes toward the antagonists. The significance of his poem must evolve dynamically.[1] Yet he is protected against mere idiosyncrasy by the fact that his subject-matter derives from our oldest and most viable literary tradition.

Whether or not *Hyperion* is to be called an epic, its particular characteristics may be defined by contrast with our epic tradition, which began, it seems safe to say, in the humanising of what had been narratives about divinities, myths.[2] Much of the power in epics such as *Gilgamesh* and the *Iliad* derives from the way in which their human protagonists emerge, under our eyes so to speak, from purely magical and religious contexts, in which gods, not men, dominate all activity. Achilles' manhood is impressive because he stands so close to the gods. In *Hyperion* man reassumes divine proportions; epic re-approaches myth. The Titans and the Gods are, if the word may be divested of pejorative associations, super-men. Keats's monumental figures, so enormously sensual, express spiritual actions and attitudes. So their strength is curiously similar to that of Achilles or Gilgamesh. Though complex, self-conscious and aesthetic as their "primitive" forebears were not, Keats'

[1] Hence the variety of interpretations of the poem, to many of which my study is indebted. I should perhaps single out the following as most influential: Douglas Bush, *Mythology and the Romantic Tradition* (Pageant Books reprint, New York, 1957, of the original edition, Cambridge, Mass., 1937), pp. 115–128; Kenneth Muir, "The Meaning of Hyperion" in *John Keats: A Reassessment*, ed. Muir (Liverpool, 1959), pp. 102–122; M. H. Shackford, "*Hyperion*," *Sewanee Review*, XXII (1925), 48–60; D. G. James, *Scepticism and Poetry* (London, 1937), pp. 198–202; James Ralston Caldwell, "The Meaning of *Hyperion*," *PMLA*, LI (1936), 1080–1097; Stuart Sperry, "Keats, Milton, and *The Fall of Hyperion*," *PMLA*, LXXVII (1962), 77–84. Bernard Blackstone's latest study, in *The Lost Travellers* (London, 1962). pp. 276–84, is disappointing after his discussion in *The Consecrated Urn*, cited below. All quotations are from H. W. Garrod, *The Poetical Works of John Keats* (Oxford, 1958) 2nd edition.

[2] See for example G. R. Levy, *The Sword from the Rock* (London, 1953).

protagonists, like the earlier heroes, have their being in a realm that is not earth, not heaven, but inseparable from both.

Hyperion narrates the birth of a new kind of divinity. Keats is not literarily archaistic; he does not ask us to admire the ancient Greek god Apollo; he asks us to see Apollo as a manifestation of the evolutionary principle which gives dynamic order and meaning to the universe. Thus the "remoteness" of the Titanomachia also serves Keats's central purpose.

For this reason the mythic, rather than symbolic, nature of the *personae* of *Hyperion* is appropriate. Apollo does not "stand for" something other than himself, yet he is not merely the old Apollo. He is not a literary reconstruction of a dead mythological figure, yet he is not fully separable from the ancient mythological figure. Keats's Apollo manifests a beauty that surpasses his individuality. He is *a* god. He is not a symbol of unchanging divinity nor is he a timeless object of adoration. Apollo must be one of many gods, not merely because there are other Olympians, but because there have been and will be other kinds of gods, other dazzling manifestations of developing beauty.

To Keats beauty is harmony, and there can be progress from simple to complex harmony. Such progress is dramatized by *Hyperion,* which moves from the description of Saturn, wherein sensory particularities are subdued to the harmony of a single mood of tranced sadness, to the narrative of Apollo's dying into godhead, which unifies in vital concord contrasting sensations, feelings, and thoughts. The Olympians, as Oceanus' says, surpass the Titans in "might" because the Olympians are "first in beauty." Titanic beauty is little more than mechanical unity; Olympian beauty is an organic unity which reconciles contraries and diversities.

But *Hyperion* is more than story, it is history—the early history of the universe.[3] The progress from Titanic to Olympian beauty reveals our cosmos to be a developing historical entity, as subject to (and a theater for) evolutionary processes. Keatsian evolution, however, differs from Darwinian. Keats thinks in purely aehthetic terms; he does not anticipate the later scientific concept. Darwin applies the theory of evolution horizontally, to one level of being at a time. Keats concentrates upon the "thresholds" of being. The scientific evolutionist seeks to connect man with the animals and the physical world, but Keats seeks to connect man with the gods and a supranatural world.

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[3] Bernard Blackstone, *The Consecrated Urn* (London and New York, 1959), p. 237: "*Hyperion* is to be a cosmogonic epic. It will 'unfold through images the theory of the world,'" Blackstone's emphasis is upon the relevance of Phato's *Timaeus*.

Nevertheless, the "system" of *Hyperion* is evolutionary;[4] in this respect Keats labors in direct opposition to Milton, and, indeed, to the entire classical-Renaissance literary tradition upon which so much of *Hyperion* depends.[5] What principally characterizes Keats's poem, in fact, is the intensity with which a commemorative, traditionalistic impulse interacts with a prophetic, progressive impulse. Keats fabricates a new "personal" mythology out of old religion and traditional literature.

Hyperion progresses from simple harmony to complex. The marvelous opening lines portray a scene in which all the details are of a piece, each contributing to a mood of sad silence appropriate to Saturn's fallen divinity.

> *Deep* in the *shady sadness* of a vale
> *Far sunken* from the healthy breath of morn,
> *Far* from the fiery noon, and eve's one star,
> Sat *gray-hair'd* Saturn, *quiet as a stone,*
> *Still* as the *silence* round about his lair;
> Forest on forest hung about his head
> Like *cloud on cloud. No stir* of air was there,
> *Not* so much life as on a summer's day
> Robs *not* one light seed from the feather'd grass,
> But where the *dead leaf fell,* there did it *rest.*
> A stream went *voiceless* by, *still deadened more*
> By reason of his *fallen* divinity
> Spreading a *shade:* the Naiad 'mid her reeds
> Press'd her *cold* finger closer to her lips.
> Along the margin-sand large foot-marks went,
> *No further* than to where his feet had stray'd,
> And *slept* there since. Upon the *sodden* ground
> His *old* right hand *lay nerveless, listless, dead,*
> *Unsceptred;* and his *realmless* eyes were *closed;*
> While his *bow'd* head *seem'd list'ning* to the Earth,
> His *ancient* mother, for *some comfort* yet.

Saturn listens to the Earth for comfort. To Hyperion words of comfort are spoken by Coelus, who is "but a voice," whose "life is but the life of winds and tides," yet who speaks "from the universal space." Coelus is more "heavenly" than Earth, and Hyperion's superiority to his fellow Titans derives from his association with the sky. He is "earth born/ And sky engendered." One must admire

[4] Two unpublished doctoral dissertations which deal with the influence of William Godwin's *Pantheon* on Keats's system of progressive evolution deserve mention: Sister Mary Carlin, "*John Keats' Knowledge of Greek Art, A Study of Several Sources,* Catholic University of America, Washington, D. C.," 1951, and Norman Anderson, *Bard in Fealty: Keats' Use of Classical Mythology,* University of Wisconsin, Madison, 1962.

[5] See, of course, Bush, 115–128; also Ernest De Selincourt's edition of *The Poems of John Keats* (New York, 1921, 4th ed.), p. xlv: ". . . a story of the ancient world had to assume Elizabethan dress before it could kindle his imagination." Also, pp. xlvii–xlviii: ". . . The poems of Greek inspiration exhibit no trace of influence of classical literature, but are determined in each case by the influence of different models of English poetry." This last probably overstates an excellent point.

Keats's narrative strategy: Apollo and Hyperion are more equally matched than any other pair of God-Titan opponents and their clash ought to be the climax of an evolutionary movement in which "supranatural" gods are born out of the agony of "natural" deities. Apollo, though "Celestial," is not detached from the earth. Not only is he born on Delos but his assumption of divinity occurs under the aegis of Mnemosyne,

> an ancient Power
> Who hath forsaken old and sacred thrones
> For prophecies of thee, and for the sake
> Of loveliness new born.

The new celestial must encompass within his progressive divinity the memory of earthly powers. The old is not to be obliterated but absorbed into a more complicated and comprehensive unity, just as *Hyperion* is meant to absorb previous literary traditions into a new unity.

To understand Apollo's dying into life, therefore, we must understand Hyperion's living into death, which is the climactic representation of all the Titans' tragedy. Unlike Saturn, who is old and gray and surrounded by silence and inertness, Hyperion "flares" along, "full of wrath," in a blaze of crystalline and golden opulence to the sound of "slow-breathed melodies" from "solemn tubes." The entrance to his palace, unlike the tranced woods in which Saturn sleeps, is described with the dynamic richness of full Keatsian synaesthesia.[6]

> And like a rose in vermeil tint and shape,
> In fragrance soft, and coolness to the eye,
> That inlet to severe magnificence
> Stood full blown, for the God to enter in.

Yet one notices that "this haven" of Hyperion's "rest" and "this cradle" of his "glory," a structure of pure light, seems now strangely alien from the earth.[7] The beauties of the earthly world appear in reference to Hyperion's palace only in metaphors and similies. The palace, full of "the blaze, the splendour, and the symmetry" of artifice, suffers "death and darkness" when elements of the natural world intrude. The Titans have fallen. Natural phenomena appear to Hyperion as "effigies of pain," as "spectres," and as "phantoms." This is the effect of the Olympian triumph. Hyperion is a Titan, an earth-god, and he swears "by Tellus and her briny robes!"[8] Yet earthly nature enters his "lucent empire" as a

[6] I use the word synaesthesia in its more general sense. R. H. Fogle, *The Imagery of Keats and Shelley* (Chapel Hill, 1949), drawing on C. D. Thorpe's work, analyses with more intensity and profundity the significance of synaesthesia in Keats's art; see esp. p. 137.

[7] See Caldwell, 1093.

[8] A good discussion of the Titans' "earthliness" is to be found in Lucien Wolff, *John Keats, sa vie et son oeuvre* (Paris, 1910), p. 628. Though old, Wolff's book is still valuable.

threat, in its least attractive guise, as something sinister and suggestive of death: the "cold, cold gloom" of "black-weeded pools" and the "mist" of a "scummy marsh." Hyperion's impotence, when he finds himself unable to utter his "heavier threat" is imaged by a serpentine power usurping his supra-mundane godhead.

> . . . through all his bulk an agony
> Crept gradual, from the feet unto the crown,
> Like a lithe serpent vast and muscular
> Making slow way, with head and neck convuls'd
> From over-strained might.

Hyperion, "releas'd," in desperation attempts to disrupt the order of nature; he bids "the day begin . . . six dewy hours/ Before the dawn in season due should blush." Hyperion is "a Primeval God," but "the sacred seasons might not be disturbed." The Titans, more primitive divinities than the Olympians, are identified with purely natural processes; Hyperion's actions reveal how shaken is his divinity. The Olympians are not to be identified, however, with the anti-natural. Rather they represent nature advanced to a new level. Hence the conflict of the poem is not between good and evil but between one kind of truth and beauty and a superior kind of truth and beauty. The inert lifelessness of the opening scene where all the animation of the natural surroundings is deadened by Saturn's presence symbolizes the limitation of the primeval gods: they do not represent the progress and fulfillment of natural life. Their successors will be more "godlike" because they will carry forward and more nearly fulfill the developing natural processes of earthly life. Implicit here is the idea that increased consciousness fulfills, does not thwart, "nature"; man's supranatural life is the proper evolutionary successor to unreflective biological existence.

Hyperion, "by hard compulsion bent," no longer strides and stamps and flares.

> And all along a dismal rack of clouds,
> Upon the boundaries of day and night,
> He stretch'd himself in grief and radiance faint.

He is approaching the gray passivity of Saturn; he has reached the boundaries of day and night moving toward darkness. Apollo at the same moment, as we learn in Book III, has also reached "the boundaries of day and night," but the Olympian is moving toward light. He appears in a dim, quiet solitude analogous to that of Saturn, "I have sat alone/ In cool mid-forest," that is as much a psychological condition as a physical situation:

> For me, dark, dark,
> And painful vile painful vile oblivion seals my eyes:
> I strive to search wherefore I am so sad,
> Until a melancholy numbs my limbs.

But, contrary to Hyperion, Apollo begs that Mnemosyne may "point forth some unknown thing." The new and unknown attracts and draws forth his godhead instead of strangling it.[9] He does not stretch himself in grief and radiance faint but aspires toward the natural lights of the heavens, the inanimate "brilliance" and "splendour" of which he desires to fill with the passion of life.

> There is the sun, the sun!
> And the most patient brilliance of the mooon!
> And stars by the thousands! Point me out the way
> To any one particular beauteous star
> And I will flit into it with my lyre,
> And make its silvery splendour pant with bliss.

We travel from Hyperion to Apollo by way of the council of the Titans, which is held in a cavern far from the life and light of surface earth.[10] The most important speech in this deliberation is that of Oceanus,[11] who advises acceptance of the truth that the Titans have been overpowered by a "fresh perfection" and "a power more strong in beauty." Although Oceanus speaks the truth, the "comfort" and "consolation" he offers is bleak. "Receive the truth, and let it be your balm," he says, asserting that

> . . . to bear all naked truths,
> And to envisage circumstance, all calm,
> That is the top of sovereignty.

This stoicism is the "top of sovereignty" for the Titans. It is not the top of sovereignty for Apollo. Every Titan who speaks regrets that he, and his world, is no longer "all calm." The passivity of Saturn in defeat, ironically, reveals the limits of the life he ordered in triumph. Oceanus preaches stoicism because the characteristic quality of Titanic rule was placidity. Even fiery Enceladus urges renewed war to regain "the days of peace and slumberous calm."

Apollo, representative of the Olympians, does not seek "days of peace and slumberous calm." He hates his idleness, he wishes to make the stars "pant with bliss," he is exhilarated to godhead by the knowledge of "dire events, rebellions . . . Creations and destroyings." The life over which Apollo will preside is to be active, violent, aspiring.

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[9] Leone Vivante, *English Poetry* (London, 1950) provides a valuable definition of Keats's love for the new and unknown: "Keats describes . . . the moment of *novelty* as outstandingly representative of life and life's value . . ." (p. 182) " "Novelty" must be understood as laying stress on an intimate value of non-predeterminedness and potency, rather than on change." (p. 183).

[10] "The assembled Titans themselves approximate to the chaos surrounding them: . . . Plainly *Hyperion* . . . is a macrcosmic model of the psyche in ignorance and enlightenment." Blackstone, p. 238.

[11] "What Oceanus proclaims is the imaginative center of the fragment, . . ." Harold Bloom, *The Visionary Company* (Garden City, New York, 1961), p. 385.

Evolution, as described by Oceanus, is a process of rising and lifting, a process of increasing movement and activity, a process by which more and more vitality emerges and gives meaning to inert, disorganized matter. "From Chaos and parental Darkness came/ Light," he says. The "sullen ferment" of chaotic darkness "for wondrous ends/Was ripening in itself," and when "the ripe hour came" light was born.

> Light, engendering
> Upon its own producer, forthwith touch'd
> The whole enormous matter into life.

First chaos, then light, an ordering of inanimate matter, finally life, a further ordering of light. The Titans came into being with the appearance of life. They are now to be superseded, not because life is to vanish, but because a more intense kind of life is being born out of the old life, just as the old life (a more intense kind of "light") was born out of the older light, which, in turn, had emerged from darkness.

The new life that is being born, the life of which the Olympians are the highest representatives, is a life of increased intelligence, and, since the universe now includes life, increased consciousness of life, increased consciousness of self. "Knowledge enormous makes a God of me," cries Apollo. He is aware of becoming a god, his godhead is in large measure his self-awareness.

The intensity of Apollo's self-awareness is impossible for Oceanus. He is aware of the god who replaces him and he knows the new god is somehow superior to him, but in what this superiority consists he does not know. Were he capable of the "knowledge enormous" which fills Apollo's mind Oceanus would be an Olympian. He is not capable of that knowledge, and, because he is the wisest of his kind, he does not try for it. He retires stoically.

Clymene, not so wise, experiences the anguish of not being able to comprehend. She suffers what Oceanus would have suffered had he not possessed the wisdom to recognize his limits. In so suffering, however, Clymene prepares the reader for Apollo's apotheosis. *Hyperion* opens with a scene of complete deadness and silence, one without consciousness, for Saturn sleeps and his divine sleep trances his surroundings. When Hyperion himself appears we have action, but arrested action, awareness (Hyperion recognizes the stifling of his divinity), but arrested awareness. In the cavern we have more activity, the arrival of Saturn, the debate, and finally the appearance of Hyperion. But this activity is cramped, self-lacerating, inconclusive, and the same adjectives might be applied to the awareness developed by the arguments.[12] Oceanus' opening plea for storical endurance is finally answered by Enceladus' hopeless fulminations.[13] But the Titans' struggle into self-defeat is the matrix of agony out of which the Olympians are born, and in the unfinished third book we move upward and outward from the cavern to reach, finally, the ecstatic sufferings of Apollo dying into a more intense and harmonious life, a life fully conscious of its own power and capable, therefore, of reconciling the potent diversities of a wonderful and ever developing cosmos. Apollo's ecstasy and its significance is adumbrated by Clymene, whose plaintive speech links Oceanus' stoicism to Enceladus' rage.

Clymene dramatizes the truth of what Oceanus has said (while emphasizing the painfulness of his truth). Her story reveals how unfit are the Titans to control the new life that pervades the universe.

> I stood upon a shore, a pleasant shore,
> Where a sweet clime was breathed from a land
> Of fragrance, quietness, and trees, and flowers.
> Full of calm joy it was, as I of grief;
> Too full of joy and soft delicious warmth;
> So that I felt a movement in my heart
> To chide, and to reproach that solitude
> With songs of misery, music of our woes.

Clymene could only *reproach* the joy and warmth of nature with "songs of misery." It is not in the Titans' power to *reconcile* contraries, as it is in the Olympians' power, as is shown by the music which destroys Clymene's sad melody murmured into "a mouthed shell." "That new blissful golden melody" was, for Clymene, "a living death" which, she relates, made her "sick/ Of joy and grief at once." What sickens her and is for her "a living death" is the new harmony which enables Apollo "with fierce convulse" to "die into life."

The apotheosis of Apollo which concludes the fragmentary third book is, as one might guess from Clymene's story, the exact opposite of Saturn's trance at the opening of the poem. Saturn sleeps in silence, dimness, and inertness.[14] The apotheosis of Apollo is a

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[12] A. E. Powell (Mrs. E. R. Dodds), *The Romantic Theory of Poetry* (London, 1926), p. 229: "In their [the Titans'] very passion there is no conflict, no struggle to recreate their being out of tragedy. The "vale of Soul-making" is not for these. They are like great natural forces, which governed by an overmastering law fulfill easily and unconsciously that for which they are formed. It is not theirs to win knowledge and by art to make, with all the agony and effort of creation. The new gods seem smaller, but more vivid . . . they are convulsed in making . . . . Art and knowledge have entered into their singing, so that it is able to express their complex life, with its active, conscious effort to shape things to its intent."

[13] Bush, 124: "The Titans, however benign and beneficent, had in a crisis behaved not like deities but like frail mortals; they had lost, and deserved to lose, the sovereignty of the world because they had lost the sovereignty over themselves." Note that Keats stresses Saturn's loss of "identity," see I, ll. 112–116.

[14] "All is negative here. The divisions of the day are, as it were, obliterated: the four elements are presented in terms of silence and inaction. There is no air. The rhythms of the verse gyrate sluggishly . . ." Blackstone, *The Consecrated Urn*, p. 234.

birth full of sound, movement, and the radiant anguish of emerging consciousness. The contrast between the two passages is best told in the concluding images. Saturn, like a sculptured figure, is long bowed to the earth for comfort, whereas from Apollo's "limbs Celestial" some yet undefined power is forever about to emanate. But the contrast is not merely that Saturn retreats toward familiar consolation and Apollo yearns toward new and painful wonder. The difference between the two divinities lies in the different harmonies which unify the contrasting passages. The description of Saturn is harmonious in that nothing contrary to the mood of tranced stillness intrudes. The narrative of Apollo's apotheosis reconciles contraries. For instance, Apollo's ecstatic words contrast to Mnemosyne's "silent face," as the "wild commotions . . . of his limbs" contrast to her rigid pose, "upheld/ Her arms as one who prophesied."[15] Likewise "*dire* events . . . pour" into his brain like "some *blithe* wine"; his "level glance . . . steadfast kept/ Trembling with light." Virtually every word in this narrative of "Creations and destroyings" is matched by a contrary, so that the Dionysiac fury of the event is controlled by an Apollonian symmetry of form.

The harmony of the Saturn passage is substantive, that of the Apollo passage compositional, a total order imposed upon diverse sensations, feelings, and ideas. The beauty born with Apollo is the beauty of complex design. The particularities retain their integrity: pain remains pain, it does not become pleasure; death and life remain distinct conditions; creations and destroyings remain opposed processes. But pain and pleasure, life and death, creations and destroyings interlock in a design that reconciles them.[16] Apollo's birth is meant to transform the value, the meaning, of each of these particular elements, because the god's birth is the birth of understanding of the place of each particularity and its opposite within the scheme of cosmological history.

The comprehension of this scheme, the dying out of incomplete life into total life, should not merely change the value of the parts but should also increase it, because the formal symmetry of the whole event will reflect back upon each particle more energy than it alone can generate. Once the encompassing design is conceived, each element within it will be seen to contribute not alone to its own existence but to the ordering, the significance, of all existences

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[15] On this point see D. G. James, *The Romantic Comedy* (London, 1948), p. 136.

[16] James, p. 128: "The beauty of the new Gods is a more difficult and terrible beauty than that of the old; yet it is none the less greater. The Godhead of *Hyperion* is that which acknowledges for its own the world in which Lear suffered and Cordelia was hanged, and is yet no less a principle of Beauty and Order; . . ." I think this is the point toward which Dorothy Van Ghent moves in "Keats's Myth of the Hero," *Keats-Shelley Journal,* III (1954), 7–25 (pp. 10–16 on *Hyperion*), but I confess I do not fully follow her argument. See also R. D. Havens, "Of Beauty and Reality in Keats," *ELH,* XVII (1950), 206–13, for a discussion of how the connotations of "beauty" change in Keats's later poetry.

together. The final contrast between Apollo and Hyprion is probably that life become conscious of its system of vitality is more intense and precious and enduring, more fully supranatural, self-transcending, divine, than unreflective life, life unaware of its own potency.[17]

One must speak tentatively because Keats did not finish *Hyperion.* We can only speculate as to why he was dissatisfied with it, but his own "explanations" suggest that he was more troubled by stylistic problems than by his subject-matter. Perhaps he did not control the style necessary to represent the Olympian life, a style which ought to transcend that of the first books. The logical culmination of the Keatsian Titanomachia ought to be the triumph of Apollo over Hyperion. Oceanus' stoical retirement before Neptune is not a reconcilement of contraries, not an absorption of an old, incomplete beauty into a new, more complete beauty. This reconcilement and absorption are necessary to authenticate Olympian divinity, and they should be fashioned in a manner suggested by but not fully realized in the narrative of Apollo's apotheosis.

At least partial realization of this new manner is found, perhaps, in the early portion of *The Fall of Hyperion: A Dream,* Keats's recasting of the original poem.[18] *The Fall* is certainly a more personal poem than *Hyperion,* and it might be argued that it is also more literary,[19] that it includes a wider range of literary references and incorporates a more intense appreciation of its mythological and poetic sources.[20] The key to this double development seems to me to lie in Keat's recognition that the life of full consciousness, including of course consciousness of self, must be deeply involved with visions or dreams.

Consciousness, after all, is more than mere perception. A mind fully aware is not satisfied by appearances, it strives to comprehend more than meets the eye. Consciousness is also something more than commonsense. A mind fully aware is sensitive to causes and motives which lie beyond the reach of workaday rationalism. No one could deny that scientific activity of the past one hundred and fifty years has advanced man's awareness of the workings of his universe and of his own being. And the modern understanding of the

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[17] Caldwell, 1096.

[18] Sperry, 80: "The life-and-death struggle with which the first *Hyperion* ends is carried over and expanded in the second. But its context is changed in such a way as to lead one more and more to consider Keats's allegory within a framework of sin and redemption." My only diagreement with Mr. Sperry's excellent point is that he seems to make it exclusive; without denying the relevance of "sin and redemption" to *The Fall of Hyperion,* I should say that some less orthodoxly religious conceptions are as important.

[19] See Sperry, 77.

[20] John D. Rosenberg, "Keats and Milton: The Paradox of Rejection," *Keats-Shelley Journal, VI* (1957), 87–95. Rosenberg argues that the principal change between the two *Hyperions* is to be traced to Keats's effort "to humanize the poem" (p. 91).

natural universe is founded, as A. N. Whitehead pointed out, upon a willingness to accept as truth explanations that seem to controvert "commonsense." Most important work in the physical sciences today concerns phenomena which simply cannot be observed by "the naked eye." Psychoanalysis of course, is founded upon the study of what appears to be irrational, particularly upon the study of the "truth" of dreams.

Keats was neither a proto-Freud nor a proto-Einstein. He knew little about science and contributed nothing directly to its development. In some respects he looked backward, toward Socrates, who "examined" life with the most intense rationality, who constantly sought self-awareness, and whose climactic utterances passed beyond dialectic into stories of visions. But Keats also looked forward. In *The Fall of Hyperion* he suggests a conception of poetic truth as "visionary" truth which foreshadows our contemporary interest in extra-ordinary mental conditions and in new systems of logical enquiry and organization. This is perhaps why *The Fall of Hyperion* is so complex, and why, specifically, even more than the earlier version it speaks in two voicees, one commemorative, one prophetic.

The Fall of Hyperion is above all else what Keats himself called it: a dream. In the first eighteen lines of the fragment the word "dream" appears five times.

> Fanatics have their dreams, wherewith they weave
> A paradise for a sect; the savage, too,
> From forth the loftiest fashion of his sleep
> Guesses at Heaven; pity these have not
> Trac'd upon vellum or wild Indian leaf
> The shadows of melodious utterance.
> But bare of laurel they live, dream, and die;
> For Poesy alone can tell her dreams,—
> With the fine spell of words alone can save
> Imagination from the sable charm
> And dumb enchantment. Who alive can say,
> "Thou art no Poet—mayst not tell thy dreams"?
> Since every man whose soul is not a clod
> Hath visions, and would speak, if he had lov'd
> And been well nurtured in his mother tongue.
> Whether the dream now purposed to rehearse
> Be Poet's or Fanatic's will be known
> When this warm scribe my hand is in the grave.

The distinction drawn here appears to be intended as the foundation for everything else in *The Fall.*[21] Keats distinguishes be-

[21] Bloom, p. 412: "Keats implies that the fanatic and the savage are imperfect poets, with a further suggestion that religious speculation and mythology are poetry not fully written." p. 413: "Moneta . . . is a priestess of intense consciousness doing homage to the dead faiths which have become merely materials for poetry."

tween the poet on the one hand and, on the other, the fanatic, the savage, and the "man whose soul is not a clod: but who has not "been well nurtured in his mother tongue." These latter differ from the poet only in that they do not or cannot effectively tell their dreams, so their dreams die with them. The poet is like them in that he, too, dreams. But his melodious utterance lives on after his death. "Every man," Keats says, "hath visions and would speak"—if he could. The fanatic differs from "every man" and the savage in that he does speak. The fanatic can "weave/ A paradise for a sect." The poet, then, differs from the savage and "every man" in that he does speak, with his "fine *spell* of words" he escapes the "sable charm," achieves something more than "a paradise for a sect," achieves something precious for *all* men.[22]

All men, including poets, are dreamers. The poet alone can effectively tell his dreams. Hence the poet can be certainly recognized only after his death. If what he has told results only in "a paradise for a sect" he is to be identified as a fanatic. If his melodious utterance does more than delude a few, does more than create a fantasy world of escape, and bodies forth, instead, heretofore unrecognized truth, he is to be identified as a poet.

This differentiation is not possible until the Apollo of *Hyperion* has died into life. Until life has evolved to the point where it not only exists but is conscious of its existence, the problem of "dreaming" cannot arise. As long as we are unconscious of ourselves we cannot be mistaken about ourselves. But as soon as we attain self-consciousness we are open to self-misunderstanding and self-delusion.

That Keats was interested in this problem is implied, I believe, in his dramatic strategy of presenting his story as a vision within a vision within a dream. His first words after the introduction are: "Methought I stood where trees of every clime." He is "purposed to rehearse" a dream, and the supra-reality of that dream is accentuated by its setting, an idyllic garden where, contrary to nature's practice, every species of tree flourishes. In this paradisical setting Keats drinks a "transparent juice" which he describes as "parent of my theme," because it induces a "swoon" from which he wakes, not in the garden, but in "an old sanctuary," an "eternal domed monument." There he encounters Moneta, who transports him,

[22] Sperry, p. 78: ". . . the *true* poet, as the closing lines of the paragraph make clear, is the very opposite of the fanatic who speaks merely to a "sect." True poetry implies not only imaginative activity but the perception of value and meaning relevant to all mankind. "In dreams," Keats seems to say with Yeats, "begins responsibility," and the special obligation of the poet to society is destined to become, particularly through Moneta's urging, the major concern of Keats's dreamer."

first, to "the shady sadness of a vale" where he can observe Saturn and Thea, because

> . . . there grew
> A power within me of enormous ken,
> To see as a god sees, and take the depth
> Of things as nimbly as the outward eye
> Can size and shape pervade,

and later to Hyperion's palace where he observes in the same god-like fashion.

By presenting inspired perceptions with a vision of which he dreamed Keats makes his form functional, that is, representative of the nature and worth of that awareness which transcends ordinary observation and ordinary reason. The truth he seeks to establish, after all, is extraordinary. Ultimately it is the manner of the dream's presentation that must convince us of its substantive value. Keats seems to want his literary dream, in one way at least, to be like an actual dream, in which style is literally substance. Dreams differ from waking thoughts in that form or manner of apparition is decisive in dreams. One can rephrase an argument but not a dream. A dream can recur only by repeating its form.

Keats also discusses dreamers with Moneta, and about that discussion have gathered most of the critical controversies concerning *The Fall of Hyperion.*[23] There is too little evidence for anyone to explain with assurance Keats's meaning and intentions, but I should like to suggest some ways in which my understanding of the direction of his thinking relates to the major problems of the poem. If we accept *The Fall* in the most nearly finished form Keats achieved, that is, with the twenty-three lines beginning "Majestic shadow, tell me" (the cancelled passage comprising lines 187–210 of Book I) exised, Keats's argument is not inherently difficult, for it does not become fully engaged with the dreamer-poet distinction.[24] Keats asks by what right he has been allowed to attain the altar, and is told:

> . . . Thou hast felt
> What 'tis to die and live again before
> Thy fated hour; . . .
> None can usurp this height . . .
> But those to whom the miseries of the world
> Are misery, and will not let them rest.
> All else who find a haven in the world,
> Where they may thoughtless sleep away their days . . .
> Rot on the pavement where thou rotted'st half."

[23] For a recent example, David Perkins, *The Quest for Permanence* (Cambridge, Mass., 1959), pp. 276–82.

[24] A most important and helpful article on this matter is that of Brian Wicker, "The Disputed Lines in *The Fall of Hyperion*," *Essays in Criticism*, VII (1957), 28–41. A famous discussion of the lines is that of J. M. Murry, "The Poet and the Dreamer" now in *Keats* (London, 1955), pp. 238–49.

Keats then asks why he is alone, since

> "Are there not thousands in the world . . .
> Who love their fellows even to the death,
> Who feel the giant agony of the world,
> And more, like slaves to poor humanity,
> Labour for mortal good?"

These humanitarians are like Keats in that the miseries of the world will not let them rest. They are, however, more than he:

> . . . "they are no dreamers weak;
> They seek no wonder but the human face,
> No music but a happy-noted voice—
> They come not here, they have no thought to come—
> And thou art here, for thou art less than they."

We may overestimate Keats's praise of busy go-gooders. He certainly credits them with virtue, but perhaps he subtly implies their limitations, too, by having Moneta—one must remember that her wisdom is not complete, for she is not a true Olympian but "the pale Omega of a wither'd race"—praise the humanitarians in terms which recall those "who find a haven in the world." The humanitarians find their satisfaction and fulfillment, their "haven," in the world. True, they "feel the giant agony" of the world, but in a fashion that might be meant to recall the giant agony of the Titans, who were unable in *Hyperion* to sustain the feeling, as Apollo could, of pain and joy together. If so, from one point of view Keats is indeed "less" than the humanitarians, as the Olympians give the impression of being physically less than the Titans in *Hyperion,* but from another point of view he is more: he can bear "more woe than all his sins deserve," and can be "admitted oft" to paradise-like gardens.

Then in a passage which Keats (according to his good friend and careful scribe Woodhouse) meant to strike from *The Fall,* the discussion is carried from the poet-humanitarian contrast to the poet-dreamer contrast. Keats proposes that poets are not "useless," that their "melodies" do good, though he does not yet claim himself to be such a poet, a "physician to all men." Moneta replies with the query: "Art thou not of the dreamer tribe?" And she asserts:

> The poet and the dreamer are distinct,
> Diverse, sheer opposite, antipodes.
> The one pours out a balm upon the world,
> The other vexes it.

In the introductory lines Keats states plainly that the poet is a dreamer. The difference between poet and fanatic lies in the effectiveness of their expressions, but both tell their dreams. Possibly Moneta's distinction is meant to assist in refining the earlier definition. According to her the poet-dreamer pours out a balm upon the world while the fanatic-dreamer vexes it. Both, as it were, offer potions: that of the poet-dreamer heals, that of the fanatic-dreamer poisons.

At any rate, Moneta's words bring forth an angry exclamation from Keats, his first violent outburst:

> Apollo! faded! O farflown Apollo!
> Where is thy misty pestilence to creep
> Into the dwellings, through the door crannies
> Of all mock lyrists, large self-worshippers,
> And careless Hectorers in proud bad verse.

This is the first mention of Apollo in *The Fall*, and, in keeping with the pattern of imagery introduced by the word "physician" at the opening of the cancelled passage, he is invoked, not as the god of poetry, but as the god of pestilence.[25] But Keats skillfully links the god's two functions: Apollo is called upon to destroy not dreamers but bad poets, "mock lyrists," and "careless Hectorers in proud bad verse." This returns us to the problem of Moneta's words. In the introduction Keats defines the fanatic as less than the poet but not as evil. Now he condemns those who tell their dreams without genuine poetic gifts as vexatious poisoners of the world. He who weaves "a paradise for a sect" is now identified as a "self-worshipper"—not a worshipper of Apollo's supra-personal truth?—who ought to be destroyed.

> Tho' I breathe death with them it will be life
> To see them sprawl before me into graves.

It may be that the harmless fanatic is now seen to be the poisonous dreamer because Keats has reached the point where he is able to invoke Apollo, that is, he has passed the first tests of his initiation into genuine poethood. It is certain that this Apollo is not the new-born god of *Hyperion*. He is "faded" and "farflown." It appears to be the bad poets, the fanatic dreamers, who have exiled him. As remarked above, the effectiveness of a dream depends entirely upon its style. A badly told dream is a falsification, a distortion of the dream's truth. The "large self-worshippers" destroy the truth of Apollo, not because they dream, but because they recount their dreams badly. The poet recounts his dreams well and thus makes manifest the truth of his vision; by his art he invokes Apollo the healer who "pours out a balm upon the world." Keats, not claiming to be a poet yet, is nonetheless dedicated to the "objective" truth of vision. Thus it will be "life" to him, even though

[25] This imagery fits in with the pattern of sickness-medicine imagery, so far as I know unnoticed by the critics, which runs throughout the second version of *Hyperion*. For example, by Moneta's "propitious parley" the poet is "medicin'd/In sickness not ignoble," and later the face of the goddess is described as "bright blanch'd/By an immortal sickness which kills not; . . . deathwards progressing/To no death . . ."

he must personally suffer extinction in the process, to see the proud falsifiers of vision destroyed.

I do not wish to insist dogmatically on the correctness of this reading, and I propose it principally because it suggests that at the end of his career Keats may be reaffiming his faith in the truth expressed by Apollo's apotheosis in *Hyperion*. But if so Keats does not merely repeat his earlier celebration of evolutionary consciousness. He recognizes that increased consciousness leads inevitably beyond ordinary rationality to the exploration of the truth of dreams and visions.[26] And he recognizes that the best authentication of such visionary consciousness lies in the manner of its expression. The moral, then, would be that in the modern world the evil man is he who falsifies his dream or vision by telling it badly. This is no minor, aesthetic sin. It is blasphemy, the distortion of the highest truth. The genuine poet must be a good and useful man —"a sage, a humanist, a physician to all men"—for his well-told dream will embody the truth that surpasses the limited truth of sensory observation and rational discourse.[27] The dedicated poet expresses the one truth fully appropriate to modern man's capacity for conscious life.

Whatever the problems and uncertainties of *The Fall of Hyperion* may be, this faith is his art, this confidence in the worth of his poetry as something more than ornamental and entertaining, sustains all Keats's finest work.[28] In this belief, moreover, Keats is typical of his era, not unique. His contemporaries share his passionate conviction that in uttering beautifully their private visions they contribute to a better, a more fully human life for all men—that they in fact help to bring to birth the new life falsely promised by political revolutionists and social reformers, fanatic-dreamers who are not poets.

[26] Rosenberg, 93: "He [Keats] reveals an instinctive historical sense and faith in the collective development of mind."

[27] Albert Gérard, "Coleridge, Keats and the Modern Mind," *Essays in Criticism*, I (1951), 249–61, emphasizes the general significance of this point. For example: "The Romantics . . . firmly believed that *within* 'mankind' there is room for a faculty that goes beyond reason. This is the basic assumption of romanticism." (p. 253).

[28] "*The Fall of Hyperion* must be regarded as one of the major attempts within European romanticism to reconcile the imagination with a realistic and human awareness of the suffering of mankind." (Sperry, p. 83). Mr. Sperry's insistence on the poem's adherence to the orthodox pattern of sin and redemption leads him to stress the dark side of *The Fall*—he speaks of Keats's final attitude as "closer to resignation than to hope— perhaps even despair." I wish to emphasize the element of reaffirmation within Keats's admittedly ever more tragic view of life.

PRINCIPLES OF SOIL CONSERVATION AND SOIL IMPROVEMENT AS THEY APPLY TO CERTAIN GROUPS OF SOILS IN SOUTHEASTERN WISCONSIN

M. T. Beatty and A. E. Peterson

Modern technology has made available an ever increasing number of practices for the conservation and improvement of soils. These practices are based on one or more of five fundamental principles. It is the purpose of this discussion to illustrate the application of these principles to problems in the conservation and improvement of two major groups of soils in southeastern Wisconsin.

PRINCIPLES OF SOIL CONSERVATION AND IMPROVEMENT

The many practices and techniques of soil conservation and soil improvement are based on five fundamental principles. These are:

1. The amount of soil which can be lost by erosion without serious damage to the productivity of the remaining soil varies among the many soil types.
2. Soil losses by erosion can be minimized by protecting the soil surface with living or dead organic matter, and/or by reducing the velocity or amount of water which flows over the soil.
3. Among the various kinds of soil, considerable difference exists in the ease with which the soil structure may be damaged by excessive or improper soil tillage.
4. Many soils can be improved beyond their natural state for the production or crops and/or wildlife by appropriate and timely applications of lime, fertilizer and organic matter, and by controlling the water table by drainage or flooding.
5. Appropriate combinations of practices based on one or more of the above principles are frequently needed on most soils or groups of soils.

While these five principles have been known for a considerable period of time, the importance of some of them is only now being

[1] Contribution from the Department of Soils and the Soil Survey Division, Wisconsin Geological and Natural History Survey; University of Wisconsin, published with the approval of the Director, Wis. Agr. Expt. Station, Madison, Wis.

[2] Associate Professors of Soils. Appreciation is expressed to Professor F. D. Hole for his helpful suggestions on the manuscript.

more fully recognized. Modern technological advances such as land forming, minimum soil tillage and numerous others which can be combined to produce high crop yields have greatly aided in the application of these principles to everyday agriculture.

APPLICATION OF PRINCIPLES TO GROUPS OF SOILS

The application of the fundamental principles of soil conservation and soil improvement outlined previously, as implemented by modern technology, must be carefully fitted to particular combinations of soil type, length and gradient of slope, amount of existing topsoil and the overall physiography of the land being treated. Standards for the application of such practices have been developed from research by Agricultural Experiment Stations and by the United States Department of Agriculture. The Soil Conservation Service, U.S.D.A., has prepared standards for such practices in Wisconsin (1956, 1958).*

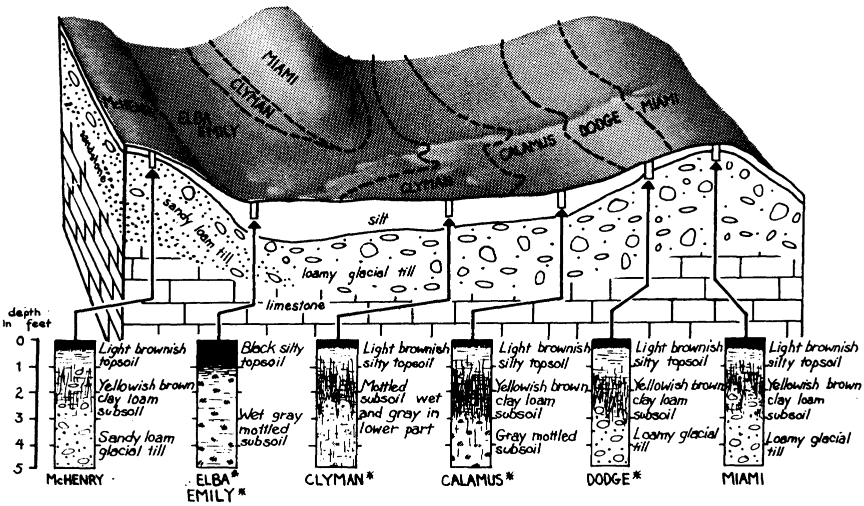
While every tract of land must be treated individually in the design and layout of soil conservation and soil improvement practices, there are certain repeating patterns of soils and slopes which are found in nature. This regularity of soil and slope patterns is a result of systematic variations in the factors of soil formation: parent material, relief, biological activity, time, and climate. These repeating patterns of soils and slopes make it possible to draw maps and diagrams of groups of related soils. Such maps and diagrams can include the major soils of landscapes throughout an area where soils have formed as a result of particular combinations of the five factors of soil formation. An example is the series of maps and accompanying landscape diagrams showing major groups of soils, and combinations of soil conserving and soil improving practices for each group, which has been prepared for the major soils of southeastern Wisconsin by Beatty and Murdock (1960). Diagrams of soils in two typical landscapes in southeastern Wisconsin illustrate the application of the principles of soil conservation and improvement outlined previously.

The most extensive group of soils in southeastern Wisconsin is one consisting of light-colored, medium textured soils formed from losses and calcareous glacial till on glaciated uplands and the poorly drained depressional soils associated with them. The areas of occurrence in this group of soils are shown in Figure 1. Figure 2 shows a cross section of a typical landscape in which these soils occur. Sketches of profiles of major soil series have been set into the diagram to portray important soil characteristics. The soils are shown in the landscape position in which they typically occur.

* Number in parentheses refer to literature cited.

Figure 3 illustrates the combination of soil conservation and improvement practices which would allow intensive development of these soils for agriculture, wildlife and forestry without excessive erosion or other permanent damage to the soil. These practices are based on the principles of soil conservation and soil improvement outlined previously, as implemented by new soil management techniques such as minimum tillage of row crops, especially on the rolling McHenry, Miami and Dodge soils, and land forming and water table control on the Elba, Emily and Clyman soils. The amounts and velocities of water flowing over the surfaces of all soils subject to erosion are controlled by terraces, diversions, waterways and by alternate contour strips of sod-forming and tilled crops. The Elba and Emily soils are recommended either for development for agriculture, for wildlife or for both simultaneously. If developed for agriculture, they can be used intensively for row crops if large amounts of fresh organic matter from crop residues or barnyard manure are returned to the soil, if pests can be adequately controlled, if high soil fertility is maintained, and if minimum soil tillage is practiced. This is possible because these soils are seldom subject to erosion, and have a structure which is not easily damaged by tillage.

Adoption of this combination of land-use practices on this group of soils, with minor modifications to fit variations in slope and



* **Tentative soil name**

FIGURE 1. Geographic extent of light-colored soils of the glaciated uplands.

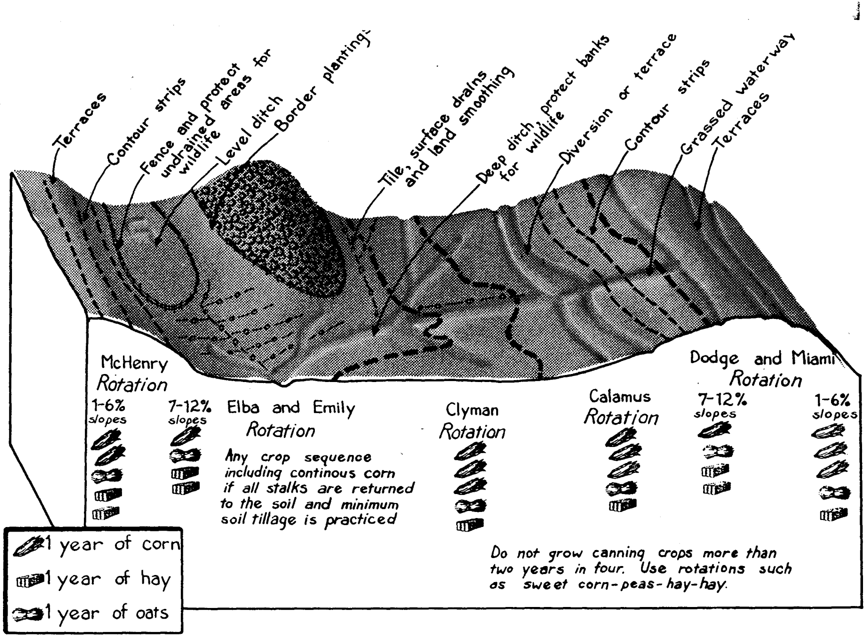


FIGURE 2. Typical landscape relationships of light-colored soils of the glaciated uplands in southeastern Wisconsin. * Tentative soil name.

other conditions, would represent an intensive program of multiple land-use development for agriculture, wildlife and forestry. All five principles of soil conservation and improvement need to be applied for the intensive multiple development of these soils.

Figure 4 shows the extent of the principal soils found in the Kettle Moraine of southeastern Wisconsin; figure 5 shows the typical landscape relationships of the soils in this group and figure 6 illustrates the combination of practices which will allow multiple land-use development for agriculture and wildlife on an intensive basis.

The intensity of recommended land use varies among the soils in the landscape in accordance with their potential for damage by erosions (see first principle above). For soils such as the McHenry, the permissible soil loss by erosion is greater than for shallow soils over sand and gravel such as the Casco. Therefore, more intensive cropping is allowed on the former soil under similar slope lengths and gradients. Permanent cover is recommended for the very shallow Rodman soil, because soil loss by erosion would almost totally destroy it. The irregular slopes in this landscape limit the use of mechanical practices for soil conservation. For this reason, rotations of crops which keep vegetative cover on the land much of the time are recommended. The structure or tilth of Boyer sandy loam is somewhat less susceptible to damage from excessive or improper tillage (see principle 3) than is that of other soils in the group. The fourth principle, that of improving the natural condition of a soil, is illustrated by the practices recommended for peat or muck. Many of these deposits occur in small depressions which have no drainage outlet. This, together with their small size,

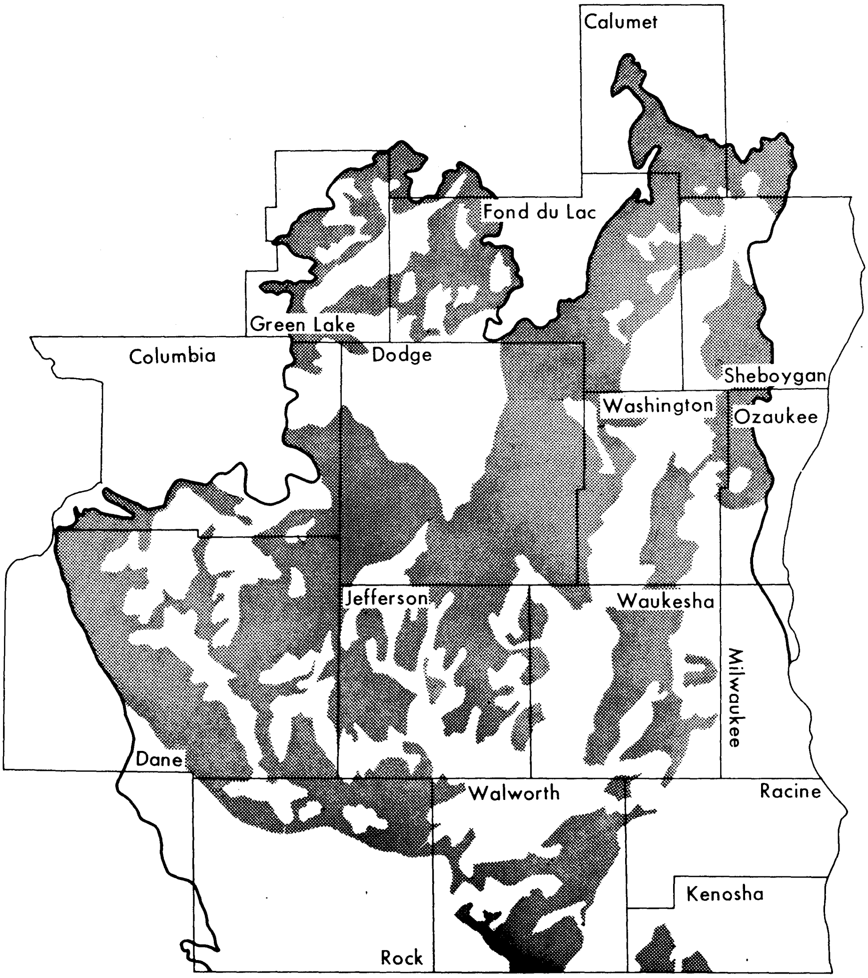


Figure 3. Soil conservation and soil improvement practices adapted to light-colored soils in a typical glaciated upland landscape in southeastern Wisconsin.

greatly limits their use for agriculture, but many of them can be greatly improved as wildlife habitat. The fifth principle of using combinations of practices applies particularly well to this group of soils.

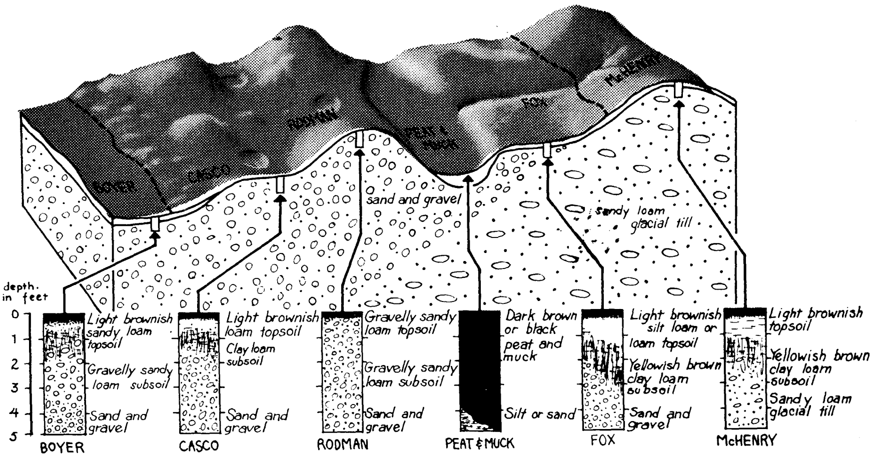


FIGURE 4. Geographic extent of soils of the Kettle Moraine.

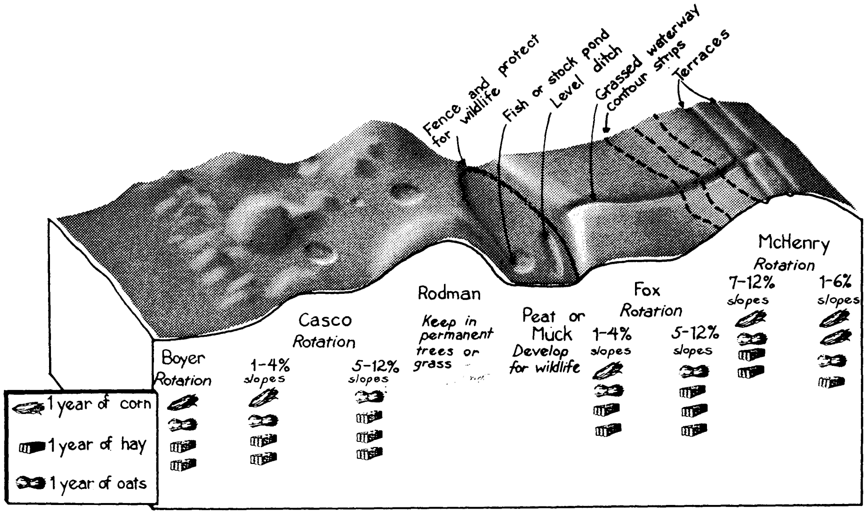


FIGURE 5. Typical landscape relationships of the major soils of the Kettle Moraine.

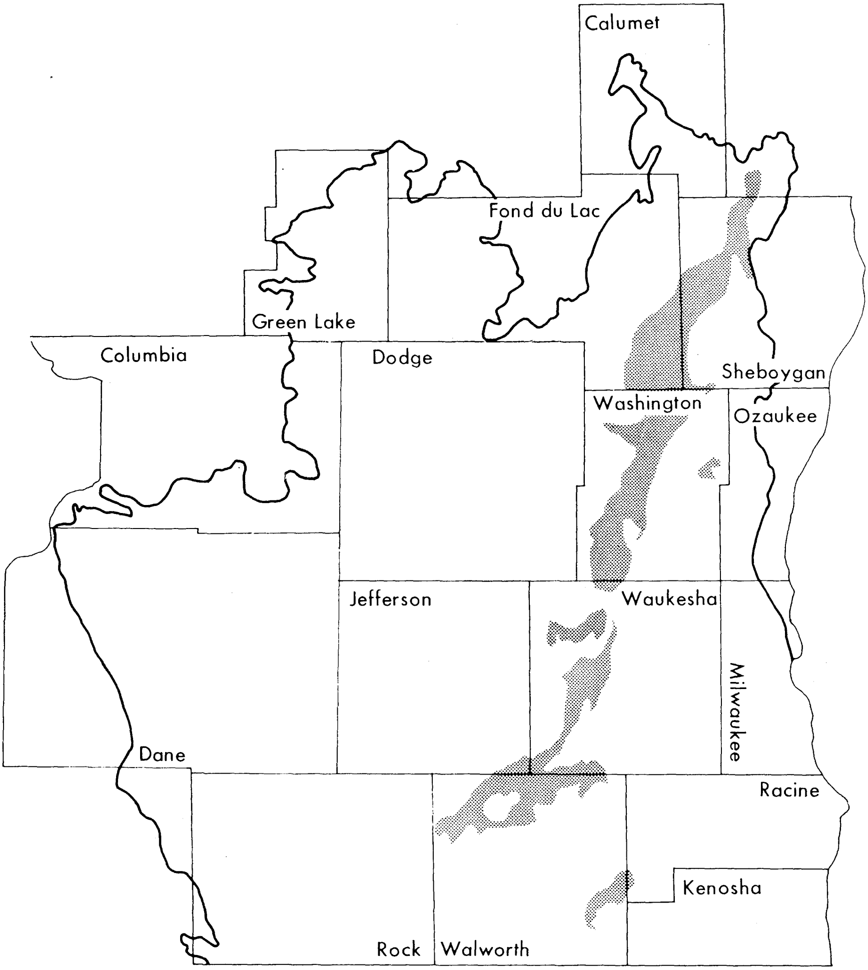


FIGURE 6. Soil conservation and soil improvement practices adapted to soils in a typical landscape of the Kettle Moraine.

DISCUSSION

The two groups of soils used as examples illustrate the wide range of soil and slope conditions found in parts of southeastern Wisconsin. It is also apparent from figures 3 and 6 that a variety of mechanical and vegetative soil conservation and soil improvement practices are needed for intensive development of these soils. The illustrations also show that soils in typical landscapes of the area are in many cases adapted to use for agricultural crops, for woodlands and for wildlife. Planning the land-use for tracts of land may involve assigning bodies of soil to one or more of these uses.

Comparison in the field of soil improvement and soil conservation practices now in use on typical landscapes of the soil groups with practices needed for adequate soil conservation and intensive soil development have shown that these soils are now generally far below their potential for multiple development for agriculture, forestry and wildlife. Soil conservation practices have not been applied to the extent considered necessary for adequate control of soil erosion.

Summary

The application of principles of soil conservation and improvement to a diverse group of soil and slope conditions on two landscapes in southeastern Wisconsin are illustrated. Of the two landscapes, the first is typical of much of southeastern Wisconsin, and the second contains extremes of soil and slope conditions and thus is well suited to illustrating the basic principles of soil conservation and improvement. Widespread application of the recommended practices would lead to more intensive multiple development of such soils for agriculture, woodland and wildlife, and would greatly reduce the possibility of excessive soil erosion.

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A STUDY OF THE NATURAL PROCESSES OF INCORPORATION OF ORGANIC MATTER INTO SOIL IN THE UNIVERSITY OF WISCONSIN ARBORETUM

Gerald A. Nielsen and Francis D. Hole

Soil studies on long term plots under natural vegetation in the 1200 acre University Arboretum at Madison were undertaken in 1956 at the suggestion of the late Professor John T. Curtis of the Botany Department of the University of Wisconsin. Measurements were made to determine (1) annual production of natural litter in forest and prairie areas, (2) relative contributions by roots and above ground parts of prairie plants to the store of nitrogen in the soil, and (3) rate and processes of incorporation of organic matter in forest soils (Nielsen, 1963). Twenty-six rectangular plots were established and sampled in 1956 and total soil nitrogen contents determined by W. A. Noel. Resampling of the soils and analysis of total nitrogen were done three years later by the senior author (Nielsen, 1960). Measurements of production of vegetative growth have been continued from 1956 to date.

INTRODUCTION

A soil is a three-dimensional body (Soil Survey Staff, 1951) that records past events. The record, in the form of arrangements of chemical bonds, mineral and organic compounds, soil aggregates and horizons (layers) and the soil body itself, is a summary or synthesis of pedologic changes. In this sense a soil is a "synthometer", an integrated product of a succession of external and internal conditions. Climate, flora, fauna and man himself have all left their mark upon the soil.

Prairie and forest soils of Wisconsin (Figure 1) embody a partial record of Wisconsin's natural history for a period of at least 12,500 years (Frye and Willman, 1960). This includes the deposition of Cary dolomitic glacial drift and an overlying 2- to 3- foot

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deposit of loess, and subsequent changes in vegetation and climate (Curtis, 1959) to the present. Starting with the two-layered parent material, loess over drift, widely different plant and animal communities and associated microclimates have differentiated contrasting prairie and forest soils in southeastern Wisconsin. The prairie soil, called Brunizem by Simonson, Riecken and Smith (1952) has the simpler profile of the two. It consists of an acid, deep, dark, granular surface soil, the A_1 horizon, overlying a weakly developed blocky subsoil, the B_2 horizon (see Parr silt loam, Hole, 1956, p. 55). Content of organic matter in the Brunizem soil decreases gradually with depth. The deciduous forest soil, termed Gray-Brown Podzolic by Baldwin (1927), has a shallow, nearly neutral surface soil (A_1) overlying a bleached layer (A_2) and strongly developed clayey subsoil (B_2) (see Dodge silt loam, Hole 1956, p. 40). The content of organic matter does not decline gradually with depth, as in the Brunizem, but decreases abruptly at the lower boundary of the shallow A_1 horizon.

Five plots, measuring 12 feet on a side, were created in 1956 at each of three sites on the Curtis Prairie of the University Arboretum. Prairie vegetation was established at the three sites in 1940, 1950, and 1956. Four plots were created in each of two oak stands, the Noe and Wingra woods. Prior to the 1840's in which decade plowing began on what was then the farm of Eliphalet Cramer, the soils of these areas were all forest soils (Gray-Brown Podzolics) similar to the Dodge silt loam of Figure 1. Although there is evidence that in the 1830's the forests were largely of the oak opening type with prairie vegetation betwen the scattred oak trees[1] (Curtis, 1951; Cottam, 1949), still the soil exhibits characteristics related to forest stands and not to prairies. The soils of the Noe and Wingra woods have never been plowed, whereas the soils of the artificial prairies were plowed repeatedly from about 1840–1926 and again at the time of establishment of the prairie stands. The brown 5- to 7-inch plow layer is still visible in the prairies, but is undergoing modification. Given sufficient time, the present vigorous prairie may be expected to produce a Brunizem soil, as the savannah of the 1830's did not. On the 23 plots the natural organic materials were manipulated, and resulting changes in nitrogen contents of the soils were measured. Manipulation included the addition or removal of plant materials above-ground. These plot treatments are described below.

It is understood that the data collected over a short period and summarized in this paper constitute a progress report.

[1] Estimates from the original Government land survey of 1835 suggest that bur and white oak trees were more or less randomly scattered over the uplands at a rate of 15–20 trees per acre. Certain large oaks over 150 years old still remain as relics of the original oak openings (Curtis, 1951).

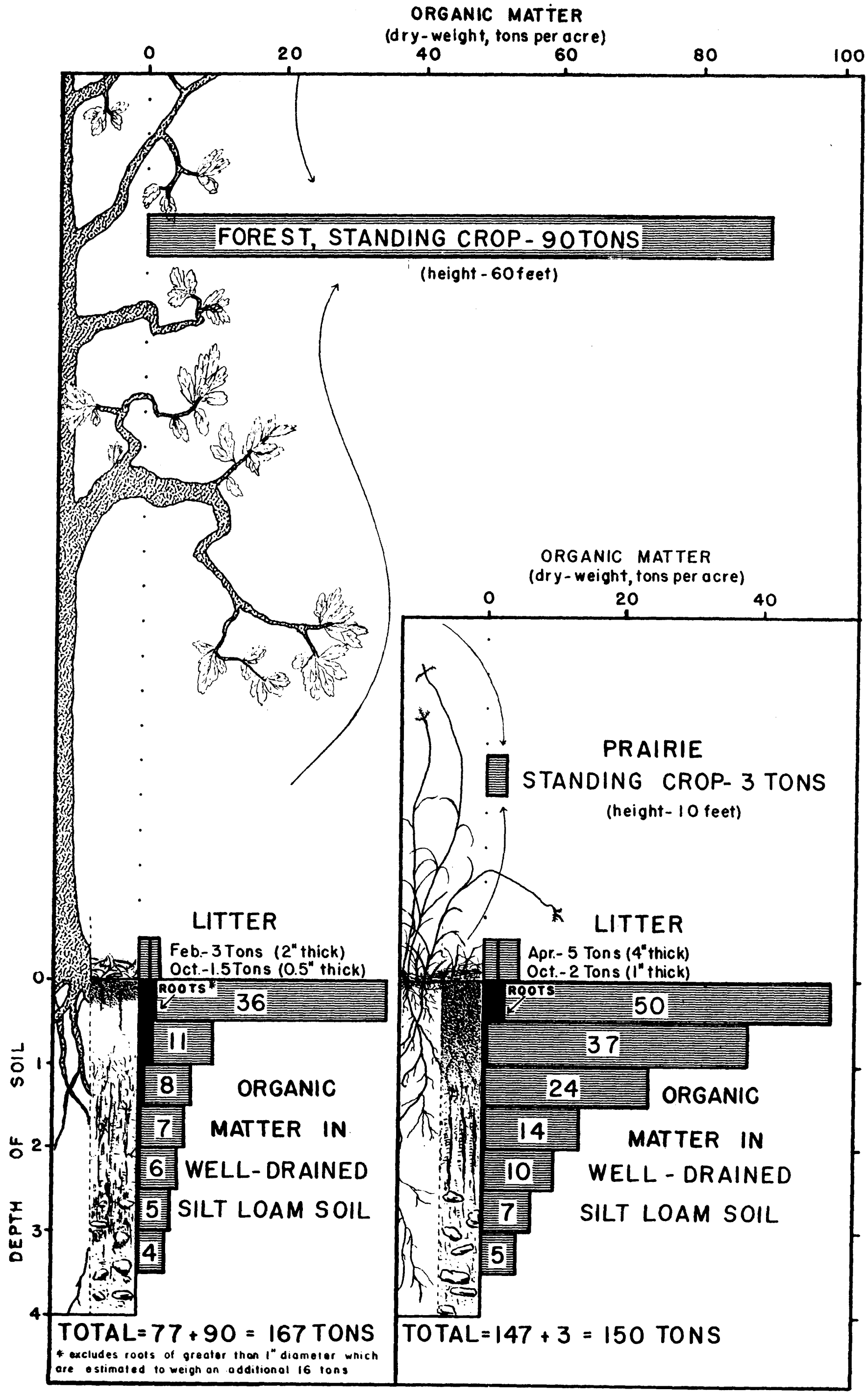
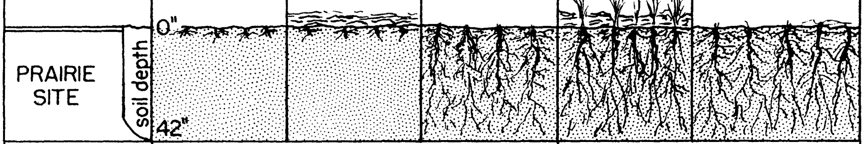


FIGURE 1. The distribution of organic matter in forest (white oak, black oak) and praire (big bluestem, Indian grass) ecosystems in south central Wisconsin: generalized presentation.

Plot Number	1	2	3	4	5
Plot Treatment	Clipped frequently	Clipped & mulched	Harvested annually	Undisturbed	Burned



	1	2	3	4	5
	Weight of Vegetation[a] (lbs/acre, oven-dried)				
1940 Prairie	1100[b]	1400[b]	4700[b]	5100[c]	6900-3800[c,d]
1950 Prairie	1800[b]	1900[b]	6800[b]	6300[c]	7600-6700[c,d]
1956 Prairie	1400[b]	1800[b]	3700[b]	5600[c]	3100-3500[c,d]
Average	1400[b]	1700[b]	5100[b]	5700[c]	5900-4700[c,d]
	Weight of Mulch[e] (lbs/acre, oven-dried)				
1940 Prairie	Trace	(4700)[f]	Trace	3000[c]	150-3000[c,d]
1950 Prairie	Trace	(6800)[f]	Trace	4900[c]	90-3400[c,d]
1956 Prairie	Trace	(3700)[f]	Trace	2500[c]	300- 350[c,d]
Average	Trace	(5100)[f]	Trace	3500[c]	180-2250[c,d]
	Depth of Mulch[g] (mm)				
1940 Prairie	6	46	10	65	5[h]
1950 Prairie	5	68	8	148	28[h]
1956 Prairie	6	30	6	69	19[h]
Average	6	48	8	94	17
	Seed stalks per Plot[i]				
1940 Prairie	0	0	465	300	830-120[d]
1950 Prairie	0	0	485	345	240[j]
1956 Prairie	0	0	305	335	243-60[d]
Average	0	0	418	327	438-90

FIGURE 2. Production of vegetation and accumulation of mulch on plots at three prairie sites in the University of Wisconsin Arboretum.

[a] Vegetation refers to above-ground organic material produced in a growing season and harvested in November, 1959, 1960, 1961.

[b] Data based on material from entire plot (16 yd^2).

[c] Data based on material from one square yard per plot.

[d] The first figure is for data obtained in the autumn after springs when the plots were burned. The second figure is for years when there was no spring burning.

[e] Mulch refers to dull brown, partially decomposed above-ground organic material remaining from previous growing seasons and measured in November, 1959, 1960, 1961.

[f] These data represent fresh harvest transferred in November from plot #3 and not weight of year-old mulch. Therefore, the data are not strictly comparable with the data from plots #4 and #5.

[g] Each figure is an average of measurements taken with a point frame apparatus at 40 points per plot in April 1961.

[h] These plots had been burned shortly before these data were taken. Variations in depth of mulch are attributable to the erratic character of burning.

[i] Average number of seed stalks of big bluestem and Indian grass as counted in August, 1960, and 1961.

[j] Average for 2 years in which plots were burned in the spring.

Investigations in the Prairies

The five treatments on the three prairie sites are shown diagrammatically at the top of Figure 2: plot #1 was kept clipped so that vegetative growth both above- and below-ground was minimal; plot #2 was likewise kept clipped, but was mulched each autumn with the total stand harvested from plot #3; plot #3 was disturbed only by removal of vegetation each autumn, as previously stated; plot #4 was undisturbed throughout; plot #5 was subjected to spring burning biennially, on the average, but was otherwise undisturbed. Corrugated galvanized iron strips, embedded about a foot in the soil and protruding 6-inches above the surface, created a vertical barrier around plots #1 and #2.

Soil sampling[2] in 1956 and 1959 in plots at prairie and forest sites was by means of an Oakfield soil sampling tube[3], and contents of total nitrogen were determined by the Kjeldahl method (Jackson, 1958; Bremner, 1960).

Production of Vegetation and Accumulation of Mulch

The field data summarized in Figure 2 indicate that production of vegetation growth on plots #1 and #2 was suppressed by clipping, although much less than anticipated. Simultaneously the composition of the vegetation changed from big bluestem *(Andropogon gerardi)*, Indian grass *(Sorghastrum nutans)* and switchgrass *(Panicum virgatum)* to quack grass, dandelion, bluegrass and other species capable of surviving severe treatment. Data for plots #3, #4 and #5 are based on material collected each November. The averages for these three plots imply that annual production of vegetation has not been greatly influenced by the different treatments during the three-year period. However, if data for the two older prairie sites are averaged, the mean annual dry weight of vegetation produced under the three treatments is 5,750 pounds on the harvested plots (#3), 5,700 pounds on the undisturbed plots (#4), and 7,250 pounds on the burned plots (#5) in the year of burning. These figures seem to substantiate the contention of some ecologists (Weaver, 1954; Curtis, 1959) that burning to remove excessive natural mulch promotes the growth of prairie vegetation. Growth on plot #5 in the two older prairies in years without burning averaged 5,250 pounds, dry weight. The 1956-prairie seeding, however, was still in the process of establishing itself in 1956–1959, and showed best growth[4] on the un-

[2] Columns of soil 42″ deep and ¾″ in diameter were taken at 15 points per plot.
[3] Description available from the Oakfield Apparatus Co. Oakfield, Wisconsin.
[4] "Best growth" refers not only to greater weights of vegetative growth, but also to the larger number of seed stalks of Indian grass and big bluestem produced in years prior to 1961. In 1960 plots 3, 4 and 5 of the 1956– prairie produced 90, 300 and 60 seed stalks respectively.

disturbed plot (#4) when a mulch was accumulating, and poorest growth where autumn harvesting (plot #3) or spring burning (plot #5) removed mulch. Robocker and Miller (1955) also found that under certain conditions burning was detrimental to the establishment of big bluestem in south central Wisconsin. The higher production of the 1950-prairie, as compared with the oldest (1940) prairie, may be attributed to the slightly more moist soil conditions and higher content of available phosphorus of the moderately-well drained Gray-Brown Podzolic soil at the 1950-prairie and 1956-prairie sites. A nearly complete cover of moss on plot #3 of the 1940 prairie may be correlated with reduced growth of prairie vegetation on that plot.

Data on numbers of seed stalks of bluestem *(Andropogon gerardi)* and Indian grass *(Sorghastrum nutans)* per plot indicate that uninterrupted accumulation of mulch, as on the undisturbed plots (#4) depressed the production of seed stalks. This is most evident on the oldest (1940) prairie, where the undisturbed plot (#4) producd 165 less stalks than the harvested plot (#3) and 530 less stalks than the burned plot (#5). The count for plot #5 of the 1950-prairie is low because switchgrass *(Panicum virgatum)* was abundant on that plot and seed stalks of that plant were not counted. The figures for the 1956-prairie plots must be interpreted in the light of the fact that the vegetation was in the process of establishing itself, as has already been mentioned. On August 29, 1958, a year when burning of the 1940-prairie did not take place, the harvested plot (#3, 1940-prairie) displayed 300 seed stalks in August, in contrast to the other near-by plots as well as the surrounding prairie, where no seed stalks of big bluestem and Indian grass were to be seen. In 1961, on both the 1950- and 1956-prairies, the grasses on the undisturbed plots (#4) in early September showed darker green leaves and delayed flowering as compared with the harvested (#3) and burned (#5) plots. These phenomena are associated with an effectively cooler and more moist soil climate than obtains in the absence of a mulch. On the same date on the oldest (1940) prairie, the grasses on the undisturbed plot (#4), as well as on the harvested plot (#3) showed slight symptoms of nitrogen and phosphorous deficiencies, whereas the vegetation of the burned plot (#5) was free of such symptoms, though lighter green than the less mature vegetation on undisturbed plots (#4) at the 1950- and 1956-prairie sites. A beneficial effect of burning on an established prairie is suggested.

Data for a wet prairie (big bluestem and Indian grass on a Humic-Gley soil) based on annual sampling from 3 quadrats, 1 square yard each, indicate an average annual production of 4,000

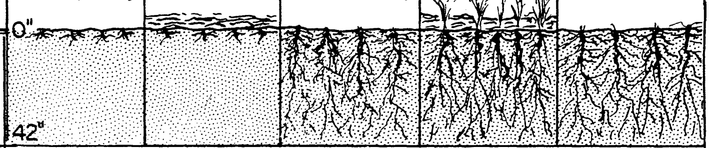
Plot Number	1	2	3	4	5
Plot Treatment	Clipped frequently	Clipped & mulched	Harvested annually	Undisturbed	Burned
SOIL DEPTH (ins)					
	Prairie Site Established in 1940				
0 to 3	1430 − 10	1390 +40	1290 +60	1320 +40	1390 +20
3 to 6	960 +100	990 − 10	860 +50	900 −60	1050 +80
6 to 15	1650 + 90	1590 +30	1380 +60	1530 −240	1920 +150
15 to 42	2340 + 90	2520 −180	2430 00	2700 −210	2520 00
0 to 42	6380 +270	6490 −120	5960 +170	6450 −470	6880 +250
	Prairie Site Established in 1950				
0 to 3	1240 + 60	1200 +120	1300 + 60	1250 + 80	1420 + 20
3 to 6	1080 − 10	1110 − 70	1160 + 30	1140 + 20	1200 + 30
6 to 15	2070 − 180	1980 − 120	2100 +240	2100 + 30	2160 +120
15 to 42	2340 −270	2520 − 180	2520 00	2250 + 90	2430+ 90
0 to 42	6730 −400	6810 −250	7080 +330	6740 +220	7210 +260
	Prairie Site Established in 1956				
0 to 3	1050 + 50	1040 +140	1070 +100	1050 +200	870 +170
3 to 6	920 − 20	930 − 70	940 + 50	1000 + 20	810 − 20
6 to 15	1710 + 60	1770 −150	1800 +120	1890 + 150	1140 +120
15 to 42	2070 +540	2070 −360	2160 + 90	2340 +270	1620+360
0 to 42	5750 +630	5810 −440	5970 +360	6280+640	4440+630
	Average for 1940, 1950, and 1956 Prairie Sites				
0 to 42	6287 + 167	6370 − 270	6337 +287	6490+130	6177 +380

FIGURE 3. Nitrogen content of soils (1 lb. per acre) in prairie plots, University of Wisconsin Arboretum, in 1956; and gains and losses of nitrogen, 1956–1959.

Note: In columns 1 through 5 the first of a pair of figures signifies pounds of nitrogen per acre in 1956, and the second figure represents the gain (+) or loss (—) of nitrogen during the period 1956–1959.

Data in this figure, as well as in figure 6, are based upon the percent total soil nitrogen as determined by a modified Kjeldahl method (Jackson, 1958). The first figure of the pair in each column was obtained by multiplying percent total nitrogen by an assigned soil density of 1,000,000 pounds per acre 3-inch layer. Thus the 0 to 3, 3 to 6, 6 to 15 and 15 to 42 inch layers of soil was given weights 1, 1, 3 and 9 million pounds per acre respectively. Soils of the type studied would in fact range from about 800,000 pounds for the top 3-inch layer to about 1,100,000 pounds for a 3-inch layer near the bottom of the profile, because their bulk densities range approximately from 1.2 in the top 6 inches to 1.7 at a 42 inch depth (Shields, 1955). Assignment of the same bulk density to the same bulk density to the entire soil profile introduces slight errors in the figures showing total weight of soil nitrogen. However, it has little effect on figures showing changes in content of nitrogen.

The second figure of the pair in each column of this figure, as well as of figure 6, was obtained by subtracting pounds of nitrogen in 1956 from a similar figure (not given) based on the soil samples collected in 1959.

Each figure of the 0 to 3 inch and 3 to 6 inch layers is an average of duplicate analyses of soil samples taken at three diffrent soil depths, whereas the 6 to 15 inch and 15 to 42 inch layers represent duplicate analyses of samples taken at four different depths within each of the two zones indicated (Fig. 4).

The average deviation from the mean for all duplicate analyses was 0.0015 percent nitrogen. This is equivalent to about 15 pounds of nitrogen per arce 3-inch layer of soil.

lbs per acre of above-ground prairie vegetation. This area, like that of the entire mesic prairie is burned annually or biennially.

Gains and Losses of Soil Nitrogen, 1956–1959. The data presented in Figure 3 record the status in 1956 of the soils of the prairie plots in terms of total nitrogen. The significance of the figures for gains and losses of nitrogen during the short period, 1956–1959 is as yet unclear. Future studies can be expected to show to what extent the gains and losses represent actual changes in soils, on the one hand, and experimental errors in sampling and analysis, on the other. However, the present data suggest the following trends. (1) The effect of tillage in lowering soil nitrogen content (from M.F. to C.F., Figure 8) is being erased by the increase in soil nitrogen which is occurring under prairie vegetation

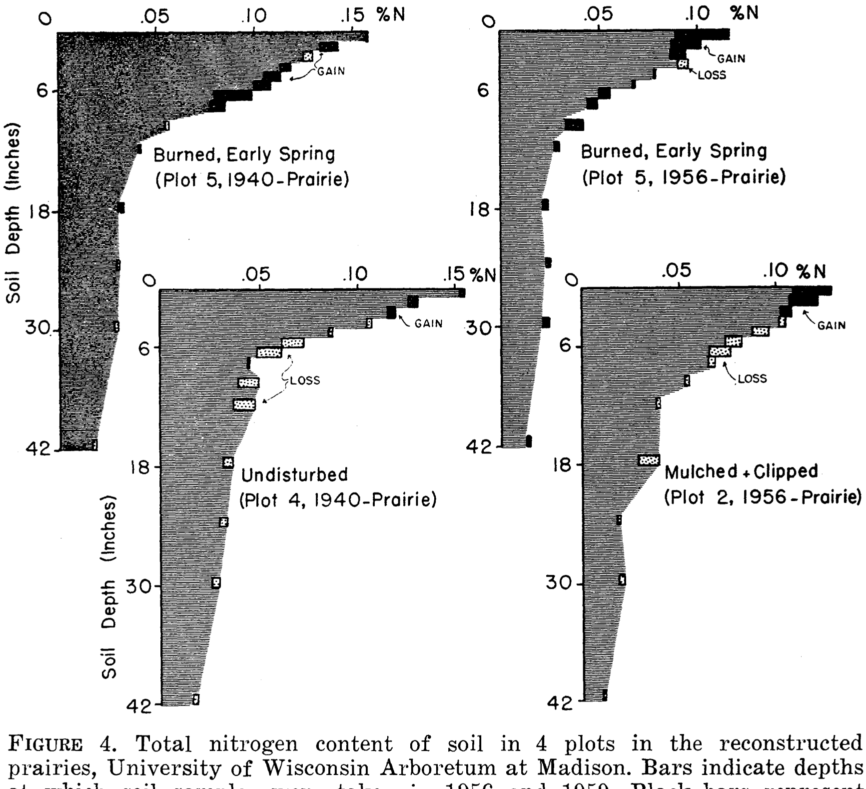


FIGURE 4. Total nitrogen content of soil in 4 plots in the reconstructed prairies, University of Wisconsin Arboretum at Madison. Bars indicate depths at which soil samples were taken in 1956 and 1959. Black bars represent gains in total soil nitrogen over the 3-year period. Dotted bars represent losses in nitrogen during the same period. Burning of plot #5 took place in late April of 1957 and 1959 on the prairie established in 1940, and in late April, 1958 at the prairie planted in 1956. Plot #2 of the 1956 prairie received each autumn the harvested prairie stand from an adjacent plot. Vegetation on plot #2 was kept clipped throughout each growing season. Plot #4 of the prairie which was established in 1940 was not clipped, harvested nor burned.

(from C.F. to Y.P. in Figure 8). This trend is further illustrated in Figure 4, plots #2 and #5 of the 1956-prairie which show a 3-year loss of nitrogen at a depth of 4 inches, and a gain above that. (2) The removal of mulch from soil has promoted increases in soil nitrogen. This is evident in the burned plots (#5) where soil profiles showed an average 3-year gain of 380 pounds of nitrogen per acre, and in the harvested plots (#3), where the gain in nitrogen averaged 287 pounds. Smaller gains or outright losses occurred under natural (plots #4) and artificial (plots #2) mulches. (3) The soils at the three prairie sites of the University Arboretum are in early stages of development with respect to nitrogen content, and are far from the steady state of mature prairie or Brunizem soil (Figures 1 and 8). Fourteen of the fifteen prairie plots gained nitrogen in the upper 3 inches of soil. Plots number 3, 4, and 5 in the 3-year-old (1956) prairie gained twice as much nitrogen in the upper 6 inches of soil, as well as in the entire profile, as did the soil at the 19-year-old (1940) prairie site.

Investigations in the Forest

The four treatments at two wooded sites are shown diagramatically at the top of Figure 5. Plot #1 was stripped of 6 inches of topsoil (A_1 and A_2) and refilled with yellowish subsoil (upper B horizon material) containing much less organic matter. Since this treatment in 1956, natural forest litter has been allowed to accumulate on this plot. Plot #2 was kept free of leaves and other litter that fell onto the surface of the A horizon. Plot #3 received a double application of litter each year. Plot #4 was left undisturbed.

The approximate weight and composition of litter received on the forest soil plots is presented in the body and footnotes of Figure 5. The litter that fell by November each year on forest plots #1 and #4 averaged 4600 pounds (oven-dry weight) per acre. This included branches and other woody materials with an equivalent diameter of less than ¾ inch.

Studies in Noe Woods of the monthly changes (Oct. 1960–Dec. 1961) in weight, depth and composition of litter have shown: 1) the total weight of litter on the forest floor to increase from a low of 2700 pounds per acre (35% leaves, 65% woody material) on October 1, 1960 to a maximum of 6300 pounds (58% leaves, 42% woody material) on April 7, 1961. 2) The depth of litter ranged from 18 mm on October 3, 1960 to 48 mm on December 3, 1960. 3) Observations at 80 points per month using a vertical point-frame with 1/16th-inch diameter rods indicated that on October 1, 1960 leaves appeared on only 46 percent of the forest floor area while wood and bare soil were exposed at 22 percent and 32 percent of the area respectively. On February 11, 1961 leaves constituted 98 percent and wood 2 percent of the exposed surface of the forest floor.

The litter depth data in Figure 5 indicate the relative amounts of litter remaining on the Noe Woods plot on October 3, 1961. A litter depth of 24 mm on the undisturbed plot #4 agrees exactly with the litter depth obtained on October 12th by measuring at 80 points along a 640-foot transect in Noe Woods. The litter depth for plots #3 and #4 measured the same on October 3 (Figure 5). This suggests that decomposers have in one years time reduced the double amount of litter on plot #3 to about the same as that on plot #4. Field observations of the A_{oo} horizons on these plots substantiate this conclusion as does the larger population of earthworm *(Lumbricus terrestris)* middens[5] and the greater weights of earthworm casts[6] deposited on the plot receiving a double amount of litter. Field observations also indicate that the low figure (15mm) for litter depth on plot #1 (Figure 5) results from the removal of leaf litter by agents of erosion. Litter remaining on the plot was concentrated in the vicinity of *Lumbricus terrestris* middens (Nielsen and Hole, 1964). Between middens there was a smooth and rather hard soil surface with few castings or plants to stabilize the litter.

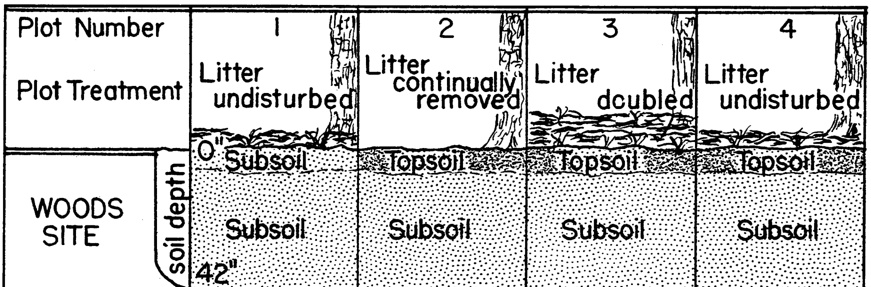
Data for a 30-year-old pine *(Pinus strobus* and *Pinus resinosa)* plantation on formerly plowed Dodge silt loam soil, showed an average production since 1955 of 3300 (range 2800 to 3700) pounds (oven-dry weight) of little per acre per year. The litter consisted of 92 percent needles, 5 percent cones and 3 percent twigs. The weight of the L (upper litter) and F (fermenting) horizons or total "litter" accumulated on the forest floor averaged 10,700 (range 7200–12,400) pounds per acre and contained 90 percent needles, 6 percent cones and 4 percent twigs. Earthworms continued to mix these organic materials with the underlying mineral soil. This apparently explains the absence of a H (humus) layer below the F layer.

Gains and Losses of Soil Nitrogen, 1956–1959. The data presented in Figure 6 record the status in 1956 of the forest soil plots

[5] The number of middens of *Lumbricus terrestris* in duplicate four-square-foot quadrats on soil plots in Noe Woods on June 23, 1962 were as follows: plot #2 (litter continually removed) 5,5; plot #1 (topsoil removed, litter undisturbed) 14, 18; plot #3 (litter doubled) 26, 30; plot #4 (litter undisturbed) 13, 16; middens counted had burrow openings at least ¼th inch in diameter.

[6] Weight (oven-dry) of casts collected 7 times between April 8 and October 3, 1961 from 3 by 20.9 inch (10^{-5} acre) staked quadrats in the Noe and Wingra Woods soil plots was as follows: for plots #1, #2, #3 and #4 the weights were 62.2, 48.8, 149.9 and 112.3 grams per quadrat or 6.8, 5.4, 16.5 and 12.7 tons per acre respectively. The average range of duplicates was 15.5 gm or 1.7 tons per acre.

in terms of total nitrogen. The figures for gains and losses of nitrogen during the period 1956–1959 suggest the following trends. 1) A new A-horizon is being formed on plot #1 of the wooded sites. The top 6-inch layer of plot #1 is the Noe Woods gained 250 pounds of nitrogen per acre after receiving a natural supply of litter for 3 years (Figure 6). This 30 percent increase in soil nitrogen is illustrated in Figure 7. At this rate of nitrogen accumulation on this plot a period of 30 to 40 years would be necessary for the nitrogen content of the new A-horizon to reach the level of that of A-horizon (0″ to 6″) in surrounding undisturbed forest



	Average Weight of Litter[a] (lbs/acre) Received each November, 1957–1961			
Noe Woods	5500[b,c]	Trace	11000[b]	5500[b,c]
Wingra W'ds	3800[d,e]	Trace	7600[d]	3800[d,e]
Average	4600	Trace	9200	4600
	Depth of Litter[f] (mm), October 3, 1961			
Noe Woods	15	1	24	24

FIGURE 5. Weight, depth and composition of natural litter on forest soil plots of the University of Wisconsin Arboretum.

[a] Natural litter includes leaves and acorns as well as woody materials with an equivalent diameter of less than ¾ inch.

The weight of forest litter falling on the surface of plots #1 and #4 is based upon the oven-dry weight of litter that falls each year on triplicate square yard collecting screens located near the plots.

[b] The litter is predominantly from white oak *(Quercus alba)* and black oak *(Quercus velutina)*. The average composition of the litter was 75% leaves, 15% twigs, 9% bark and 0.3% acorns and cups.

[c] This figure represents a range from 4300 pounds per acre in 1957 to 5900 pounds in 1961.

[d] The litter is predominantly from red oak *(Quercus borealis)*. The average composition of the litter was 69% leaves, 11% twigs, 3% bark and 17% acorns and cups.

[e] This figure represents a range from 3300 pounds per acre (6% acorns) in 1960 to a high of 4400 pounds (29% acorns) in 1958.

[f] Depths measured at 40 points per plot with a point frame apparatus.

Plot Number	1	2	3	4
Plot Treatment	Litter undisturbed	Litter continually removed	Litter doubled	Litter undisturbed
SOIL DEPTH (ins)	0" Subsoil / Subsoil / 42"	Topsoil / Subsoil	Topsoil / Subsoil	Topsoil / Subsoil
		Noe Woods		
0 to 3	370 + 130	2430 − 280	2470 + 220	2600
3 to 6	490 + 120	920 + 30	880 + 350	1010
6 to 15	1710 00	1680 − 120	1680 + 120	1620
15 to 42	2880 − 360	2700 − 180	2610 00	2700
0 to 42	5450 − 110	7730 − 550	7640 + 690	7930
		Wingra Woods		
0 to 3	400 + 40	2090 − 60	2180 + 320	2130
3 to 6	550 − 70	810 − 110	690 + 70	750
6 to 15	1530 − 210	1500 − 120	1500 − 210	1280
15 to 42	2970 − 90	3420 − 360	2880 − 180	3240
0 to 42	5450 − 330	7820 − 650	7250 00	7400
		Average		
0 to 42	5450 − 220	7775 − 600	7445 + 345	7665

FIGURE 6. Nitrogen content of forest plots (lbs. per acre), University of Wisconsin Arboretum in 1956 and gains and losses of nitrogen, 1956–1959. In columns 1 to 3 the first of a pair of figures is pounds of nitrogen per acre in 1956 and the second figure is the gain (+) or loss (—) of nitrogen during the period 1956–1959. Data in column 4 are for 1959 only. (See footnote to Figure 3.)

soils. 2) The systematic removal of forest litter for 3 years resulted in a loss of 250 pounds per acre of nitrogen in the top 6-inches of plot #3. This 7 percent decrease is illustrated in Figure 7. 3) Doubling the application of litter caused the top 6-inch of soil in plot #3 to gain 570 pounds of nitrogen per acre. This 14 percent increase is illustrated in Figure 7.

SUMMARY

This progress report on a continuing study in the University of Wisconsin Arboretum of factors affecting the incorporation of organic matter into soils under natural vegetation documents the

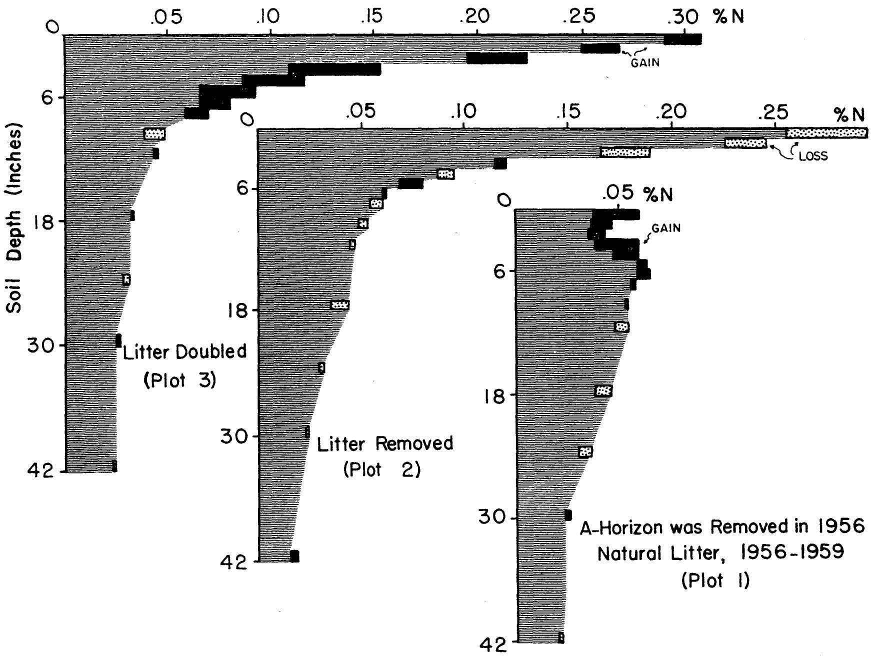


FIGURE 7. Total nitrogen content of soil in 3 plots in the Noe Woods, University of Wisconsin Arboretum at Madison. Bars indicate depths at which soil samples were taken in 1956 and 1959. Black bars represent gains in total soil nitrogen over the 3-year period. Dotted bars represent losses in nitrogen during the same period. In plot #1 B^1-horizon material was substituted for the A-horizon removed in 1956.

major contrast between soils of deciduous forests and soils of prairies. Storage of organic matter is largely above-ground at forest sites studied and largely under-ground at the prairie sites (Figure 1). The accumulation of above-ground parts of prairie plants as a mulch on the soil not only suppresses the vigorous growth of the prairie vegetation but may be of little benefit as a source of soil organic matter. Over a period of about 90 years (1840's to 1930's) under agricultural management, the forest soil studied lost about 20 tons of organic matter or 26 percent of the total organic matter in the undisturbed forest soil (Figure 8). Within a period of 19 years (1940 to 1959) under planted prairie vegetation the soil has regained about 12 tons of organic matter, or 60 percent of that lost under agricultural management (Figure 8). The abrupt lower boundary of the plow layer has been partially erased. The greatest changes in three years (1956–1959) in the organic matter content of the soils studied were associated with earthworm activity in forest soil plots. A plot receiving twice the normal weight of forest litter for 3 years gained in the 0″ to 6″ soil layer 570 pounds of nitrogen, or about 5½ ton of organic matter per acre. Investigation is being continued of the sources of soil organic matter and the processes and rates of incorporation of it into soil.

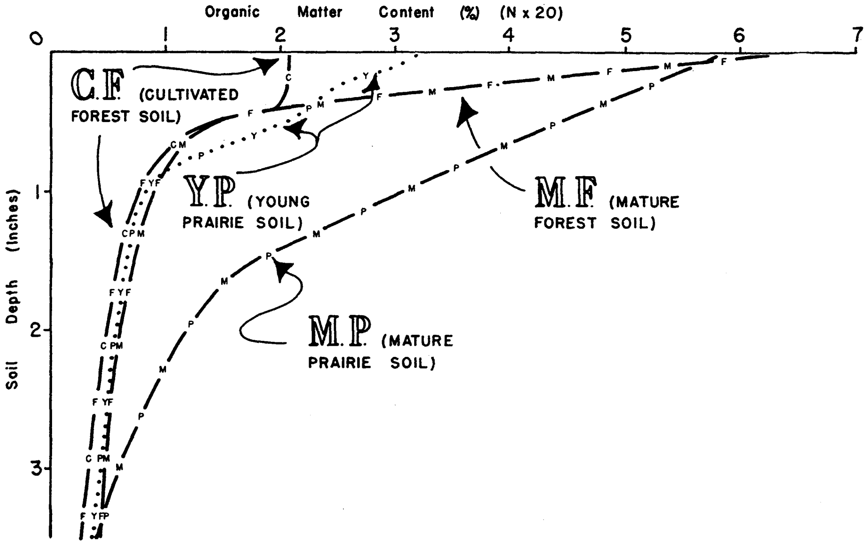


FIGURE 8. Distribution of organic matter in a mature forest soil (Noe Woods), a forest soil cropped for about 90 years (1956 prairie site), a cropped forest soil under prairie vegetation for 19 years (1940 prairie site) and a mature prairie soil (generalized from data of Shields, 1955 and Simonson, *et al*, 1952).

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NOTES ON WISCONSIN PARASITIC FUNGI, XXIX

H. C. Greene

This series of notes is based in large part on observations made on phanerogamic specimens in the Wisconsin section of the University of Wisconsin Herbarium. As a result of the activity of Professor H. H. Iltis and his students a great many new Wisconsin specimens have been added to our herbarium in the past eight years. Many of these have yielded new records of parasites, but older specimens have also been examined, with similar results. In some cases adequate material has been available for a separate fungus specimen, but in other instances where this has not been possible "(U. W. Phan.)" is appended to the record. Also included are notes on specimens collected in the season of 1962.

The following undetermined powdery mildews have been noted on hosts not previously reported as bearing these fungi in Wisconsin: 1) On *Brassica nigra*. Sauk Co., near Sauk City, September 1961. Coll. O. Glaeser; 2) Associated with pycnia of *Gymnoconia peckiana* on *Rubus occidentalis*. Dane Co., near Cross Plains, May 23, 1962; 3) On *Taraxacum erythrospermum*. Dane Co., Madison, June 5, 1962; 4) On *Sedum purpureum*. Dane Co., Madison, August 8, 1962.

ERYSIPHE GRAMINIS DC., in its conidial stage, occurs very commonly on *Poa pratensis* in Wisconsin. In the course of a long collecting career the writer has examined hundreds of such infections without observing even incipient formation of cleistothecia until collecting them in abundance on this host at a station near Cross Plains, Dane Co., June 19, 1962. As indicated by specimens in the Wisconsin Cryptogamic Herbarium, development of cleistothecia on *Poa pratensis* is probably not uncommon in northwestern America, but it is certainly most unusual in Wisconsin.

MYCOSPHAERELLA sp. occurs on dead tips of plants of *Eleocharis palustris* collected at Madison, June 25, 1962. The lower portions of the plants are still green. The perithecia are black, gregarious, lenticular, approx. 100–115 in long diam. The asci are broadly clavate, about 37–40 x 14–15 μ. The ascospores are somewhat variable, subfusoid, subcylindric, or slightly falcate, subhyaline with a faint greenish tinge, 21–24 x 3.5–4.5 μ. They are borne in a compact group in the stout ascus, usually not completely filling the upper ascus. Possibly parasitic.

MYCOSPHAERELLA sp. is present on overwintered leaves of *Cornus canadensis,* collected by H. H. Iltis, June 14, 1959, near Porcupine Lake, Florence Co. It seems possible this is connected with *Septoria canadensis Peck.* The latter is quite common on this host in Wisconsin and the spots are similar. The perithecia are black, closely gregarious, subglobose, approx. 200–250 μ diam. The asci are slender-cylindric to subfusoid, 35–42 x 6–7 μ. The ascospores have a pallid greenish tint, are subfusoid, mostly biseriately arranged, and with the septum not median, but toward the base of the spore, about ¼ to ⅓ of the distance to the apex, approx. 11–12.5 x 3.5–4 μ.

MYCOSPHAERELLA sp. occurs in profusion on the overwintered basal leaves of *Pentstemon gracilis* var. *wisconsinensis,* collected by J. Patman near Neshkoro, Marquette Co., June 14, 1959. The entire leaf surface is black from the closely crowded, globose perithecia, which are about 100 μ diam., with numerous curved—obclavate asci, 27–30 x 8–9 μ. It seems likely this is connected with *Septoria pentstemonicola* Ell. & Ev. which is very common on this host. The Wisconsin collection does not seem to bear any reation to *Mycosphaerella pentstemonis* Earle, collected on dead stems of *Pentstemon* in Colorado.

MYCOSPHAERELLA sp. was found consistently on *Galium concinnum* on rounded, translucent lesions of the type usually associated with so-called *Phyllosticta decidua* Ell. & Kell., in a specimen collected near Verona, Dane Co., June 21, 1962. The perithecia, one or two per lesion, are black, thick-walled, subglobose, approx. 125–140 μ diam., the asci cylindric to subclavate, slightly curved and short-pedicellate, about 30–35 x 6–8 μ, the ascospores hyaline, broadly fusoid and noticeably constricted at the median septum, approx. 12–13 x 3.5 μ. As in other specimens of this general type one suspects primary insect action in the formation of the lesions, yet the absence of frass and other signs of such activity leave the matter open to doubt.

LEPTOSPHAERIA sp. is present with considerable regularity on lower leaves of specimens of *Agrostis perennans* in the Wisconsin Herbarium. Such leaves are usually, but not always, brown and dead. A specimen collected near Hatfield, Jackson Co., August 23, 1940 (L. H. Shinners 2676), has mature perithecia on leaves which are, in the main, still green, indicating possible parasitism. The perithecia are brownish, thin-walled, broadly oval in outline and somewhat flattened, approx. 115–125 μ diam. The asci are cylindric, 46–48.5 x 7.5–8 μ, the ascospores greenish olivaceous, slender falcate-fusoid, 5 septate, about 20 x 3 μ.

MELANNOMA sp. occurs in an uncertain relationship to the host on hairy branchlets of *Hudsonia tomentosa,* collected by J. Patman near Prescott, Pierce Co., June 28, 1959. The superficial, black, subconic perithecia, approx. 225–300 μ diam., are scattered and firmly nested within the tomentum, appearing confined to the previous season's growth. The large asci are curved-clavate with a short pedicel, approx. 125–135 x 25–28 μ, the ascospores broadly fusoid, 3 septate and olivaceous with the two central cells of a slightly deeper tint, 35–38 x 13–15 μ.

OPHIOBOLUS INSTABILIS Ell. & Ev. on *Artemisia biennis* was described from material collected by J. J. Davis at Racine, Wis. in 1897. The type specimen has withered leaves which appear frostbitten. This same fungus has been noted on several recent Wisconsin collections of *A. biennis* where, except for the infected leaves, the hosts are still green, indicating that the fungus may be a parasite.

PSEUDOPEZIZA SALICIS (Tul.) Pat. *(Drepanopeziza salicis* (Tul.) Hoehn.), the perfect stage of *Gloeosporium salicis* West. *(Monostichella salicis* (West.) v. Arx.), was collected on overwintered leaves of *Salix* (probably *S. fragilis)* at Madison in June 1962 by A. Nelson.

PUCCINIA CORONATA Cda. is the only rust recorded up to now on *Schizachne purpurascens* in Wisconsin. However, several specimens of this grass, particularly one collected by N. C. Fassett at Ontario, Vernon Co., June 14, 1936, bear mature uredia whose spores have dimensions markedly smaller than those ascribed to *P. coronata,* leading to the supposition that they are the spores of *P. recondita,* but no positive record can be made since telia are not present.

PUCCINIA sp. ii, III is present in small amount on *Oryzopsis pungens* collected by N. C. Fassett at Necedah, Juneau Co., May 22, 1932. It is difficult to say whether the leaf on which the rust occurs was produced in 1932 or the season before, but it looks quite fresh and green. The few urediospores observed were broadly obovate to globoid, 28–30 x 22–27 μ, the wall slightly yellowish, about 2.5 μ thick, echinulate, with 3–4 equatorial pores. The teliospores are golden yellow throughout, rather variable in shape, from obovate to narrowly clavate, or almost cylindric, and from almost no constriction to moderately constricted between the cells, tip subobtuse to almost acuminate, wall 1.5–2 μ thick at sides, 5–7 μ above, pedicel not collapsed, about as long as spore and tinted near it. A good many of the teliospores have germinated, which would seem to indicate previous season's origin for the host leaf. Uredia of another rust occur on an old specimen of *O. pungens* collected by G.

Roden near Appleton, Outagamie Co., in May 1890. The sori are aparaphysate, the spores obovate to narrowly obovate or ellipsoid, the best developed about 22–25 x 16–18 μ. the wall yellowish, about 1.5 μ thick, finely echinulate(with smooth areas on some spores, pores obscure. No rusts are listed on this host in Arthur's Manual.

PUCCINIA ASPARAGI DC. I has been reported in the phytopathological literature as occurring on *Allium cepa* var. *viviparum* in Wisconsin, but there have been no specimens in our herbarium until a profuse infection on this host was discovered July 4, 1962 by H. M. Clarke on his property near Cross Plains, Dane Co. According to Arthur only the aecial stage has been collected on *Allium* in nature.

Isopyrum biternatum has had no rust recorded as occurring on it in Wisconsin, but in a collection made near Leland, Sauk Co., June 2, 1962, there are pycnia, but no aecia, of a rust which it seems very likely is *Puccinia recondita* Rob. ex Desm.

PHYLLOSTICTA GROSSULARIAE Sacc. has been reported on *Ribes sativum (R. vulgare)* in Wisconsin and such specimens as are in the Wisconsin Herbarium have well-defined, margined spots. In a collection on this host, made July 25, 1962 at Madison, the spots are immarginate, dingy brown, broadly oval, about 1.5 cm. long. Microscopically the specimen, with conidia about 5–7 x 3 μ, corresponds well with the description of *P. grossulariae* and has been so named.

PHYLLOSTICTA NUMEROSPORA H. C. Greene (Amer. Midl. Nat. 50: 506. 1953) on *Potentila argentea* has up till now been noted only on the type from Madison, but it has recently been detected on phanerogamic specimens collected in various counties, including Columbia, Grant, Marinette, Rock, Sauk and Waupaca.

PHYLLOSTICTAE indet. have been noted on a number of hosts and are reported on collectively, as follows: 1) On *Sparganium eurycarpum* coll. by H. C. Wilson near Johnson Creek, Jefferson Co., August 23, 1961. Leaf lesions are elongate, marginal, dull yellowish brown with narrow darker border, the black pycnidia innnate and, conforming to the narrow band of tissue available for their development, markedly flattened, approx. 150–175 μ diam., and scattered. The conidia are hyaline and globoid, 10–11 x 11.5–12.5 μ, with granular contents and a smooth wall about 1 μ thick. The general macroscopic aspect is very similar to that of *Stagonospora sparganii* (Fckl.) Sacc., except that in that species the pycnidia are even more deeply sunken and inconspicuous; 2) On *Sparganium chlorocarpum* coll. by W. A. Skroch near Babcock, Wood Co., June 26, 1961. Pycnidia are on brownish, but current season's, basal leaves. Pycnidia themselves are light brown, gregarious, thin-walled, somewhat flattened, about 100–115 μ diam., with a prominent ostiole. Conidia are cylindric, hyaline, mostly biguttulate, but with no evidence of septation, 7–10 x 2.5–3 μ. What appears to be the same fungus is present on a leaf of *Sparganium americanum,* coll. by J. J. Davis at Spring Green, Sauk Co., July 14, 1921; 3) In small amount on sharply defined, elongate, dark bordered, pallid tan lesions on *Aristida intermedia* coll. by T. G. Hartley in the Camp McCoy area, Monroe Co., August 19, 1956. The pycnidia are brownish, flattened, subellipsoid, approx. 75 μ in longest dimension, with prominent ostiole, the conidia hyaline, rod-shaped, of the micro- type, 4–5 x 1–1.3 μ. A very similar *Phyllosticta* has been noted on a specimen of the adventive *Bouteloua gracilis,* coll. by O. Anderson and H. C. Greene near Black Earth, Dane Co., August 1, 1950; 4) On cinereous dead areas on leaves of *Agropyron repens* coll. at Madison, June 28, 1962, where the pycnidia are pallid brownish, thin-walled, about 115–125 μ diam., the conidia hyaline, short cylindric, approx. 4–5 x 1.5–2 μ. Perhaps a microsporous stage, but the spores are somewhat wider than is usual in such forms; 5) On *Silene dichotoma,* coll. near Harrisville, Marquette Co., August 15, 1960. The conidia are up to 10 x 3.5, outside the range of *Phyllosticta nebulosa* Sacc., reported on this host in Wisconsin, and approach *P. silenes* Peck where they are 10–12.5 x 3.5–5 μ; 6) On *Astragalus canadensis* coll. by G. Struik near Juda, Green Co., August 8, 1956. The pallid-brownish pycnidia are epiphyllous and zonate, about 125–150 μ diam., with hyaline, subcylindric conidia 5–7 x 2–2.5(–3) μ. Evidently very similar to, and perhaps identical with, a fungus reported on this host by J. J. Davis (Trans. Wis. Acad. Sci. Arts Lett. 19(2) : 686. 1919). Davis considered his fungus as possibly identical with *Gloeosporium davisii* Ell. & Ev. which was described from a specimen coll. in Wisconsin on pods of *Vicia americana,* but stated that he had filed the specimen provisionally under the name *Gloeosporium astragali.* There is currently no specimen in the Wisconsin Cryptogamic Herbarium under this name, nor is there any specimen on *Astragalus* filed under *G. davisii.* In his revision of *Gloeosporium* von Arx states, and I think correctly, that *G. davisii* is sphaeropsidaceous and names it *Dothiorella davisii* (Ell. & Ev.) von Arx. This fungus, however, has conidia distinctly larger than either of the specimens on *Astragalus;* 7) On rounded tan spots, 4–5 mm. diam., with narrow darker border, on *Acer saccharum* coll. near Browntown, Green Co., June 13, 1962. The light brown pycnidia are subglobose, approx. 100–175 μ diam., the hyaline conidia 5–6 x 1.8–3 μ Similar to an undetermined *Phyllosticta* on *Acer rubrum,* reported on in my Notes 24. (Trans. Wis. Acad. Sci. Arts Lett. 47: 102. 1958); 8) On *Impatiens balsamina* (cult.) coll. at Madison, August 27,

1962. The well-marked spots are rounded and cinereous, with brownish margins, about .3–.5 cm. diam. The globose, blackish pycnidia are epiphyllous and gregarious, about 125–225 μ diam., with a prominent ostiole marked by a ring of darker cells. The hyaline conidia are rod-shaped, biguttulate, approx. 4–6.5 x 1.3–1.5 μ. This is evidently not *P. balsaminae* Vogl., said to have conidia 7 x 2.5 μ and smaller pycnidia. Seemingly, no satisfactory description of *P. impatientis* Fautr. *(Depazea impatientis* Kirchn.) exists and I have been unable to locate any specimens so labeled for study; 9) On *Galium aparine* coll. June 5, 1962 near Verona, Dane Co. On sordid brownish immarginate areas, usually on only one leaf of a whorl. The pycnidia are few, scattered, pallid brownish, subglobose, prominently ostiolate, approx. 125–140 μ diam., conidia hyaline, cylindric, straight or slightly curved, 7–11 x 2.5–3 μ. This fungus has somewhat the aspect of an *Ascochyta,* but none of the apparently well-matured conidia are septate, so far as observed; 10) On *Galium triflorum,* coll. at the same time and place as 9), there is a similar, possibly identical *Phyllosticta.* The rounded, reddish-brown spots with narrow, dark margins are much more sharply defined than those on *G. aparine,* but the pycnidia are about the same. The conidia, however, are 5–8 x 1.8–2.5 μ; 11) On sordid brownish to blackish, indefinite, but rather extensive areas involving the tips of leaves of *Galium circaezans* coll. June 21, 1962 near Verona, Dane Co., in the same general location as 9) and 10). The thin-walled, flattened pycnidia are pallid brownish, approx. 90–125 μ diam., the conidia hyaline, narrow-cylindric, (4–)5–6(–7) x 1.3–1.7(–2) μ; 12) In an uncertain relationship on the cinereous upper side of lesions caused primarily by the microcyclic *Puccinia silphii* Schw. on *Silphium perfoliatum* coll. near Leland, Sauk Co., July 21, 1962. The pycnidia are black when viewed with a hand lens, but translucent and merely sooty under high magnification, globose, with a ring of darker cells delimiting the rather wide ostiole, and are approx. 165–200 μ diam. The hyaline conidia are narrowly cylindric to narrowly subfusoid, straight or slightly curved, often biguttulate, (5.5–)6.5–7.5(–10) x 1.5–2(–2.5) μ. Two of the eight pycnidia examined also contained some globose conidia, about 9–10 μ diam., but the cylindric type seem characteristic; 13) On *Aster sagittifolius* coll. near Verona, Dane Co., July 25, 1962. The suborbicular, sordid brownish spots are about 1 cm. diam., the pycnidia deeply immersed, thin-walled, pale yellowish brown, approx. 90–110 μ diam., the conidia hyaline, short-cylindric, 5–7.5 x 2.5–3 μ. Quite different from a *Phyllosticta* on the same host mentioned in my Notes 28.

PHOMA sp. occurs on stems of *Paronychia fastigiata* from Somerfield Island, Buffalo Co., collected August 27, 1926 by N. C. Fassett. In my Notes 20 (Trans. Wis. Acad. Sci. Arts Lett. 43: 167. 1954) I informally described this same fungus on *Paronychia canadensis*. Discovery of it on *P. fastigiata* would seem to indicate that it is probably a characteristic parasite of *Paronychia*. Neither specimen in hand is ample for formal description.

PHOMA sp. infects stems and leaves of a specimen of *Spergularia rubra*, collected by H. H. Iltis (13704) in the State Forest Nursery at Trout Lake, Vilas Co., June 16, 1959. Since the affected parts have been killed back, parasitism is uncertain. The closely gregarious pycnidia are dark brown, subglobose, prominently ostiolate, about 75–100 μ diam. Conidia are hyaline, ellipsoid to broadly ellipsoid, or occasionally subfusoid, 4–5(–6) x 1.8–2.7 μ.

PHOMA sp. is present in small amount on stems of *Talinum rugospermum*, collected near Newark, Rock Co., July 18, 1957 (E. W. Fell 57–774). The flattened brown pycnidia are about 75 μ diam., the hyaline, elongate-fusoid conidia 13–17 x 4–5.5 μ, without any indication of incipient septation. Perhaps parasitic.

PHOMA (?) sp. occurs in profusion on the stem of an old specimen of *Portulaca oleracea*, collected at Poynette, Columbia Co., July 10, 1886 by H. L. Russell. The pycnidia are jet black and large, approx. 200–250 μ diam. and closely gregarious. The hyaline conidia are broadly ellipsoid and large, 17–19 x 11–13(–14) μ. The general aspect of this fungus and the size and shape of the conidia suggest that it is perhaps an immature *Sphaeropsis*, but whatever its taxonomic niche, there seems little doubt it was strongly parasitic. *Phoma stigma* Cke. & Hark., described on *P. oleracea*, has minute pycnidia and conidia 6 x 3 μ.

MACROPHOMA spp. are occasionally noted on senescent or dead lower leaves of various grasses. One such has been studied on a specimen of *Bouteloua curtipendula*, collected by L. H. Shinners at Elkhart Lake, Sheboygan Co., September 2, 1940. The innate, subglobose, black pycnidia are about 175 μ diam., the large, elongate, subfusoid, hyaline conidia approx. 21–25 x 7–8 μ. What appears to be the same fungus occurs on *Agrostis scabra*, collected by Shinners at Spooner, Washburn Co., July 7, 1942. Sprague notes a number of species of *Macrophoma* on Gramineae, but considers them to be at most weakly parasitic.

PHOMOPSIS DIACHENII Sacc. has been noted occasionally on leaves and fruits of *Pastinaca sativa* in Wisconsin, but has appeared to be at most a mild parasite. In 1962, however, numerous plants of this weed in the University of Wisconsin Arboretum at Madison were killed back by profuse development of *P. diachenii* on the upper stems.

PHOMOPSIS sp. occurs on *Phyllosticta decidua*-type lesions on *Solidago canadensis,* collected at Madison, July 26, 1962. The fuscous pycnidia are approx. 140–160 μ diam., the *Phoma*-type conidia hyaline, fusoid, 7.5–9 x 2.7–4 μ, the scolecospores hyaline, from straight to strongly curved, subobtuse, 8–10 x 1.2–1.5 μ Possibly parasitic.

ASCOCHYTA sp. on dead lower leaves of a specimen of *Agrostis stolonifera* collected by N. C. Fassett at Marquette, Green Lake Co., September 18, 1929, does not correspond in spore dimensions with any of the species mentioned by Sprague in his "Diseases of Cereals and Grasses in North America". The black pycnidia are 85–110 μ diam., the hyaline conidia 7–9 x 2.5–3.5 μ.

ASCOCHYTA sp., which may be referable to *A. utahensis* Sprague, occurs on the dead lower leaves of the current season's culms of *Agropyron smithii,* collected by L. H. Shinners near Granville, Milwaukee Co., June 26, 1940. Sprague found this fungus on *Agropyron inerme* and *A. trachycaulum* in the Rocky Mountain region. He states *A. utahensis* is definitely parasitic and distinguished by its large spores which exceed in size those of any other *Ascochyta* on Gramineae. He gives pycnidial size as 110–150 μ and conidia as 22–29 x 6.5–10 μ. If anything the Wisconsin specimen has slightly larger pycnidia and the conidia are about 30–33 x 6.5–8 μ. It may be noted that *Agropyron smithii* is adventive in Wisconsin from farther west.

ASCOCHYTA, which seems close to but is probably not identical with *Ascochyta chelidonii* Kab. & Bub., occurs on more or less well-defined dead areas on leaves of *Chelidonium majus* collected near Verona, Dane Co., June 5, 1962. In the Wisconsin specimen those conidia which are septate and seem best developed are mostly about 10–13 x 3–3.5 μ, whereas Kabat and Bubak give the measurements as 10–22 x 4–6 μ.

ASCOCHYTA sp. on *Amphicarpa bracteata* from near Leland, Sauk Co., August 18, 1962, is very well marked and seems distinct from any species of *Ascochyta* reported on closely related Leguminosae. I have found no species of *Ascochyta* listed on *Amphicarpa* and if additional collections are made a formal description will probably be justified. Notes on the specimen are as follows: Spots orbicular, .3–.7 mm. diam., tissue thin, translucent, ashen-brown in center, with narrow dark brown margin; pycnidia gregarious, pallid brownish, thin-walled and translucent, subglobose, approx. 115–150 μ diam.; conidia hyaline, cylindric or broadly ellipsoid, not constricted at septum, 7–9(–10.5) x 2.5–3.5 μ.

ASCOCHYTA sp. on *Viburnum lentago,* collected near Leland, Sauk Co., July 21, 1962, is on translucent spots of the type ascribed to *Phyllosticta decidua* Ell. & Kell. The sooty, somewhat flattened pycnidia are black when viewed from above, but are quite thin-walled, approx. 180–230 μ diam., the conidia hyaline, narrowly ellipsoid to fusoid or subfusoid, 8–11 x 2.5–3(–3.5) μ and the septum median. Possibly, but not certainly, saprophytic.

ASCOCHYTA COMPOSITARUM J. J. Davis was reported on *Solidago ulmifolia* from Madison in my Notes 26. This collection had conidia about of the size specified in Davis' description, 15–22 x 4–6 μ. In a very ample specimen on the same host, collected near Lake Lulu, Troy Twp., Walworth Co., August 13, 1962, and somewhat doubtfully referred to *A. compositarum,* those conidia which are septate run (7.5–)9–10 x 2.7–3 μ, at the lower end of the size range of the form which Davis originally designated as *A. compositarum* var. *parva,* but later incorporated with the species. In the recent specimen only a small minority of the conidia are septate. Those which are continuous are slender-cylindric, about 6–8 x 2 μ. In some less well developed pycnidia no septate conidia are to be found and those present run even shorter than the 6–8 μ just mentioned. However, the large, blackish-brown, orbicular, more or less zonate lesions are quite characteristic for *A. compositarum.*

DIPLODIA sp. has been noted on leaves of *Chrysothamnus graveolens* from a plant in the University of Wisconsin Arboretum at Madison, June 25, 1962. Although the infected leaves are dead and brown there seems little doubt that the *Diplodia* was primary. The pycnidia are light brown, subglobose, erumpent and papillate, approx. (115–)140–155(–180) μ diam., the conidia pale grayish, subcylindric or broadly subfusoid, septum median and not constricted, or only slightly so, (18–)22–26(–28) x 10–12.5 μ. The host plant appeared to be very seriously damaged. I have found no record of any species of *Diplodia* on this or closely related hosts.

STAGONOSPORA BROMI Sm. & Ramsb. and *Ascochyta graminicola* Sacc. *(A. sorghi* Sacc.) have both been reported on species of *Bromus* and, it would seem, grade into one another. In a specimen on *Bromus japonicus* collected at Madison, August 1, 1962, many of the spores are 2 septate, but all are less than 20 μ long, so the specimen fits neither *S. bromi* nor *A. graminicola,* but is close to both.

STAGONOSPORA ZONATA J. J. Davis, noted on a specimen of *Asclepias exaltata (A. phytolaccoides),* collected near Athelstane, Marinette Co., August 11, 1956, has conidia which are 6–7 septate and

35–40 x 7–8 μ, as opposed to an earlier collection on the same host where the conidia were somewhat narrower and mostly only 1–2 septate. A highly variable, yet integrated species, as shown by numerous collections on other species of *Asclepias*.

SEPTORIA (?) sp. occurs associated with *Puccinia recondita* on leaves of *Agrostis perennans,* collected by L. H. Shinners near Tony, Rusk Co., August 24, 1940. The thin-walled, pale brown pycnidia are about 125–150 μ diam. and are somewhat flattened. The spores are hyaline, straight to slightly curved, approx. 20–30 x 3 μ, obscurely 1–3 septate. Somewhat resembling *Septoria nodorum* Berk. which, however, has thicker-walled and larger pycnidia. Still another in the confusing assemblage of forms on the borderline between *Stagonospora* and *Septoria,* so prevalent in the Gramineae.

SEPTORIA sp. occurs on leaves of *Alopecurus pratensis* collected by J. Patman near Cadott, Chippewa Co., June 26, 1959. The small black pycnidia are only about 50–65 μ diam., the hyaline acicular spores (18–)23–27 x 1.5 μ. I find no mention of any species of *Septoria* on *Alopecurus* in North America, but *S. graminum* Desm. is reported on *Alopecurus* in Europe. This species has small pycnidia and slender spores, but they are twice the length of those of the Wisconsin specimen.

SEPTORIA sp. is present in some quantity on Aster angustus collected by S. C. Wadmond at Horlicksville, Racine Co., September 30, 1898. Although some leaves are heavily infected only a few of the pycnidia contain spores indicating, perhaps, the presence of an overwintering stage. Similar structures present on the stems likewise do not have differentiated contents. The pycnidia are globose, black, with large ostiole, approx. 75–85 μ diam., the spores hyaline, slightly curved or sinuous, about 20–32 x 1.5–2 μ, 2–3 septate.

COLLETOTRICHUM sp., which appears to have been parasitic, occurs in abundance on long, pallid streaks on the fruiting stalks and capsules of *Camassia scillioides (C. esculenta)* collected by S. C. Wadmond at Dill, Green Co., July 18, 1931. The acervuli are thickly beset with coarse, subacuminate, blackish-brown setae which are only slightly curved, several septate, from 50–125 x 4–6 μ. The hyaline conidia are slender-falcate, 20–23 x 3–3.5 μ.

COLLETOTRICHUM sp., appearing parasitic, occurs on pale brownish, more or less elongate and wedge-shaped lesions located distally on the lobes of leaves of *Cryptotaenia canadensis,* collected near Albany, Green Co., July 19, 1962. The acervuli are amphigenous, scattered to gregarious, variable in diameter. The setae are blackish below, paler near the tip, long-tapering, several septate and divergent, mostly from the edge of the acervulus, approx. 60–190 μ long by 3.5–6 μ wide at the base. The conidia are hyaline, falcate, about 18–23 x 3–4 μ. The lesions tend to shred and curl toward the outer edge. Except for the infected portion the leaves are deep green and seemingly in flourishing condition. It was noted that the infected plants were all growing in deep shade, whereas closely adjacent plants in a sunny opening were free of the *Colletotrichum*. Also found near New Glarus, Green Co., the same day.

ACREMONIUM sp. had overgrown the uredia of *Kuehneola uredinis* (Lk.) Arth. on Rubus allegheniensis collected at Madison, October 24, 1961. The hyaline, ellipsoid to subfusoid conidia approx. 4–6 x 1.5–2 μ, are produced acrogenously from slender, simple side branches from the equally slender, decumbent mycelium. Possibly parasitic. It seems likely that a similar fungus on *Pucciniastrum agrimoniae,* reported by me as a possible *Monosporium* (Amer. Midl. Nat. 41: 730. 1949), would be better assigned to *Acremonium.*

EPICOCCUM NEGLECTUM Desm. has been reported as a possible weak parasite of soybean and hog-peanut in Wisconsin. The fungus occurs in a similar relationship on small, oval, sharply defined tan spots on leaves of *Erythronium americanum* collected at Madison, May 23, 1962.

RAMULARIA (?) sp. is hypophyllous on dull reddish-brown, orbicular to somewhat elongate lesions, about .5–1 cm. diam., on leaves of *Spiraea alba,* collected at Madison, September 11, 1960. This is a very delicate fungus, scarcely discernible with an ordinary pocket hand lens. The hyaline or subhyaline conidiophores are rather widely scattered, arising at right angles from mycelial threads which themselves appear superficial at the points of origin of the phores. The phores are simple, straight and quite rigid, 70–120 x 2.5–3 μ, sometimes continuous, but mostly 2–3 septate, with a cluster of spore scars at the tip and occasionally in whorls at points lower on the phores. The hyaline conidia are subfusoid, continuous so far as observed, (7.5) 10–13 (–17) μ, and show some evidence of catenulation. This seems close to, but probably not identical with, *Ramularia spiraeae* Peck which occurs on *Physocarpus (Spiraea) opulifolius* in Wisconsin and has conidia which are very similar to those of the specimen in question, but whose conidiophores are rather rudimentary. Conidiophore length is, of course, often strongly influenced by external environmental factors and the infected *Spiraea alba* was growing in a low, marshy site in a more than ordinarily wet summer. More specimens, collected in different years would be desirable for comparative study.

RAMULARIA sp., somewhat similar to *Ramularia variata* J. J. Davis, yet differing in being more delicate and in an epiphyllous habit, occurs on *Satureja vulgaris* collected by W. M. Shaughnessy near Cable, Bayfield Co., October 3, 1959. The mostly 1 septate conidia have a maximum length of 20 μ, are about 2.5–3 μ wide, and lack the subfusoid configuration found in many of the conidia of *R. variata.*

RAMULARIA VIRGAUREAE Thum. was observed in profuse fruiting on overwintered basal rosette leaves of *Solidago nemoralis* at Madison, May 16, 1962. When sections were made the conidiophores were seen to be produced from the surface of globose, perithecium-like bodies which, no doubt, developed in the fall of 1961. At the time of collection new leaves, presumably susceptible to infection, were being produced, insuring perpetuation of the parasite without intervention of a perfect stage.

STIGMINA JUNIPERINA (Georg. & Bad.) M. B. Ellis is the name applied by C. S. Hodges to the fungus on *Juniperus communis* var. *depressa,* originally cited in the Wisconsin lists as *Cercospora sequoiae* var. *juniperi* Ell. & Ev. and later referred to *Exosporium deflectens* Karst. As for the similar fungus on *Juniperus virginiana,* Hodges places it once again in *C. sequoiae* var. *juniperi.* Chupp does not consider this to be properly a species of *Cercospora,* but Hodges has made an intensive study of the group, so it seems advisable to accept his names for the time being.

CERCOSPORELLA CANA Sacc., on lower leaves of *Erigeron annuus,* collected by E. Beals near New Post, Sawyer Co., June 24, 1959, has completely killed back the leaves and on the old spots there are very numerous black, thick-walled, astomous, spherical fruiting bodies, 55–60 diam., which contain very large numbers of hyaline microconidia, approx. 3–4 x .6–.8 μ.

CERCOSPORA sp. has been observed on the stem of a specimen of *Polygonella articulata* collected by T. G. Hartley near Burr Oak, LaCrosse Co., September 5, 1956. The conidiophores are in divergent fascicles from small stromatic bases, clear deep brown in color, tortuous, rather closely multigeniculate, approx. 35–60 x 3–4 μ. Conidia are fuliginous, narrowly obclavate, truncate below, with noticeable scar, (20–)25–35(–45) x (2–)2.5–3 μ, 1–3 septate. Chupp does not report any species of *Cercospora* on *Polygonella.* This seems rather similar to *C. avicularis* Wint. on species of *Polygonum,* but *C. avicularis* has conidia 30–75 x 3–5 μ.

CERCOSPORA GEI Fckl., as interpreted by Chupp in his "Monograph of Cercospora", includes in the synonomy several species of

Ramularia which have been described on *Geum*. This may be as satisfactory a disposition as any for what is a puzzling series, the extremes of which seem distinct, yet in which there are intergrading forms. As far as Wisconsin collections are concerned, an attempt has been made to keep separate the extremes, but the more specimens examined, the less valid such treatment seems. A recent collection on *Geum allepicum* var. *strictum* has been referred to *Cercospora*, yet earlier specimens on this host have seemed more *Ramularia*-like and have been so placed.

CERCOSPORA sp. occurs on leaves of *Chelone glabra* collected by R. C. Koeppen near Middleton, Dane Co., September 7, 1956. The spots are rounded and small, with cinereous centers and dark-purplish borders. The epiphyllous conidiophores are in spreading tufts from small blackish stromata. The phores are (40–)70–100 x 4–5 μ, slightly curved, mildly tortuous and geniculate, several septate, clear light brown. The few conidia seen were hyaline, narrowly obclavate, truncate below, about 3–4 septate, approx. 50–75 x 3–4 μ. Chupp does not mention *Chelone* as a host genus.

Elymus canadensis, collected by D. Ugent on Chambers Island, Door Co., July 2, 1961, bears on the leaves elongate "char" spots, the locules of which contain a mixture of vast numbers of short, rod-shaped microconidia and considerably longer, but equally slender scolecospores. The spots suggest *Septogloeum oxysporum* Sacc., Bomm. & Rouss., common on a variety of grasses in the northwest, but in Wisconsin known so far only on *Glyceria striata*.

Aralia nudicaulis from near Verona, Dane Co., June 26, 1962, bears a so far undetermined parasite which is hypophyllous on large, suborbicular or irregularly angled, sordid brownish, subzonate blotches, 2–4 cm. diam., or sometimes more, with very narrow, dark brown borders. The scattered, more or less decumbent conidiophores are up to 3 mm. long, slender, approx. 13–15 μ wide, with occasional constricted areas, many septate, clear brown, mostly simple but sometimes branched, candelabrum-like, near the base, the fruiting tips appearing simple or, if branched, only in very rudimentary fashion. The conidia are hyaline, moderately thick-walled, broadly ellipsoid or ovoid, (8.5–)10–11(.12) x (5.5–)6.5–7 μ. No conidia have been seen attached, but it appears they may be borne successively from small protuberances clustered near the apex.

Salix humilis leaves, collected near Swan Lake, Pacific Twp., Columbia Co., September 21, 1962, bear conspicuous, applanate, shining black, non-fruiting fungus growths which may involve as much as half the area of otherwise still green leaves. The fungus appears to be intraepidermal on both surfaces, but is particularly noticeable only on the smooth upper surface. The tissues between the epidermal layers have largely disintegrated. There is no sign of insect action. *Rhytisma salicinum* (Pers.) Fr., of which this is somewhat reminiscent, is decidedly more limited in extent and is also elevated well above the leaf surface.

Additional Hosts

The following hosts have not been previously recorded as bearing the fungi mentioned in Wisconsin.

Peronospora parasitica (Pers.) Fr. on *Erysimum cheiranthoides*. Grant Co., near Platteville, June 26, 1960. Coll. R. P. Wunderli.

Sphaerotheca humuli (DC.) Burr var. fuliginea (Schl.) Salm. on *Erigeron divaricatus*. Columbia Co., near Lodi, November 16, 1929. Coll. N. C. Fassett (9202). (U.W. Phan.).

Erysiphe graminis DC. Conidia on *Poa annua*. Jackson Co., near Hatfield, June 28, 1947. Coll. D. F. Grether. (U. W. Phan.).

Pseudopeziza medicaginis (Lib.) Sacc. on *Medicago lupulina*. Manitowoc Co., near Newtonburgh, June 4, 1960. Coll. R. Bolge. Although reported for Wisconsin in the Agricultural Handbook of Plant Diseases, there is no earlier specimen on *M. lupulina* in the Wisconsin Cryptogamic Herbarium.

Venturia sporoboli H. C. Greene on *Andropogon scoparius*. Iowa Co., Gov. Dodge State Park, August 15, 1962. The elongate, fuscous lesions are strikingly similar to those produced on *Sporobolus*. The dry, narrow, strongly ribbed leaves of *A. scoparius* provide a developmental site very much like that offered by *Sporobolus cryptandrus* on which this fungus was originally described.

Phyllachora graminis (Pers.) Fckl. on *Agropyron smithii*. Dane Co., Madison, June 18, 1921. Coll. J. J. Davis. (U. W. Phan.). Although the parasite is present in only small amount it is in excellent maturity.

Elsinoe veneta (Burkh.) Jenkins. *Sphaceloma* stage on *Rubus* sp. (dewberry). Dane Co., Pine Bluff, September 7, 1962. While the host species is undetermined, it is not *Rubus allegheniensis, R. occidentalis,* or *R. strigosus,* the three species previously reported as bearing this fungus in Wisconsin.

Ustilago striiformis (West.) Niessl on *Agrostis perennans*. Grant Co., Glenhaven, September 14, 1940. Coll. N. C. Fassett (21940). (U. W. Phan.).

CINTRACTIA CARICIS (Pers.) Magn. on *Carex abdita* and on *Carex richardsoni*. Both collected May 31, 1962 in Sect. 1, Town of Verona, Dane Co., near Madison. Also on *Carex blanda*. Dane Co., near Verona, July 1, 1962. Coll. J. H. Zimmerman.

SCHIZONELLA MELANOGRAMMA (DC.) Schroet. on *Carex abdita*. Kenosha Co., 4½ mi. S. of Kenosha near Lake Michigan shore, May 27, 1962. Coll. H. H. Iltis.

ENTYLOMA DACTYLIDIS (Pass.) Cif. on *Agrostis stolonifera*. Green Lake Co., Marquette, September 18, 1929. Coll. N. C. Fassett (8573).

DOASSANSIA MARTIANOFFIANA (Thum.) Schroet. on *Potamogeton gramineus*. Grant Co., Glenhaven, September 9, 1930. Coll. N. C. Fassett (12618). U. W. Phan.).

MELAMPSORELLA CARYOPHYLLACEARUM Schroet. II on *Stellaria calycantha*. Forest Co., near Alvin, August 12, 1953. Coll. E. M. Christensen.

CRONARTIUM RIBICOLA Fisch. ii, III on *Ribes sativum*. Dane Co., Madison, September 11, 1961.

PUCCINIA RECONDITA Rob. ex Desm. II on *Agropyron psammophilum (A. dasystachum)*. Door Co., Washington Island, July 6, 1931. Coll. J. J. Davis. (U. W. Phan.).

PUCCINIA POAE-NEMORALIS Otth II on *Alopecurus carolinianus*. Vernon Co., Northwood Nurseries near Coon Valley, June 15, 1942. Coll. T. R. Koethe. Also on *Alopecurus aequalis*. Marathon Co., near Mosinee, September 10, 1940. Coll. N. C. Fassett (21189). (U. W. Phan.).

PUCCINIA CORONATA Cda. III on *Cinna latifolia*. Florence Co., near Pine Lake, July 17, 1941. Coll. J. T. Curtis. (U. W. Phan.). It seems likely that the report by J. J. Davis of *P. coronata* on *Cinna arundinacea* should be dropped, as a collection from Luck, Polk Co., of which his specimen seems to be a part, has been authoritatively re-determined as *C. latifolia*. Also on *Beckmannia syzigachne*. Milwaukee Co., Milwaukee, August 2, 1938. Coll. L. H. Shinners. On a phanerogamic specimen in the herbarium of the University of Wisconsin-Milwaukee. Comm. J. W. Baxter.

PUCCINIA GRAMINIS Pers II, III on *Oryzopsis pungens*. Vernon Co., Wildcat Mt. State Park, July 17, 1956. Coll. T. G. Hartley. (U. W. Phan.). Referred here because of the very characteristic urediospores. The teliospores observed are well within the width range for *P. graminis*, but at the lower limit of the length, as given in Arthur's Manual. However, intensive studies of grass rusts by Cummins and others in recent years have usually resulted in decided revisions, in both directions, of the spore size ranges given in the Manual. Also on *Agropyron psammophilum (A. dasystachum)*, Sheboygan Co., Terry Andrae State Park, September 1949. Coll. E. L. Loyster.

PUCCINIA DIOICAE P. Magn. I on *Oenothera strigosa*. Marathon Co., near Edgar, June 23, 1957. Coll. H. Gale. (U. W. Phan.). II, III on *Carex deweyana*, Marathan Co., near Hogarty, June 10, 1961. Coll. R. A. Schlising. (U. W. Phan.).

PUCCINIA SPOROBOLI Arth. I on *Lilium michiganense*. Jefferson Co., Faville Prairie near Lake Mills, June 9, 1947 (H. C. Greene 1166). *Uromyces holwayi* Lagh., according to Arthur's Manual, has aecia which are cupulate in groups and the writer's No. 1166, which corresponds to this account, was distributed to several herbaria as *U. holywayi*. D. B. O. Savile has examined this specimen and commented on it in a recent article (Mycologia 53: 34. 1961). He points out that Arthur's description of the aecia as cupulate is in error, since they are actually bullate, and that Arthur's description very probably was based on aecia of a grass rust, perhaps *Puccinia sporoboli*. My 1166 was collected in close proximity to a large stand of *Sporobolus heterolepis* which commonly bears *P. sporoboli* II, III in this area, so the collection is referred here, especially since *Lilium* is known to bear *P. sporoboli* and since my material corresponds very well in spore wall thickness and in other characters. It is of interest that J. J. Davis *did* collect two Wisconsin specimens on *Lilium* with the bullate aecia of *Uromyces holwayi*.

PUCCINIA ARENARIAE (Schum.) Wint. on *Spergula arvensis*. Lincoln Co., Merrill, August 12, 1956. Coll. M. H. Iwen.

PUCCINIA MARIAE-WILSONI Clint. O on *Claytonia caroliniana*. Iron Co., near Upson, May 27, 1956. Coll. P. F. Maycock. (U. W. Phan.).

PUCCINIA HELIANTHI Schw II, III on *Helianthus decapetalus*. Sauk Co., near Denzer, October 7, 1961. Coll. R. W. Berry.

UROMYCES PECKIANUS Farl. ii, III on *Aristida basiramea*. Trempealeau Co., near Whitehall, August 27, 1940. Coll. L. H. Shinners (2781).

UROMYCES STRIATUS Schroet. II on *Medicago lupulina*. Dodge Co. near Horicon, August 25, 1958. Coll. C. Martz. In September 1962 J. W. Baxter collected the rust on this host at Milwaukee.

UROMYCES TRIQUETRUS Cooke III on *Hypericum canadense.* Jackson Co., near Millston, September 9, 1958. Coll. A. M. Peterson.

XENOGLOEA ERIOPHORI (Bres.) Syd. on *Scirpus atrocinctus.* Juneau Co., near Mauston, July 12, 1962.

PELLICULARIA FILAMENTOSA (Pat.) Rogers on *Dianthus armeria.* Iowa Co., Gov. Dodge State Park, July 4, 1959. Coll. B. Wislinsky. (U. W. Phan.). Also on *Veronica serpyllifolia.* Lincoln Co., near Merrill, September 7, 1960. Coll. T. A. Ebert.

PHYLLOSTICTA AMARANTHI Ell. & Kell. on *Amaranthus tuberculatus* (Moq.) J. D. Sauer (host det. Sauer). Grant Co., Potosi, September 8, 1930. Coll. N. C. Fassett (13649). (U. W. Phan.).

PHYLLOSTICTA BOEHMERIICOLA J. J. Davis on *Urtica dioica.* Dane Co., near Pine Bluff, August 9, 1962. As in collections on *Laportea canadensis* assigned to this species, the pycnidia are almost superficial, whereas in the type on *Boehmeria* they are somewhat more deeply imbedded. More material on *Boehmeria* would be desirable. There is no question at all of the identity of the fungi on *Laportea* and *Urtica,* but it would seem they may be varietally different from the type, although similar in every way except growth habit on the host.

PHYLLOSTICTA NEBULOSA Sacc. on *Silene armeria.* Racine Co., Racine. Coll. T. J. Hale. (U. W. Phan.). The date of collection is not given, but this specimen is at least one hundred years old and well illustrates the durability of sphaeropsidaceous fungi, since after a short time in mounting fluid the conidia appeared in excellent condition and matched those of recently collected specimens of this fungus.

PHYLLOSTICTA FRAGARICOLA Desm. & Rob. on *Fragaria virginiana.* Jefferson Co., Faville Prairie near Lake Mills, August 2, 1962. The large, black, epiphyllous pycnidia are very sparingly developed on cinereous lens-shaped spots which have a rather wide purplish border. The spots are about 3–5 mm. long and tend to lie along the midrib. *Ramularia* spots are also present and somewhat confuse the picture. Previous collections of *P. fragaricola* in Wisconsin have been on species of *Potentilla.* An undetermined *Phyllosticta* on *Fragaria virginiana,* microscopically similar to this, but producing very different lesions was mentioned in my Notes 26 (Trans. Wis. Acad. Sci. Arts Lett. 49:89. 1960).

PHYLLOSTICTA PALUSTRIS Ell. & Dearn. on *Stachys hispida.* Iowa Co., Gov. Dodge State Park, August 15, 1962.

PHYLLOSTICTA VERBASCICOLA Ell. & Kell. on *Verbascum blattaria*. LaCrosse Co., Bohemian Valley, Washington Twp., June 22, 1959. Coll. A. M. Peterson.

PHYLLOSTICTA DECIDUA Ell. & Kell. on *Solidago gigantea*. Dane Co., Madison, June 18, 1962. A dubious parasite but, to my knowledge, convincing proof of saprophytism has never been presented.

PHYLLOSTICTA CACALIAE H. C. Greene on *Cacalia suaveolens*. Green Co., Decatur Lake near Brodhead, August 28, 1962.

PHOMA MARIAE Clint. on *Lonicera morrowi*. Dane Co., Madison, March 25, 1945. Coll. M. S. Bergseng. (U. W. Phan.). The characteristic bleached areas on the twigs are immediately adjacent to expanding leaf buds.

ASCOCHYTA GRAMINICOLA Sacc. on *Poa pratensis*. Milwaukee Co., Milwaukee, August 1962. Coll. F. Kroll. Comm. E. K. Wade. This is on leaves which also have presumably been attacked by *Helminthosporium vagans* Drechsler, although no conidia of that species were observed.

ASCOCHYTA SILENES Ell. & Ev. on *Silene cucubalis (S. latifolia)*. Vilas Co., near Found Lake, July 11, 1940. Coll. F. W. Stearns. (U. W. Phan.). The *Ascochyta* is present in rather small amount at the bases of leaves which have numerous perithecia of *Mycosphaerella* on their dead tips.

ASCOCHYTA RIBICOLA H. C. Greene on *Ribes missouriense*. Dane Co., Madison, October 6, 1962.

ASCOCHYTA ASCLEPIADIS Ell. & Ev. on *Asclepias (Acerates) lanuginosa*. Rock Co., near Shopiere, May 30, 1957. Coll. E. W. Fell. (U. W. Phan.). The conidia are 7–9 x 3–3.5 μ, with a faint greenish tinge.

DARLUCA FILUM (Biv.) Cast. on *Coleosporium viburni* Arth. II on *Viburnum lentago*. Dane Co., Madison, September 25, 1962.

STAGONOSPORA ARENARIA Sacc. on *Dactylis glomerata*. Dane Co., near Pine Bluff, October 2, 1962.

STAGONOSPORA CYPERICOLA H. C. Greene on *Cyperus rivularis*. Lincoln Co., near Tomahawk, September 16, 1950. Coll. F. C. Seymour. The conidia are the same in width, but slightly shorter than in the type of *Cyperus filiculmis*, and mostly 1–2 septate. Very similar in the effect on the host.

SEPTORIA NODORUM Berk. on *Agropyron repens*. Dane Co., Madison, June 28, 1962. The spores in this specimen are from 2.6–4 μ

in width, much too large to be included in *Septoria elymi* Ell. & Ev., often found on *A. repens*. Also on *Agrostis scabra*. Iowa Co., near Arena, August 10, 1945. Coll. S. C. Wadmond.

SEPTORIA ELYMI Ell. & Ev. on *Lolium multiflorum*. Dane Co., Madison, October 19, 1962.

SEPTORIA TANDILENSIS Speg. on *Panicum meridionale* var. *albemarlense*. Marquette Co., Glenoaks, September 17, 1929. Coll. N. C. Fassett (8736). (U. W. Phan.).

SEPTORIA PASSERINII Sacc. on *Elymus canadensis*. Sauk Co., near Leland, July 21, 1962. The spores are mostly about 25–30 x 2.5–3 μ, rather short for this species. Also present is a microsporous stage *(Septoria microspora* Ell.) with narrow spores not more than 10–12 μ long. Sprague (Mycologia 40: 184. 1948) identifies this as being one of two such stages connected with *S. passerinii*. Much remains unknown about the *Septoria-Stagonospora* complex on broad-leaves native grasses.

SEPTORIA DIDYMA Fckl. var. SANTONENSIS Pass. on *Salix pentandra* (cult.). Barron Co., Barron, June 20, 1917. Coll. C. Goessl. (U. W. Phan.). This variety is discussed at some length in my Notes 22 (Trans Wis. Acad. Sci. Arts Lett. 45: 182. 1956).

SEPTORIA MUSIVA Peck on *Populus simoni* (cult.) Dane Co., Madison, September 12, 1962.

SEPTORIA LYTHRINA Peck on *Lythrum salicaria*. Jefferson Co., near Sullivan, June 27, 1955. Coll. G. V. Burger. (U. W. Phan.).

SEPTORIA SII Rob. & Desm. on *Berula pusilla (B. erecta)*. Rock Co., 5 mi. N. of Milton, October 7, 1956. Coll. H. H. Iltis (8509). U. W. Phan.).

SEPTORIA PSILOSTEGA Ell. & Mart. on *Galium lanceolatum*. Sauk Co., Denzer, June 16, 1948. Coll. E. A. Steuerwald. (U. W. Phan.).

SEPTORIA CAMPANULAE Lev. on *Campanula uliginosa*. Dane Co., Madison, September 29, 1962.

LECANOSTICTA ACICOLA (Thum.) Syd. on *Pinus sylvestris*. Vilas Co., Star Lake Plantation, July 11, 1962. Coll. R. F. Patton.

HAINESIA LYTHRI (Desm.) Hoehn. on *Vitis riparia*. Dane Co., Madison, September 11, 1962. In a collection on this same host made August 13, 1962 near Lake Lulu, Troy Twp., Walworth Co., most of the fruiting bodies are strongly beaked. As Shear and Dodge point out (Mycologia 13: 144. 1921): "Though ordinarily disc-shaped or patellate the sporodochia may be elongate and slender or even cylindrical. Such forms when dried and capped with a pointed mass of spores were mistaken by Cooke and Ellis for a *Sphaeronema* and described as *S. corneum.*"

HAINESIA LYTHRI (Desm.) Hoehn. on *Fragaria virginiana.* Jefferson Co., Faville Prairie near Lake Mills, August 2, 1962. J. J. Davis collected the *Scerotiopsis* stage of this fungus on *F. virginiana* at Madison. On *Potentilla argentea.* Portage Co., near Blaine, August 24, 1945. Coll. W. E. Rogers. (U. W. Phan.). On *Cornus femina.* Dane Co., near Pine Bluff, August 9, 1962. Associated with spots caused by *Septoria cornicola* and perhaps doubtfully parasitic. On *Steironema lanceolatum.* Jackson Co., near Black River Falls, July 6, 1958. Coll. A. M. Peterson.

SCLEROTIOPSIS CONCAVA (Desm.) Shear & Dodge on *Corylus americana.* Dane Co., near Verona, September 25, 1962. The parallel *Hainesia lythri* stage is not present in this specimen.

COLLETOTRICHUM FUSARIOIDES (Ell. & Kell.) O'Gara on *Asclepias amplexicaulis.* Green Co., Monroe, June 28, 1891. Coll. C. S. Stuntz. (U. W. Phan.). The fungus is on the stem in abundance. The conidia have mostly fallen away, but the characteristic short, stout setae are present in greater numbers than in most specimens.

PHLEOSPORA PANICI H. C. Greene on *Panicum meridionale* var. *albemarlense.* Waushara Co., Wautome, September 14, 1934. Coll. N. C. Fassett (17720). Sprague equated *Phleospora panici* with *Septoria tandilensis Speg.,* but the former seems to me to be distinct.

CYLINDROSPORIUM CALAMAGROSTIDIS Ell. & Ev. on *Calamagrostis inexpansa.* Ashland Co., Manitou Island, August 7, 1896. Coll. L. S. Cheney. Also on *Muhlenbergia glomerata.* Lincoln Co., Wilson Twp., September 11, 1949. Coll. F. C. Seymour (10965). I follow Sprague who assigned western material on *Muhlenbergia filiformis* to *Cylindrosporium calamagrostidis,* since the characters of the Wisconsin specimen match his account.

RAMULARIA MITELLAE Peck on *Mitella nuda.* Oconto Co., near Oconto Falls, June 24, 1958. Coll. H. Gale.

SCOLECOTRICHUM GRAMINIS Fckl. on *Agropyron psammophilum (A. dasystachum).* Door Co., Whitefish Bay, July 27, 1933. Coll. J. J. Davis. Also on *Beckmannia syzigachne.* Douglas Co., near Brule, July 20, 1897. Coll. L. S. Cheney. (U. W. Phan.).

HELMINTHOSPORIUM GIGANTEUM Heald & Wolf on *Muhlenbergia sylvatica.* Sauk Co., Aldo Leopold Memorial Tract, Sect. 1, Town of

Honey Creek, September 15, 1962. Also on *Muhlenbergia uniflora*. Wood Co., near Dexterville, September 18, 1961, Coll. W. A. Skroch. (U. W. Phan.).

CERCOSPORA MUHLENBERGIAE Atk. on *Muhlenbergia glomerata*. Adams Co., near Oxford, July 24, 1932. Coll. N. C. Fassett (14416). (U. W. Phan.).

CERCOSPORA FUSIMACULANS Atk. on *Panicum columbianum*. Sheboygan Co., Terry Andrae State Park, June 30, 1925. Coll. A. M. Fuller. (U. W. Phan.). On most specimens as old as this the conidia would have dropped away long since, but here a few were trapped in the conidiophore fascicles and these, together with the very characteristic lesions, serve to establish identity.

CERCOSPORA ELEOCHARIDIS J. J. Davis on *Eleocharis acicularis*. LaCrosse Co., near Amsterdam, Holland Twp., August 25, 1958. Coll. A. M. Peterson. Only a single conidium observed—as usual, spores produced externally on smooth surfaces have rapidly fallen away—but the very short, compact, substomatal clusters of conidiophores are entirely characteristic for the species.

CERCOSPORA AVICULARIS Wint. on *Polygonum achoreum*. Vernon Co., Chaseburg, August 24, 1920. Coll. E. A. Baird. Earlier reports fail to distinguish satisfactorily between *Polygonum achoreum* and *P. erectum*.

CERCOSPORA LECHEAE Chupp & Greene on *Lechea stricta*. Trempeleau Co., Perrot State Park at Trempeleau, August 16, 1956. Coll. T. G. Hartley. (U. W. Phan.).

TUBERCULINA PERSICINA (Ditm.) Sacc. on *Puccinia magnusiana* Körn. I on *Anemone canadensis*. Dane Co., Mazomanie, July 18, 1931. Coll. J. J. Davis. On *Puccinia punctata* Link I on *Galium concinnum*. Dane Co., near Verona, June 21, 1962. On *Puccinia stipae* Arth. I on *Aster oblongifolius*. Columbia Co., Black Hawk's Lookout near Prairie du Sac, May 31, 1962.

ADDITIONAL SPECIES

The fungi mentioned have not been previously reported as occurring in Wisconsin.

SPHAERELLA (MYCOSPHAERELLA) BACILLIFERA Karst. occurs on a number of Wisconsin specimens of *Scheuchzeria palustris* var. *americana* in the Wisconsin Herbarium. Karsten (Hedw. 22: 179. 1883) states that the type was on dead foliage, but in the Wisconsin material the infection plainly originated in living tissue of the current season. That this fungus is a parasite common on, and characteristic of, *Scheuchzeria* in this region would seem indicated by the remarkable fact that it has been found on 14 out of the 40 Wisconsin specimens in our herbarium, specimens collected at random by various collectors over a period of 100 years, and with no thought to the fungi thereon. Plants bearing the fungus are from Ashland, Barron, Bayfield, Jackson, Manitowoc, Oconto, Sawyer and Vilas counties, the earliest collected in 1889, the last in 1960. Descriptive notes, in amplification of Karsten's meager description, are as follows: Perithecia scattered over brownish or pallid zones on the narrow leaves and bracts, inmate or nearly so, black when viewed from above, but with the wall thin and pale brown at sides and below, subglobose, ostiole wide and prominent, bounded by black, rather thick-walled cells, the perithecia approx. (150–)165–185(–200) μ diam., aparaphysate, asci hyaline, rather thick-walled, often noticeably so at apex, broadly clavate or cylindro-clavate, pedicellate, 95–105 x 23–26 μ; ascospores hyaline with a faint greenish tinge, essentially straight, broadest at midpoint and tapered gradually to the subobtuse ends, 57–62 x 4.8–5.5 μ, the septum median without constriction. The arrangement of the spores in the ascus is somewhat variable, but they tend to lie alongside of and parallel with one another. The fungus has also been noted on specimens from Nova Scotia, Maine, Minnesota and Montana in the University of Wisconsin Herbarium.

LINOSPORA BRUNELLAE Ell. & Ev. on *Prunella vulgaris*. Sauk Co., near Leland, August 18, 1962. Immature, but so completely characteristic as to leave no doubt as to identity. A devastating parasite which seems to have hitherto been reported only from far northwestern North America and from Europe.

ELSINOE PANICI Tiffany & Mathre on *Panicum virgatum*. Four specimens: Columbia Co., near Lodi, June 30, 1938; Sauk Co., Ferry Bluff, August 10, 1959; Iowa Co., near Arena, August 16, 1960; Dane Co., Madison, August 8, 1962. Tiflany and Mathre (Mycologia 53: 600. 1961) have established that this fungus, only the conidial stage of which has so far been noted in Wisconsin, has an *Elsinoe* perfect stage. In my Notes 4 (Farlowia 1: 575. 1944) I discussed the conidial stage at some length, under the assumption that it was closest to the genus *Sporonema* and might be connected with *Phyllachora graminis* (Pers.) Fckl.

THECAPHORA DEFORMANS Dur. & Mont. on *Desmodium nudiflorum*. Sauk Co., Parfrey's Glen near Merrimac, September 19, 1962. Fischer reports this on *D. nudiflorum* only from Pennsylvania, Maryland and Virginia.

The late Dr. Roderick Sprague, shortly before his death, provided the following description of a species of *Coniothyrium* on *Poa pratensis,* collected in Wisconsin in 1959 and sent to him for study.

Coniothyrium poavora R. Sprague sp. nov.

Maculis luteis, ellipticis, marginibus brunneis vel vinaceis; pycnidiis paucis, interdum sub-gregariis, depressis, erumpentibus denique, globosis vel sub-ellipsoideis, brunneis v. nigris, 85–120 (–150) x 80–100 μ, ostiolatis; conidiophoris brevis; pycnidiosporulis ellipticis, apicis utrinque acutis vel sub-obtusis, aureis-brunneis, (5–) 6.5–9 (–10) x 2.4–3.2 μ.

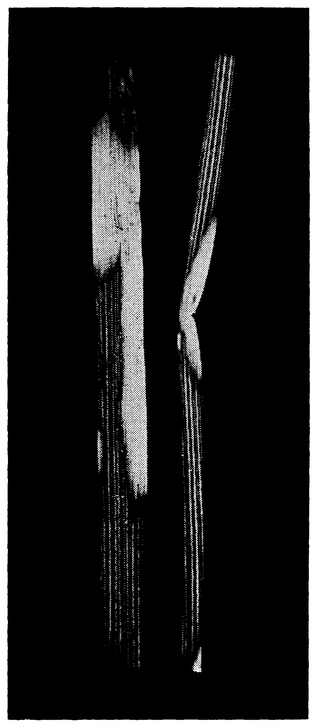

FIGURE 1. Segments of leaves of Poa pratensis showing lesions caused by Coniothyrium poavora R. Sprague. X 2.

Spots buff to straw color, elliptical, margin brown to vinaceous, pycnidia few, sometimes aggregated, depressed, finally erumpent, globose to somewhat ellipsoid-globose, brown to black, 85–120 (–150) x 80–100 μ, ostiolate; condiophores short, pycnidiospores elliptical, both ends pointed, or sometimes obtuse and almost truncated, walls relatively thick, golden brown, (5–) 6.5–9 (–10) x 2.4–3.2 μ.

On living leaves of *Poa pratensis*. Coll. by H. C. Greene near Cross plains, Dane County, Wisconsin, U. S. A., September 1, 1959. WSP 51152 is a slide removed from the specimen and retained at Washington State University. The rest of the type is filed at the University of Wisconsin.

Greene (Trans. Wis. Acad. Sci. Arts Lett. 49: 91. 1960) published a descriptive note on this fungus, pointing out the strikingly conspicuous nature of the lesions, as shown in the photograph, Fig. 1, and the fact that the infected leaves often show decided curvature at the point of the lesion.

Phomopsis filicina sp nov.

Maculis rufo-brunneis obscuris, in pinnulis partim vel absolute; pycnidiis sparsis vel gregariis, immersis, pallido-brunneis, muris tenuibus, pellucidis, subglobosis, ca. 115–140 μ diam.; scolecosporis curvis vel laxe sigmoideis, hyalinis, continuis, 25–45 x .8–1.5 μ; *Phoma*-conidiis hyalinis, subcylindraceis vel subfusoideis, 8–10 x (2–)2.5(–3) μ.

Lesions dark reddish-brown, involving portions of pinnules or entire pinnules; pycnidia scattered to gregarious, immersed, light brown, thin-walled and translucent, subglobose, approx. 115–140 μ diam.; scolecospores curved to laxly sigmoid, hyaline, continuous, 25–45 x .8–1.5 μ; *Phoma*-type conidia hyaline, subcylindric to subfusoid, 8–10 x (2–)2.5 (–3) μ.

On living leaves of *Athyrium angustum*. Madison School Forest near Verona, Dane County, Wisconsin, U. S. A., June 5, 1962. The lesions are very sharply defined with reference to the individual pinna and there seems no doubt of parasitism. A small collection of what is probably the same fungus was commented on in my Notes 19 (Amer. Midl. Nat. 50: 502. 1953).

Ascochyta osmundae sp. nov.

Maculis cinereo-brunneis vel virido-brunneis obscuris, in pinnulis, irregularibus; pycnidiis sparsis vel gregariis, muris tenuibus, pallido-brunneis, subglobosis, magnitudinibus variabilibus, ca. (90–)115–165(–200) diam. μ; conidiis hyalinis, uniseptatis ordinate, subfusoideis vel subcylindraceis, (9–)11–13(–16) x 2.8–3.5 μ.

Lesions ashen-brown or dull greenish-brown, often involving many pinnules, irregular in size and shape; pycnidia scattered to gregarious, thin-walled, pale brownish, subglobose, variable in size, approx. (90–)115–165(–200) μ diam.; conidia hyaline, uniformly uniseptate, subfusoid or subcylindric, (9–)11–13(–16) x 2.8–3.5 μ

On living leaves of the Interrupted Fern, *Osmunda claytoniana*. Adjacent to Decatur Lake, Sect. 15, Town of Decatur, near Brodhead, Green County, Wisconsin, U. S. A., August 28, 1962.

Numerous plants over a sizeable area were infected. Where many pinnules are involved, the pinna may show considerable curvature and distortion. A strong parasite on a host previously known only to bear a rust in Wisconsin.

SEPTORIA DIANTHICOLA Sacc. on *Dianthus barbatus*. Sauk Co., Town of Greenfield, June 1961. Coll. H. M. Clarke. (U. W. Phan.). The spores are shorter and narrower than in *Septoria dianthi* Desm.

Rhabdospora hyperici sp. nov.

Pycnidiis in caulibus, erumpentibus, seriebus comminus, nigris, muris crassis, subglobosis, applanatis infra, ostiolis parvis, (100–) 110–125(–135) μ diam; conidiis hyalinis, tenuibus, curvis plusve minusve, obscure multiseptatis, 35–75 x 1.2–1.7 μ.

Pycnidia on stems, deeply imbedded but erumpent, closely seriate, black, thick-walled, subglobose, somewhat flattened at base, ostiole small, (100–)110–125(–135) μ diam.; conidia hyaline, slender, more or less strongly curved, obscurely multiseptate, variable in length, 35–75 x 1.2–1.7 μ.

On *Hypericum gentianoides*. Columbia County, Dells of the Wisconsin River, 3 miles northwest of Portage, Wisconsin, U. S. A., October 9, 1960. Coll. H. H. Iltis (17055).

This species has pycnidia which are much larger and spores which are completely out of the range of *Septoria sphaerelloides* Ell. & Kell. *(Rhabdospora sphaerelloides* (E. & K.) Sacc.) which occurs on *Hypericum punctatum* in Wisconsin.

CERCOSPORA FUKUSHIANA (Matsuura) Yamamoto *(C. balsaminae* Kell. & Sw. in litt.) on *Impatiens balsamina* (cult.). Dane Co., Madison, August 27, 1962. The sharply defined circular grayish spots seem characteristic for the species as it is treated by Chupp in his monograph.

CERCOSPORA OENOTHERAE Ell. & Ev. on *Oenothera serrulata*. Buffalo Co., near Mondovi, August 25, 1956. Coll. H. H. Iltis (8078). (U. W. Phan.).

ALTERNARIA ZINNIAE Pape on *Zinnia elegans* (cult.). Monroe Co., Kendall, September 1, 1962. Comm. E. K. Wade. This species has spores which are distinctive in having extremely long, slender beaks.

PRELIMINARY REPORTS ON THE FLORA OF WISCONSIN NO. 48.[1] COMPOSITAE I—COMPOSITE FAMILY I

(TRIBES EUPATORIEAE, VERNONIEAE, CYNARIEAE, AND CICHORIEAE)

Miles F. Johnson and Hugh H. Iltis

In Wisconsin, as well as in the world as a whole, the family with the largest number of species is the *Compositae,* the family of daisy and dandelion, of lettuce and chrysanthemum. Highly specialized, its flowers are not borne singly but in groups of several to hundreds, telescoped into tight *heads* in such a way as to simulate the solitary flowers of other families. While the bee and butterfly visitor, and many a layman, look upon a daisy as *one single "flower",* which *functionally* it is, the botanist knows that each head is structurally a bouquet of flowers, sometimes all alike as in Joe-Pye-Weed or dandelion, sometimes of two sorts as in the daisy, where the showy marginal *ray flowers* (or *rays)* resemble white petals and the many individual yellow *disk flowers* composing the central disk resemble yellow stamens. Surrounding all the flowers of each head are one or several series of variously modified, often green, *involucral bracts.* Sepals are rarely visible except in fruit, where, as the *pappus,* they are found on top of the *achene* ("seed"), sometimes as scales, hairs or barbed spines. In a few species, the pappus is lacking.

The arrangement of flowers into heads has evidently been a very successful evolutionary venture a success reflected in the very large number of species (some 20,000) and in the ecological predominance of *Compositae* in the vegetation of many parts of the world, as in some prairies and sedge meadows of Wisconsin. The species and genera of *Compositae* are legendary for the difficulty with which they are told apart, partly because of the minuteness of the morphological characters which have to be examined, but mainly because of the large number of similar species and genera, many of which have evolved recently or are still actively evolving, and as a consequence often hybridize. It should be borne in mind, therefore, that parts of the present treatment, as those of the *Liatris* and

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Hieracium hybrids, are highly tentative. A great deal of field work and laboratory analysis is yet needed before we can have an adequate taxonomic understanding of many of our *Compositae*.

This study includes the species of only four tribes, though two difficult genera, *Solidago*, the goldenrods, and *Senecio*, the ragworts, are dealt with further on in this volume. An unpublished master's study (Melchert 1960), treated members of the sunflower tribe, the *Heliantheae*, while certain individual groups, such as the difficult genus *Aster*, have been published on separately by Shinners (1941) and others. The magnitude of the task, as well as the desirability of making available to botanists and naturalists the present work without too much delay has made it expedient to publish this family in several parts.

This study is based on specimens in the herbaria of the University of Wisconsin (WIS), Milwaukee Public Museum (MIL), University of Wisconsin–Milwaukee (WISM), University of Minnesota (MIN), Chicago Natural History Museum (F), Northland College, Ashland, Platteville State College and St. Norbert's College, De Pere, Wisconsin.

Map dots represent exact locations, triangles represent county records. Small dots in Lincoln Co. represent sight records of F. C. Seymour (ms.), those in Central Wisconsin of J. W. Thomson (ms.). The numbers in the map corner insets indicate the amount of flowering and fruiting material available for this study as well as when the species may be expected to flower or fruit in Wisconsin. Plants with vegetative growth only, in bud, or with dispersed fruits are not included. Nomenclature and general descriptions generally follow those of Cronquist in "The New Britton and Brown Illustrated Flora" (Gleason 1952) and "Gray's Manual of Botany, ed. 8" (Fernald 1950). The order of tribes and genera follows that of Cronquist (Gleason 1952), to whom we are obliged for permission to modify his key to genera and illustration (Fig. 1), as published in "The New Britton and Brown Illustrated Flora".

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Mrs. Katharine S. Snell, our ever-busy Herbarium Assistant, deserves special thanks for aid and encouragement beyond the call of duty, Mrs. Kathryn Haberman and Mr. Steven Gilson for aid in preparation of maps, Mrs. Russell Rill for the loan of her excellent private herbarium of the Waupaca Co. region, Father Ernest Lepage, Rimouski, Ontario, Canada, for providing information concerning *Hieracium*, Dr. Gerald B. Ownbey, University of Minnesota, for carefully reading and criticizing the treatment of *Cirsium* and *Carduus*, Mr. Wayne L. Milstead, Purdue University, for preparing a key and descriptions of *Prenanthes*, Mr. Frank S. Crosswhite for critically reading the manuscript, and finally Drs. Virginia Akins and Catherine Lieneman, Wisconsin State College, River Falls, for introducing the first author to the science of Botany.

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ARTIFICIAL KEY TO TRIBES OF WISCONSIN COMPOSITAE
Based on flowering plants
After L. H. Shinners (May, 1941, unpublished)

A. Some or all of the flowers in each head tubular; strap-shaped (ray) flowers absent, or present only around the margin of the head; plants with watery juice.
- B. Pappus of bristles or hairs.
  - C. Plants not prickly; phyllaries (involucral bracts) entire, or with ragged edges, but not deeply laciniate and not spiny or prickly.
    - D. Phyllaries in 2–5 rows, equal or unequal; or in 1 row, but conspicuous white, pink, purple, or blue rays present.
      - E. Phyllaries not scarious, or scarious only on the margins.
        - F. Rays absent; flowers white, pink, or purple.
          - G. Heads purple-flowered, corymbose; leaves alternate __TRIBE VIII. VERNONIEAE.
          - GG. Plants not with all the above characters at once ______TRIBE VII. EUPATORIEAE.
        - FF. Rays present or absent; tubular flowers yellow, orange, or brown; or purple- or red-brown, but conspicuous rays present.
          - H. Disks less than 25 mm wide __________________________TRIBE V. ASTEREAE.
          - HH. Disks more than 25 mm wide ___________________________TRIBE VI. INULEAE.
      - EE. Phyllaries either entirely scarious except for a central green line not extending to the tip, or with scarious tips 1/3 or more their length.
        - I. Involucres 10–16 mm high.

J. Phyllaries loose, crisped, and rounded; heads spicate or racemose ______________ TRIBE VII. EUPATORIEAE (*Liatris* sp.).

JJ. Phyllaries appressed, acute; heads loosely corymbose-paniculate __________________ TRIBE IX. CYNAREAE (*Centaurea repens*).

II. Involucres 3–8 mm high __________________ __TRIBE VI. INULEAE. (GNAPHALIEAE).

DD. Phyllaries equal and in 1 row (sometimes with a few slender recurved bractlets below them); rays yellow, or rays absent.

K. Leaves opposite ___TRIBE VII. EUPATORIEAE (*Eupatorium rugosum*).

KK. Leaves alternate, or all basal ________________ __________________TRIBE IV. SENECIONEAE.

CC. Plants prickly, or with deeply laciniate, spiny, or prickly phyllaries ___________________TRIBE IX. CYNAREAE.

BB. Pappus of awns, scales, or teeth; or pappus absent.

L. Phyllaries not at all scarious.

M. Anthers not united; rays absent, flowers not showy ____TRIBE I. HELIANTHEAE (AMBROSIEAE).

MM. Anthers united; rays present or absent, flowers often showy.

N. Rays absent; or rays present and pointed, ragged, or sharply 2-toothed at the apex, widest near the middle or about the same width throughout ___ __________________TRIBE I. HELIANTHEAE.

NN. Rays present, widest at the 3- to 5-lobed apex.

O. Leaves opposite __TRIBE I. HELIANTHEAE (*Polymnia & Coreopsis*).

OO. Leaves alternate ___TRIBE II. HELENIEAE.

LL. Phyllaries scarious, at least around the margins.

P. Leaves opposite ________TRIBE I. HELIANTHEAE (*Cosmos & Coreopsis*).

PP. Leaves alternate.

Q. Leaves toothed, lobed, or finely divided ________ ________________TRIBE III. ANTHEMIDEAE.

QQ. Leaves not toothed or divided ________________ ____________TRIBE V. ASTEREAE (*Boltonia*).

AA. Flowers all strap-shaped; plants with milky juice __________ _________________________________TRIBE X. CICHORIEAE.

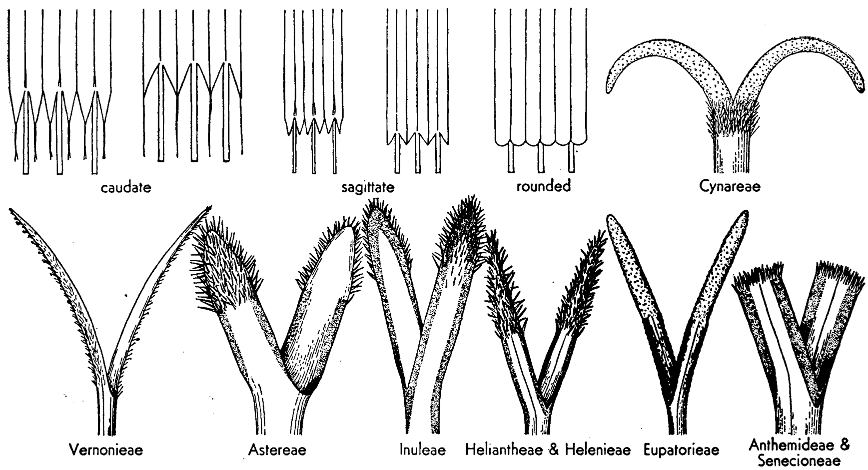


FIG. 1. CHARACTERISTIC STYLE-BRANCHES AND ANTHER-BASES IN THE COMPOSITAE. (FROM A. J. CRONQUIST, IN GLEASON 1952, 3: 324, WITH PERMISSION).

DESCRIPTIVE KEY TO THE TRIBES OF COMPOSITAE IN WISCONSIN[2]

(Wisconsin Genera grouped accordingly)

A. Flowers, or some of them, tubular and eligulate; juice watery, very rarely milky.

B. Style without any ring of hairs or distinct thickened ring below the branches; anthers (except in *Inuleae)* not tailed; plants seldom prickly; receptacle chaffy or naked, rarely somewhat bristly.

C. Style-branches more or less flattened, commonly but not always stigmatic to the middle or beyond, the stigmatic portion often conspicuously defined; flowers generally not all alike, some of them tubular and hermaphrodite (sometimes sterile), others pistillate or neutral and usually also ligulate, or, if occasionally all tubular and hermaphrodite, then yellow.

D. Anthers truncate to sagittate at base, but scarcely tailed; style-branches often but not always with terminal appendages.

E. Style-branches either exappendiculate and with a ring of hairs at the end, or with the appendages hairy on both sides.

[2] Modified after A. J. Cronquist's key in Gleason (1952).

F. Pappus chaffy or of awns or none, never capillary; style-branches chiefly with appendages, but sometimes without them.

G. Involucral bracts without scarious or hyaline margins, commonly green and somewhat herbaceous, seldom much imbricate; leaves, or the lower ones, often but not always opposite; style-branches usually but not always with appendages.

H. Receptacle chaffy ____________________________TRIBE I. HELIANTHEAE.

1. Helianthus
2. Eclipta
3. Heliopsis
4. Rudbeckia
5. Echinacea
6. Ratibida
7. Bidens
8. Megalodonta
9. Coreopsis
10. Galinsoga
11. Polymnia
12. Silphium
13. Parthenium
14. Iva
15. Ambrosia
16. Xanthium
17. Madia

HH. Receptacle naked ______________________________TRIBE II. HELENIEAE.

18. Helenium

GG. Involucral bracts with scarious or hyaline margins, scarcely herbaceous, usually well imbricate; leaves alternate; receptacle chaffy or naked; style-branches exappendiculate, as in the *Senecioneae* _________________TRIBE III. ANTHEMIDEAE.

19. Anthemis
20. Achillea
21. Chrysanthemum
22. Tanacetum
23. Matricaria
24. Artemisia

FF. Pappus of capillary bristles; style-branches mostly truncate, exappendiculate, with a ring of hairs at the end; leaves alternate or opposite; receptacle naked; involucre chiefly of equal uniseriate bracts, often with a few much smaller ones at the base __________________________TRIBE IV. SENECIONEAE.

25. Arnica
26. Senecio
27. Erechtites
28. Cacalia
29. Tussilago
30. Petasites

EE. Style branches with the appendages glabrous within; leaves alternate; receptacle naked; involucral bracts commonly but not always in several series and partly or wholly herbaceous ---------------------------Tribe V. ASTEREAE.

31. Solidago
32. Chrysopsis
33. Grindelia
34. Erigeron
35. Aster
36. Conyza
37. Boltonia

DD. Anthers tailed at base; style-branches rounded or truncate, exappendiculate; leaves alternate; receptacle naked or chaffy; corollas all tubular, or, in the large yellow heads of *Inula,* the outer ligulate; plants more or less white-woolly; leaves alternate --------------------------------Tribe VI. INULEAE.

38. Antennaria
39. Anaphalis
40. Gnaphalium
41. Inula

CC. Style-branches terete, clavate, or filiform, seldom strongly flattened, stigmatic only near the base, the stigmatic portion usually not sharply differentiated in appearance; flowers all tubular and perfect, never yellow; receptacle naked.

I. Style-branches terete or clavate, obtuse to acutish, papillate, not hairy; anthers rounded at the base; leaves opposite, alternate, or whorled ---------------------------------Tribe VII. EUPATORIEAE.

42. Eupatorium
43. Kuhnia
44. Liatris

II. Style-branches filiform, acute or acuminate, hispidulous; anthers distinctly sagittate; leaves alternate ----------------------Tribe VIII. VERNONIEAE.

45. Vernonia

BB. Stype with a ring of hairs, or sometimes merely with a thickened ring, below the branches, papillate thence to the tip, the branches apparently stigmatic to the tip; anthers tailed at the base; plants often prickly or spiny; receptacle densely bristly or sometimes naked; leaves alternate. ------------------------------------Tribe IX. CYNAREAE.

46. Arctium
47. Carduus
48. Cirsium
49. Onopordium
50. Centaurea

AA. Flowers all ligulate and perfect; juice milky or colored -- TRIBE X. CICHORIEAE.

51. Prenanthes	57. Cichorium
52. Hieracium	58. Microseris
53. Crepis	59. Krigia
54. Taraxacum	60. Lapsana
55. Sonchus	61. Leontodon
56. Lactuca	62. Tragopogon

NOTE: ONLY TRIBES VII–X ARE TREATED IN THIS PRELIMINARY REPORT.

TRIBE VII. EUPATORIEAE CASS.

Perennials with watery juice; flowers all tubular, perfect, purple, rose, white or whitish. Style branches clavate. Leaves alternate, opposite or whorled. Pappus bristly.

KEY TO GENERA

A. Leaves opposite or whorled; roots fibrous; achenes 5-angled; pappus of capillary bristles; involucral bracts not ribbed -- 42. EUPATORIUM.

AA. Leaves alternate; plants from a stout taproot or enlarged corm; achenes 10-ribbed; pappus of plumose or barbellate bristles; involucral bracts weakly or strongly ribbed.

  B. Plants from stout taproots; pappus plumose; involucral bracts strongly ribbed; inflorescence corymbiform, the heads creamy-white ---------------------- 43. KUHNIA.

  BB. Plants from enlarged corms; pappus plumose or barbellate; involucral bracts strongly imbricate, weakly ribbed; inflorescence spicate or racemose, the heads purple and often very showy. ---------------------------- 44. LIATRIS.

42. EUPATORIUM L. THOROUGHWORT; JOE-PYE-WEED

Perennials with opposite or whorled leaves, often resin-dotted on involucre and undersides of leaves. Heads small, usually many, in corymbiform inflorescences, the flowers all tubular, white, pink or purple. Involucre cylindrical-campanulate, the bracts imbricate, unequal. Achenes 5-ribbed. Pappus bristles uniseriate, capillary.

Key to Species

A. Leaves in whorls of 3, 4, or 5; heads purple or dull rose, cylindric.
  B. Stem *purple throughout or purple spotted;* flowers *9–24 per head;* very common throughout, wet habitats -- 1. *E. MACULATUM.*
  BB. Stem *green, purple only at nodes, not spotted;* flowers *3–6 (–8) per head; dry woods* ---------- 2. *E. PURPUREUM.*
AA. Leaves opposite (rarely in 3's in No. 5); heads white (rarely purple in No. 5).
  C. Leaves sessile or very short-petioled, narrowly lanceolate.
    D. Leaves free at base and not fused.
      E. Leaves attenuate to the winged petiole, broadest near middle, with *3 prominent veins beneath;* plants pubescent; SW Wisconsin ---- 3. *E. ALTISSIMUM.*
      EE. Leaves sessile, broadest at the rounded base.
        F. Plants glabrous; leaves with very prominent white midrib beneath; S. Wisconsin ------------------------------- 4. *E. SESSILIFOLIUM.*
        FF. Plants pubescent; leaves with midrib not very prominent beneath ------------------------ –5c. *E. PERFOLIATUM* forma *TRUNCATUM.*
    DD. Leaves perfoliate, their bases fused around the stem; very common throughout ----- 5. *E. PERFOLIATUM.*
  CC. Leaves long-petioled, broadly lanceolate to ovate.
    G. Leaves lanceolate, scabrous-pilose, thickish; plants branched above; rare in S. Wisconsin --- 6. *E. SEROTINUM.*
    GG. Leaves ovate, glabrous, membranaceous; plants branched at inflorescence, rarely below; throughout Wisconsin, except the Northwest --- 7. *E. RUGOSUM.*

1. Eupatorium maculatum L. Joe-Pye-Weed. Map 1.

Perennial 1–2 m or more tall. Stem unbranched, glabrous, *mottled with purple or purple throughout.* Leaves in *whorls or 4 or 5,* rarely 2 or 3, lanceolate to elliptic, gradually tapering to the petiole, the lower (8–)12–22(–26) cm long, 3–7 cm wide, *with coarsely serrate margins, the teeth usually incurved,* glabrous above, with bright orange resin dots (atoms) beneath (10X).[3] Inflorescences usually flat-topped; heads numerous, 7–10 mm high, with 9–16(–24) flowers of varying shades of *reddish-purple;* bracts obtuse, purple

[3] According to Fernald (1950:1365), leaves of *E. maculatum* are "rarely atomiferous." In Wisconsin, however, they are rarely, if ever, without resinous dots!

to green. Peduncles bright purple. Pappus of numerous capillary bristles, dull white to brown.

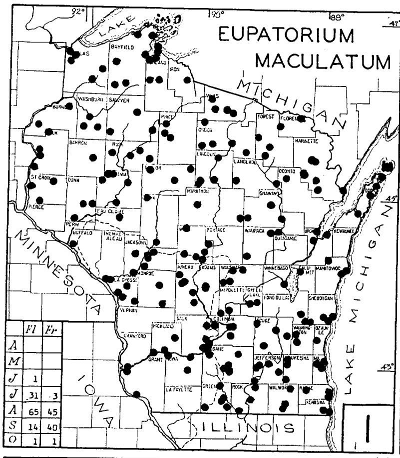
Throughout Wisconsin, characteristic of wet prairies (Curtis 1955) and especially the northern sedge meadows (Curtis 1959), in marshes, wet woods, low lands, and along streams and lakes, less commonly in bogs or drier habitats. Flowering from (early) mid-July through September (peak in early August); fruiting from late July into October. Very similar to *E. purpureum.*

2. EUPATORIUM PURPUREUM L. Sweet or Green-stemmed Joe-Pye-Weed. Map 2.

Perennial 1–2 m tall. Stem unbranched, glabrous, *purple only at nodes or green throughout.* Leaves, in whorls of 4, rarely 3 or 5, lanceolate to oblanceolate, *coarsely crenate, abruptly tapering to winged petiole,* 14–25 cm long, glabrous to sparsely pubescent above, with bright orange dots (atoms) below (10x). Inflorescences rounded, the numerous narrowly cylindric heads 8–13 mm long, each with *(4–)5–6(–8) pink to pale purple (rarely cream or whitish) flowers;* bracts light purple to tawny, with bright green to brown nerves. Peduncles tan, pubescent. Pappus of numerous tawny capillary bristles. $2n=20$, 40 (Grant 1953, ex Darlington 1955); $2n=20$ (Cooper & Mahoney 1935, presumably from Wisconsin material).

Southern Wisconsin, mainly in the southern dry-mesic oak forests (Curtis 1959) and in mesic to damp maple, basswood, and elm woods south of the "Tension Zone," less common in white cedar-hardwoods, on bluffs, damp lake shores, marshes, and in the Wisconsin river bottoms in dense underbrush of moist sloughs subject to occasional inundation to a depth of 4–8 feet (Adams Co.), seemingly completely lacking from the region of the Central Sand Plains. The Wood Co. collection, "high dry woods, Arpin, Sept. 22, 1915 *C. Goessl*" (MIL, WIS), needs verification. Wiegand (1920b) cites albino-flowered specimens (corollas white) from Brown Co. and Kaukauna, Outagamie Co. Flowering from (mid-)late July to mid-August; fruiting from August through September.

Eupatorium purpureum and *E. maculatum* are often confused in field and herbarium. Distinguishing field characters include stem color (green with purple nodes in *E. purpureum,* purple or purple-spotted in *E. maculatum),* head color (pale in *E. purpureum,* more purple in *E. maculatum),* number of flowers per head, as well as habitat preference *(E. purpureum* in mesic or drier woods; *E. maculatum* in moist to wet thickets, wet prairies, and meadows).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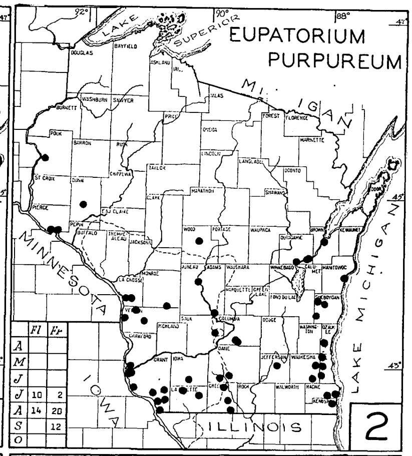
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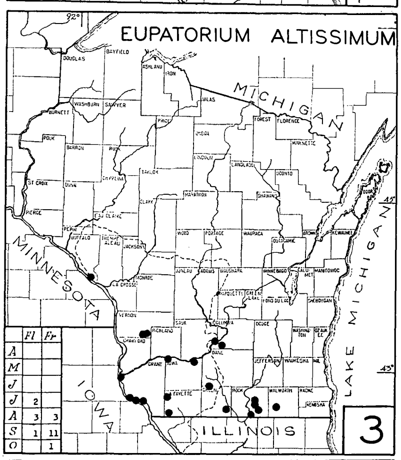
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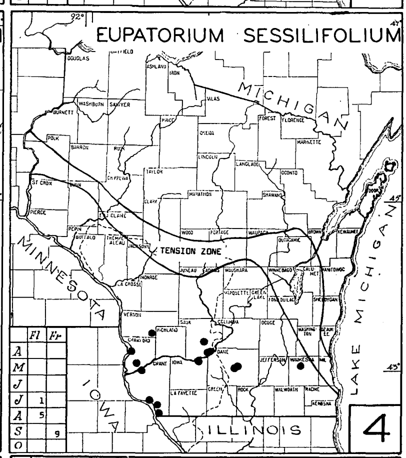
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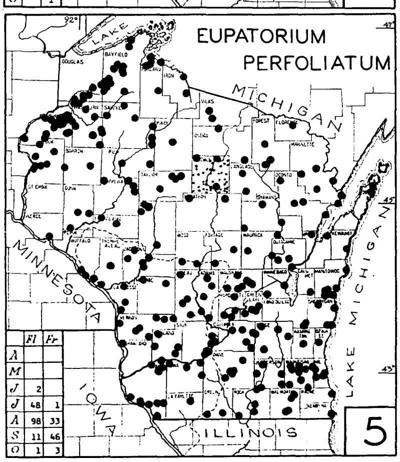
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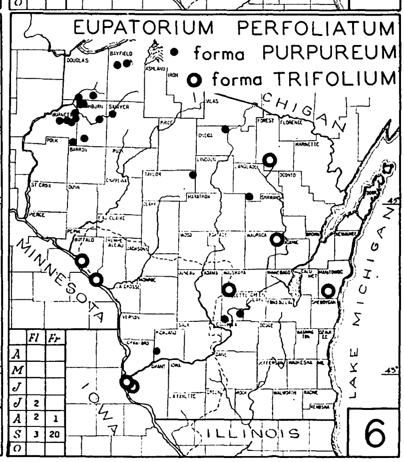
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3. EUPATORIUM ALTISSIMUM L. Map 3.

Leafy perennial somewhat resembling *Kuhnia eupatorioides,* 6–10 dm tall, pubescent throughout. Leaves opposite, narrowly lanceolate, 6–11 cm long, 1–1.4 cm wide, *tapering to winged petioles,* coarsely *toothed along the upper half,* pilose-punctate and with *three prominent veins beneath.* Heads numerous, *white.* Involucral bracts and *achenes with light yellow resin dots.*

Rather infrequent in SW. Wisconsin on dry rocky limestone (dolomite) prairies, less often on mesic prairies (Curtis 1959) and on bluffs; according to Dr. H. C. Greene, locally abundant at Benton, Lafayette Co., on bare sterile mine talings. Flowering from late July into early September; fruiting from mid-August through September.

4. EUPATORIUM SESSILIFOLIUM L. var. BRITTONIANUM Porter. Upland Boneset. Map 4.

Perennials 7–10 dm tall, glabrous except in the upper branches. Leaves opposite, *sessile, lanceolate,* 9–13 cm long, *the rounded base* 2–4.5 cm wide, long acuminate, denticulate to dentate, the *lower midrib white and very prominent.* Corymb spreading; heads numerous, white, the bracts obtuse, densely white pubescent with intermixed golden resin "atoms"; achenes also atomiferous (10X).

Uncommon in southern Wisconsin in dry, open, often sandy upland woods on tops and slopes of bluffs, mainly in the "Driftless Area", rarely in prairie relics. Flowering in early or mid-August; fruiting in September.

Because of pubescent inflorescence branches, our specimens all belong with var. *Brittonianum,* the glabrous typical variety occurring in the eastern and southern U.S.

5. EUPATORIUM PERFOLIATUM L. Boneset; Throughwort; Thoroughwort. Map 5, 6.

Coarse to slender, villous to hairy perennials 3–9(–11) dm tall. *Leaves opposite* (rarely in 3's), *all, except sometimes the upper, perfoliate (i.e., fused at the base and thus surrounding the stem,* hence the specific epithet), lanceolate, 8–14 cm long, 1.5–4 cm wide at the base, long-acuminate, crenate-serrate. Heads numerous, in flat-topped inflorescences. 2n=20 (Grant 1953, ex Darlington 1955).

KEY TO FORMS

a. Leaves opposite.
  b. Leaves fused at the base.
    c. Heads white ______________ 5a. forma *PERFOLIATUM*.
    cc. Heads purplish ______________ 5b. forma *PURPUREUM*.
  bb. Leaves not fused at the base, at least above, the heads white ______________________________ 5c. forma *TRUNCATUM*.
aa. Leaves in 3's ______________________ 5d. forma *TRIFOLIUM*.

5a. EUPATORIUM PERFOLIATUM L. forma PERFOLIATUM Map 5.

Leaves 2 at a node; corollas white.

Throughout Wisconsin, common in open moist habitats such as sandy lake shores, sand bars, beaches, sedge meadows, wet prairies (Curtis 1955), fens, southern lowland forests, northern damp Cedar-Hemlock or Tamarack-Spruce-Poplar woods, shrub carrs with *Potentilla fruticosa,* swamps, marshes, streamsides, and wet cliffs, rarer in drier habitats, though often very weedy in heavily grazed pastures or gravelly dry hillsides. Flowering from late June through September (peak in mid-August); fruiting from late July to early October.

5b. EUPATORIUM PERFOLIATUM L. forma PURPUREUM Britt. Map 6.

Flowers purple or purplish, rather than white, the bracts, inflorescences, stems and leaves sometimes purple as well, otherwise exactly as typical *E. perfoliatum.* Flowering and fruiting in August and September.

In Wisconsin this form is most common on sandy shores of the many lakes within the limits of post-glacial "Lake Barrens" (see Map 6; cf. McLaughlin 1932), which extended over much of the present-day sand barrens of NW. Wisconsin and adjacent Minnesota. *Bidens connata* Muhl. var. *pinnata* Wats. (Melchert 1960; Sherff 1962) and *Polygonum punctatum* L. var. *littorale* Fassett (Fassett 1948), minor endemics of the "Lake Barrens" region, have similar distributions, as do many of Wisconsin's otherwise local "Atlantic Coastal Plain Elements", e.g. *Xyris torta* and *Lycopodium inundatum,* and certain European weeds, e.g. *Crepis tectorum* (Map 49). For some, this area does represent an ideal "Coastal Plain" habitat. It is likely that post-glacially this area was a large "open habitat" in which plants adapted to moist, sandy, acid "Coastal Plain" conditions could find an ideal situation for rapid population expansion. The reasons for the many peculiarities found here may include the greatly expanded evolutionary opportunity that such an open habitat offers. Here, under low competition, an otherwise rare genotype could, on chance introductions, produce relatively large and uniform populations. Mutations causing anthocyanin accumulation in *E. perfoliatum,* thus, have no doubt occurred elsewhere too (see Map 6), but conditions for an extensive population buildup were particularly favorable only here. What we have been describing here, in short, is the operation of the "founder principle" of E. Mayr (cf. Goodhart 1963), where large and distinctive populations owe their peculiarities to being originally founded by only one or very few seeds selected by chance, the populations therefore genotypically poor, and hence uniform and distinctive. The "founder principle" would seem to apply also to the origin of the micro- or neoendemics of the Great Lakes, discussed elsewhere in this paper (cf. *Cirsium pitcheri,* pp. 291–292).

5c. EUPATORIUM PERFOLIATUM L. forma TRUNCATUM (Muhl.) Fassett.

Leaves free at base, or only the lower fused, sometimes alternate above, thus not perfoliate. A rather meaningless taxon including occasional abnormal plants of the typical variety, e.g.: Grant Co.: Mississippi River bottoms, Bagley, September 10, 1930, *Fassett 14804* (WIS). In most plants of forma *perfoliatum* the upper-most leaves and sometimes those of side branches are free at the base!

5d. EUPATORIUM PERFOLIATUM L. forma TRIFOLIUM Fassett. Map 6.

Leaves 3 at a node, their bases fused, otherwise as forma *perfoliatum.*

Rare and sporadic in Wisconsin on river bottoms, meadows, lake shores and low woods. Originally described from Maine. Flowering from July to September; fruiting in September.

Cronquist (1952) thinks that these and other oddities in *E. perfoliatum* may be the result of hybridization with some other species. In Wisconsin there is no support whatever for this supposition.

6. EUPATORIUM SEROTINUM Michx.

Leafy, tall perennials. Stem ribbed, pilose at least above. Leaves opposite, petioled, *broadly lanceolate,* prominently *irregularly toothed,* the lower surface pilose, the upper essentially glabrous. Corollas pale violet to white.

Native of the eastern and southern United States, very rarely introduced in southern Wisconsin. Collected three times: Dane Co.: Madison, drainage ditch, Olbrich Park, Aug. 1956 (fr). *Richards s.n.* (WIS). Grant Co.: Potosi, Sept. 1862 (fr), *George Engelmann s.n.* (WIS). Milwaukee Co.: Grant Park Nursery, Oct. 18, 1933 (fr), *Wolf s.n.* (MIL).

7. EUPATORIUM RUGOSUM Houtt. var. TOMENTELLUM (Robinson) Blake White Snakeroot. Map 7.

Perennial 3–7(–10) dm tall. *Leaves opposite, petioled, broadly ovate* to *deltoid,* 7–12 cm long, *5–9 cm wide,* the margins crenate-dentate. Inflorescence cymose, the numerous *heads borne on tomentose peduncles;* corrollas white. 2n=34 (Grant 1953); 2n=36 (Cooper and Mahoney 1935, presumably from Wisconsin material).

Abundant throughout Wisconsin, except in the extreme northwest, in rich, dry, mesic or moist woods, most prevalent in the southern dry-mesic forest (Curtis 1959), on shady river banks, in thickets, less commonly on lake shores, bluffs, and limestone cliffs. Flowering from late July through September; fruiting from (late July–) August to early October.

All Wisconsin specimens have tomentose peduncles (var. *tomentellum),* the typical variety with glabrous peduncles occuring south and east of Wisconsin.

White Snakeroot may cause a sometimes fatal disease of cattle, "trembles," caused by *tremetol,* one of the higher alcohols found in its leaves and stems. *Tremetol* is soluble in milk fat, and, transmitted to other animals or humans, may cause "milk sickness" (Muenscher 1951), which in the early days of settlement of the Middle West reached near-epidemic proportions (Blake 1941).

43. KUHNIA L. FALSE BONESET

[Shinners, L. H. Revision of the genus *Kuhnia* L. Wrightia 1:122–144. 1947.]

1. KUHNIA EUPATORIOIDES L. var. CORYMBULOSA T. & G. False Boneset. Map 8.

Densely and finely puberulent leafy perennials 6–10 dm tall. *Leaves mostly alternate,* subsessile to sessile, *linear to lanceolate,* 3–7(–8.5) cm long, 0.7–2.5 cm wide, *variously* toothed, villous beneath, *abundantly black resin-dotted* (10X). *Inflorescences* dense to open corymbs. Involucral bracts (7–)8–10 mm *high, oblong to lanceolate, strongly 3–5 nerved, finely pubescent with scattered yellow resinous dots* (10X). Pappus of white to brown plumose bristles. Achenes cylindrical, *10-ribbed,* finely pubescent, *without resinous atoms.*

In Wisconsin a widespread prairie species south of the "Tension Zone", most common in dry and dry-mesic prairies (Curtis 1959), in prairie relics on bluffs, roadsides or railroads, and sand dunes. Flowering from (July–) August through October; fruiting from late August through September (–October).

Shinners divided the species into four geographic varieties, of which only the common "prairies and plains" variety *corymbulosa* occurs in Wisconsin. Scatter diagrams and graphs based on Wisconsin plants indicate that tightly packed corymbs are more abundant than open ones, and that the number of flowers per head ranges from 13–24 (mode 18–19), all clearly within the limits of var. *corymbulosa.* Some correlation exists between inflorescence form and leaf denticulation, plants with compact inflorescences having leaves more nearly entire, the open inflorescence, toothed-leaved forms perhaps representing shade plants.

44. LIATRIS Schreb. BLAZING STAR

[Gaiser, L. O., The Genus *Liatris.* Rhodora 48: Aug.–Dec. 1946][4]

North American perennials from enlarged underground stems. Leaves alternate, narrow, entire. Inflorescences spicate or racemose, the rose-purple heads showy. Involucral bracts strongly imbricated, at times with reflexed tips or margins. Achenes conical, 10-ribbed, pubescent. Pappus barbellate or plumose.

KEY TO SPECIES

A. Pappus barbellate, not plumose, the lateral cilia 3–6 times the diameter of the bristle.

- B. Inflorescence a usually dense spike; heads sessile, small, the involucre 7–11 mm high.
  - C. Inflorescence rachis glabrous; involucral bracts obtuse, erect, appressed, *the tips not reflexed,* 7–8 mm high; SE-most Wisconsin ________________ 1. *L. SPICATA.*[5]
  - CC. Inflorescence rachis pilose-hirsute; involucral bracts acute, the *acuminate tips reflexed,* 9–11 mm high ________________________ 2. *L. PYCNOSTACHYA.*[5]
- BB. Inflorescence an open spike or raceme; heads larger, the involucre 9–20 mm high.
  - D. Inflorescence a raceme, rarely spiciform, long-pedunculate; *corolla glabrous within;* involucres 12–20 mm high, *the terminal head often much larger;* leaves scabrous-pubescent, the margins harshly ciliate ____________________________ 3. *L. LIGULISTYLIS.*[6]

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[4] Wisconsin specimens cited by Dr. Gaiser, though not examined, have been mapped.

[5] Plants intermediate between 1 and 2 are known from SE Wisconsin (see note under *L. pycnostachya*).

[6] Plants intermediate between 3 and 4 are known from NW. Wisconsin (see discussion under *L. ligulistylis*).

DD. Inflorescence spicate, rarely racemose, the heads short-pedunculate or sessile; *corolla pilose within;* involucres 9–15 mm high; leaves scabrous to glabrous, the margins not harsh ____________________4. *L. ASPERA.*[6]

AA. Pappus plumose, the lateral cilia 15 or more times the diameter of the bristle.

E. Heads campanulate, the bracts rounded, glabrous with scarious margins; a rare hybrid of 4 and 6 ____________________5. *L.* X *GLADEWITZII.*

EE. Heads cylindrical; involucral bracts mucronate to acuminate, the margins ciliate.

F. Inflorescence racemose, the heads 15–60 flowered; bracts mucronate; leaves not crowded, more lax, weakly punctate, not ciliate, 9–22 cm long, 3–7 mm wide; dry prairies, southern Wisconsin ___6. *L. CYLINDRACEA.*

FF. Inflorescence a dense to loose spike, the heads 3–8 flowered; bracts acuminate; leaves crowded, rigid, conspicuously punctate, ciliate, 6–15 cm long, 1–2 mm wide; prairies of Pierce and St. Croix counties ____________________7. *L. PUNCTATA.*

1. LIATRIS SPICATA (L.) Willd. Blazing Star. Map 9.

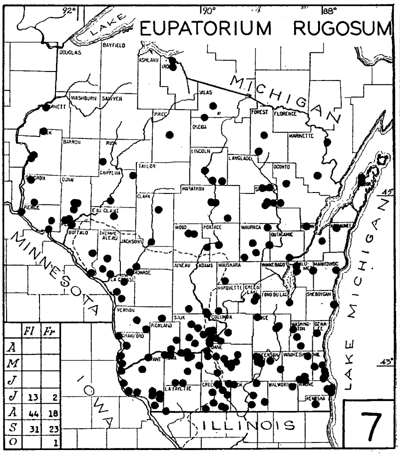
Stems stiffly erect, glabrous, 4–12 dm tall. Leaves numerous, linear-lanceolate to linear, the lower ones 12–20 cm long, 4–9 mm wide, glabrous to sparingly pilose on lower veins, the upper reduced and bractlike, *all punctate. Inflorescence a dense spike,* the heads cylindric to subcylindric. Corollas glabrous within, rich purple (white in forma ALBIFLORA Britt.). *Involucral bracts appressed, oblong to elliptic-oblong, the obtuse tips not spreading,* 7–8 mm high, green to purple, often with a scarious purple margin. Achenes 3.5–4.5 mm long. 2n=20 (Gaiser 1949).

Eastern United States, in Wisconsin rare, only in the extreme southeast, in sandy, moist, rather calcareous prairies, often with other rare plants, as on the Kenosha prairie with *Phlox glaberrima, Calamintha glabella* and *Allium cernuum,* and with *Lythrum "alatum", Pycnanthemum virginianum, Solidago rigida, S. ohioensis, S. ridellii, S. graminifolia, Aster ptarmicoides, Dodecatheon meadii, Lespedeza capitata,* and *Ratibida pinnata.* Flowering in late July and early August; fruiting in August.

Similar to *Liatris pycnostachya,* with which it may hybridize in Wisconsin, but glabrous and with appressed involucral bracts.

2. LIATRIS PYCNOSTACHYA Michx. Gay Feather. Map 10.

Stiffly erect perennials (5–) 7–9 dm tall, from an enlarged woody corm, *pilose-hirsute (especially on inflorescence rachis).* Leaves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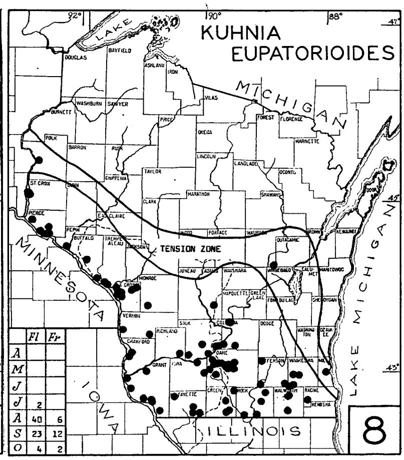
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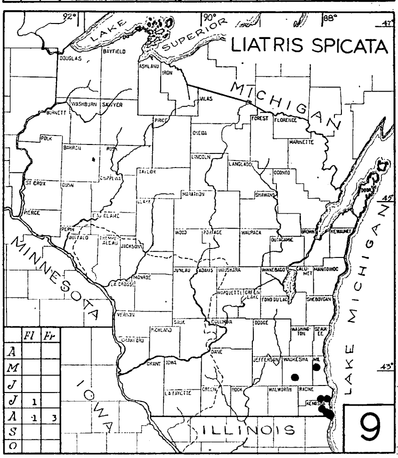
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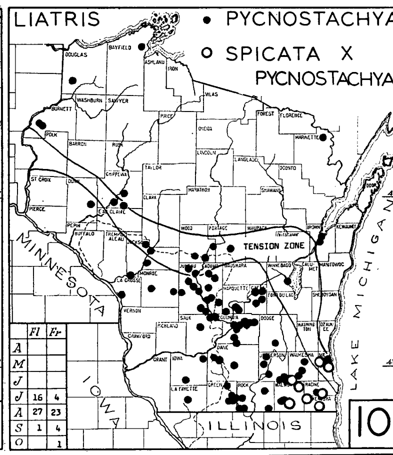
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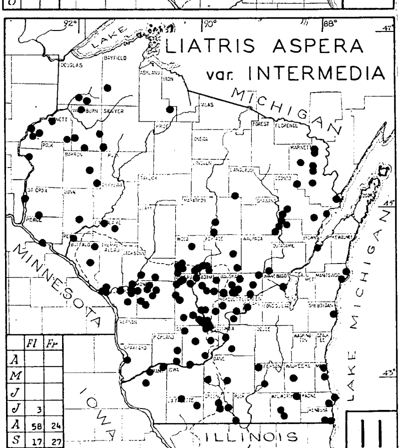
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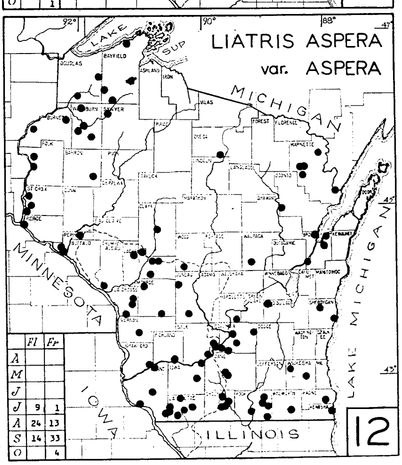
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numerous, crowded, linear-lanceolate to linear, punctate-pilose beneath to glabrous, the lower 13–35 cm long, 7–11 mm wide, the upper reduced. *Inflorescence a crowded (rarely loose) spike, the heads cylindric.* Corollas usually non-pilose within, rose-purple (white in forma HUBRICHTI E. Anderson). Involucral bracts green or purplish, *oblong to oblong-lanceolate with ciliate margins, the acute tips pronouncedly spreading,* 9–11 mm high. Achenes 3.5–4.5 mm long. 2n=20 (Gaiser 1949).

Typical of low (wet and wet-mesic) prairies (Curtis 1955), locally common on mesic prairies, in wet, sometimes rather calcareous sedge-grass meadows (fens), peat marshes, bogs, wet roadsides and wet railroad prairie relics south of the "Tension Zone", sometimes with *Liatris aspera, L. ligulistylis, L. spicata,* and *Cirsium muticum.* Often growing with many very rare species, the prairie habitat of this, one of our most showy species is in desperate need of protection! Flowering from July to early September; fruiting from (mid-July–) August through September.

Plants of *Liatris pycnostachya* from within the range of *L. spicata* are atypical, their inflorescence rachis less pilose and involucral bracts more often only slightly reflexed, all variations suggesting introgression from *L. spicata.* Natural hybridization is known to occur, the species sometimes growing together (e.g. *Runge 6331* & *6332,* Milwaukee Co. [MIL]), but the offspring are so variable that no attempt has been made to describe or name them. Gaiser (1946:245) treats these forms simply as intermediates between *L. pycnostachya* and *L. spicata.*

Though preferring more moist prairies, *Liatris pycnostachya* often grows with *L. aspera.* The two species are not known to hybridize in Wisconsin probably because of seasonal isolation, the flowering period of *L. pycnostachya* only exceptionally, if at all, overlapping that of *L. aspera.*

3. LIATRIS LIGULISTYLIS (Nels) K. Sch. Showy Blazing Star. Map 13.

Robust to slender, 8–10 dm tall; stems glabrous below, pilose on the reddish inflorescence branches, single or numerous from a shallow globose corm. Leaves glabrous to pilose, nearly always *ciliate on margins, the lower broadly spatulate to oblanceolate,* 14–36 cm long, 1.5–4 cm wide, *tapering to a long petiole,* the upper lanceolate to linear-lanceolate, sessile. *Inflorescence racemose, the heads on peduncles 1–6 (–12) cm long. Corolla* purple, GLABROUS WITHIN. Involucre campanulate, 1.2–2 cm high, 2–2.8 cm wide *(terminal head sometimes larger), the bracts glabrous, or ciliate on margin, erect,* *ovate to spatulate with irregular erose margins, usually purple.* Achenes 4.5–5.5 mm long. 2n=20 (Gaiser 1951).

Native to Wisconsin but rather sporadic, most abundant in mesic prairies (Curtis 1959), especially deep soil railroad prairies with *Stipa spartea, Andropogon scoparius, A. gerardi, Danthonia spicata,* and *Ambrosia psilostachya,* on roadsides with *Aster* and *Solidago* spp., less common on shores of lakes and swamps, low prairies and in sandy soils, in N. Wisconsin adventive on sandy roadsides and railroad embankments (Shinners 1943). Flowering in July and August; fruiting from August to early September.

Liatris aspera and *L. ligulistylis* seem to hybridize (introgress) freely in Wisconsin. These hybrids include L. X SPHAEROIDEA Michx. as recognized by Gaiser for plants rather close to *L. aspera* and L. X NIEUWLANDII (Lunnell) Gaiser for plants close to *L. ligulistylis.* These hybrids in turn reportedly back-cross to either parent, as well as to *L. spicata* or *L. cylindracea,* producing a veritable continuum of forms. In Wisconsin, where *L. aspera* is very common and *L. ligulistylis* not rare, many specimens show indications, sometimes in one, sometimes in several characters, of hybridization. Clear intermediates, as well as those listed by Gaiser (pp. 314, 326), are shown on Map 14. Many specimens of either species apparently contain minute amounts of the other's germ plasm; these are mapped with the species they most resemble, for it was not possible to formally recognize these hybrids, or to include them in a workable key. This problem is very complex and detailed population analyses are needed in areas where this hybridity is known, such as near Eagle, Waukesha County, or in NW. Wisconsin. With some plants, as those that have corollas pilose within and squarrose bracts (as in *L. aspera),* yet have heads on long peduncles in large inflorescences (as in *L. ligulistylis),* we have arbitrarily emphasized floral characters, placing them with *L. aspera.*

4. LIATRIS ASPERA Michx. Rough Blazing Star. Maps 11, 12.
Liatris sphaeroidea sensu Shinners, not Michx.

Stems slender to stout, glabrous to hirsute in the inflorescence, 4–8(–12) dm tall, singly from a rounded to irregularly elongate corm. Basal leaves lanceolate to linear, long petioled to sessile, 10–16(–27) cm long (incl. petiole), 6–17(–34) mm wide, scabrous [var. ASPERA] to glabrous [var. INTERMEDIA (Lunn.) Gaiser], the upper sessile, reduced. Inflorescence a loose spike of sessile to short- (rarely long–) pedunculate, globose to campanulate heads. Corollas purple [rarely white in forma BENKII Macbr., as in *Finger s.n.* (MIL), Sparta, or *Fassett 4482* (GH, WIS), Pepin Co.], *pilose within at base of filaments.* Involucre glabrous, green to purple, 9–15 mm high, *the outer bracts oblong to spatulate with broadly scarious, sometimes laciniate, purple margins,* the inner ones elongate, all appearing more or less blister-like and inflated (squarrose). Achenes 4–5(–5.5) mm long. 2n=20(22) (Gaiser 1951).

Throughout most of Wisconsin except the "Northern Highland," but most common on mesic prairies (Curtis 1959) and sandy prairies with *Selaginella ruprestris, Polygala polygama, Hieracium longipilum, Monarda punctata, Solidago missouriensis, Artemisia ludoviciana* and *Cladonia* spp., along mesic railroad prairies with *Andropogon gerardi, Leptoloma cognatum, Solidago rigida, Helianthus, Aster* and *Stipa spartea*, on dry prairie relics with *Bouteloua curtipendula, B. hirsuta, Silphium laciniatum, Scutellaria leonardii, Castilleja sessiliflora* and *Sporobolus* spp., becoming less common in open woods, on bluffs and river banks, and in willow thickets, often associated with Jack Pine and Scrub Oak. Flowering from mid-July to mid-September (–October); fruiting from (late July–) August through September (–October). Apparently hybridizes readily with *L. ligulistylis* (which see).

5. LIATRIS X GLADEWITZII (Farwell) Shinners
Liatris aspera Michx. (or *Liatris X sphaeroidea* Michx.) *X Liatris cylindracea* Michx.

Stems slender, pilose-hirsute, 3–5 dm tall, single or many from an irregular corm. Leaves numerous, lanceolate to linear, the lower 13–15 cm long, 6–8 mm wide, sessile, glabrous to pilose beneath, glabrous above, the upper similar but reduced and linear. *Inflorescence loosely racemose, the short-pedunculate heads cylindrical to campanulate. Involucral bracts glabrous, oblong to spatulate, with erose purple scarious margins, the lowest bracts with ciliate margin. Corolla purple, the lobes and tube pilose.* Achenes 5–6 mm long. *Pappus short-plumose,* midway between the barbellate pappus of *L. aspera* and the plumose one of *L. cylindracea.* 2n=20 (Gaiser 1951).

Reported from Ontario, Michigan and Wisconsin, here apparently rare, collected once: Crawford Co.: Dry summit of limestone bluff, Prairie du Chien, Aug. 20, 1927 [fr], *Fassett 4478* (WIS), there collected with *L. cylindracea, Fassett 4479* (WIS).

Though often growing together (e.g. Oliver Prairie Scientific Area, Green Co.), the parental species of this hybrid only very rarely hybridize. It may be significant that they are somewhat ecologically isolated, *L. cylindracea* growing in dry, *L. aspera* more in mesic prairies (cf. Curtis 1955, graph p. 563), with the latter species blooming somewhat later, though blooming dates overlap considerably.

6. LIATRIS CYLINDRACEA Michx. Blazing Star. Map 15.

Stems slender, usually unbranched, glabrous to very sparsely puberulent, 2–5(–6) dm tall, from a globose corm. Leaves glabrous to sparsely ciliate beneath or on the basal margin, 9–22 cm long, 3–5(–7) mm wide, numerous and ascending. *Inflorescence racemose, the cylindrical heads short pedunculate, subtended by a leafy bract. Corollas* purple (rarely pink or white), *pubescent on the* *inner surface.* Involucre 1–2 cm high, 6–11 mm wide, the *bracts purple to green with closely appressed, ovate, mucronate tips.* Achenes (4.5–) 5–7.5 mm long. *Pappus gray, plumose.* 2n=20 (Gaiser 1951).

A species of dry sandy soils, extending from the East Coast to the Mississippi River, in Wisconsin reaching greatest prevalence on dry prairies south of the "Tension Zone" (Curtis 1959), also on dry limestone bluffs, sandy river banks, rarely on roadsides on railroads, the range extensions north into Burnett County [there with *Petalostemum villosum* at its eastern-most extension (Fassett 1939)] and Marinette County correlated with the presence of dry sandy areas. Flowering from mid-July to early September (–October); fruiting from August to September (–October).

7. LIATRIS PUNCTATA Hook. var. NEBRASKANA Gaiser Map 14.

Stems slender, glabrous, 3–5 dm tall, several to many from a *stout vertical underground stem. Leaves numerous, stiffly ascending,* glabrous to sparingly ciliate on the margins, the lower ones 6–15 cm long, 1–2 mm wide, *conspicuously punctate.* Inflorescence a dense to loose spike, the heads narrowly cylindric. Involucral bracts ovate-acuminate, appressed *except for the spreading acuminate tip, densely punctae,* 1–1.5 cm high, the margins usually long ciliate. Achenes (4–) 6–8 mm long. *Pappus plumose.* 2n=20 (30) (Gaiser 1950).

Rare in the state in sand prairie relics and on sandstone bluffs and terraces along the St. Croix and Mississippi Rivers in St. Croix and Pierce Counties. Flowering in August; fruiting in August and September. The typical variety, to the west and south, has broader leaves with conspicuous ciliate margins.

TRIBE VIII. VERNONIEAE CASS.

Perennials with watery juice. *Flowers all tubular, perfect, purple;* style branches filiform, acute or acuminate, hispidulous. *Leaves alternate.* Pappus bristly, brown.

45. VERNONIA Schreb. IRONWEED

1. VERNONIA FASCICULATA Michx. Ironweed. Map 16.

Perennials 9–16 dm tall, with scaley underground offshoots, glabrous throughout, the stems often purplish. Leaves numerous, lanceolate to lancelinear, long-acuminate, sharply and finely toothed, 9–15 cm long, 1–3 cm wide, the *underside densely punctate* (10X). Inflorescences dense, flattopped, the numerous heads on short, thin, tomentose peduncles. *Involucral bracts numerous, green or purple, closely appressed and imbricate.* Heads 18–25 flowered, the *corolla rich purple.* Achenes cylindrical, farinose between ribs. *Pappus bristles purple when young, becoming brown,* 6–7 mm long.

Locally abundant south of the "Tension Zone", occasional in the North, especially in wet-mesic prairies (Curtis 1959), tall forb communities along railroads, open lake shores and river banks, open river bottom forests, swamps and marshes, and often a prominent weed in low overgrazed pastures. Flowering from mid-July into September (peak in early August); fruiting from late July through September (peak in late August).

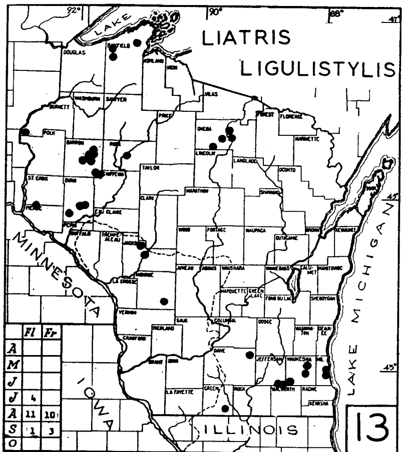
VERNONIA CRINITA Raf., a perennial, whose large round heads have loose involucral bracts with elongate linear tips, a native of Missouri, Kansas, Arkansas and Oklahoma, reputedly has been collected once in Wisconsin; Manitowoc Co.: Cleveland, along railroad, August, 1907 [fl] *Goessl s.n.* (WIS), a record possibly based on error. *Vernonia altissima* Nutt. and *V. missurica* Raf. have been collected from the Illinois counties bordering Wisconsin within the past five years, and may soon be expected in southern Wisconsin.

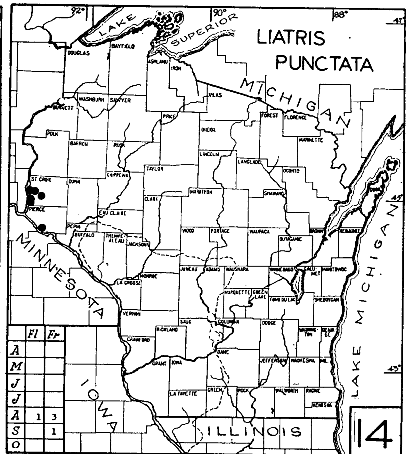
TRIBE XI. CYNAREAE SPRENG.

Annuals, biennials or perennials with basal rosettes or alternate cauline leaves. *Corollas all tubular, often deeply cleft, purple, rarely blue, yellow or white. Style bearing ring of hairs or thickened ring, above which the branches are papillate and stigmatic to the tip. Anther bases tailed.* Heads globose to campanulate, the involucre imbricated, the bracts tipped with spines, hooks, or appendages, Achenes stout, truncate, the pappus bristly.

KEY TO GENERA

A. Achenes attached by the base to the receptacle; flowers all alike; bracts entire, sometimes hooked or spiny, not laciniate at tip; pappus various, usually more than 5 mm long.
  B. Leaves broadly rounded at base, unarmed; involucral bracts terminated by a hook *(Burdocks)* -- 46. ARCTIUM.
  BB. Leaves lanceolate to ovate, prickly, the bases decurrent or not; involucral bract each terminated by a rounded or flattened straight spine or merely mucronate *(Thistles)*.
    C. Involucral bracts with needle-like spiny tips or merely mucronate, often with a glutinous ridge on back; pappus plumose -------------------------- 48. CIRSIUM.


LIATRIS
LIGULISTYLIS
LAKE
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
13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LIATRIS
PUNCTATA
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
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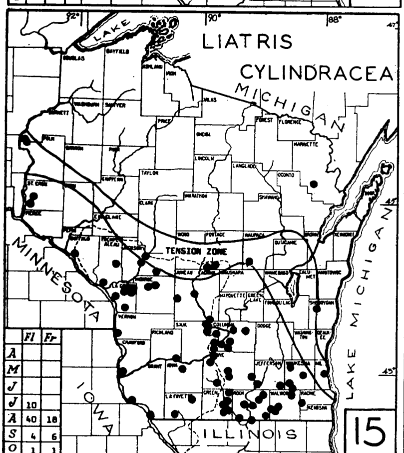
14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MICHIGAN
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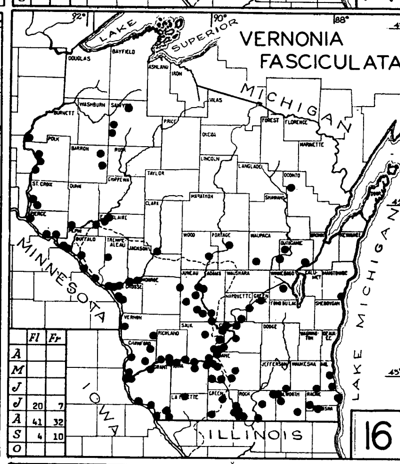
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
15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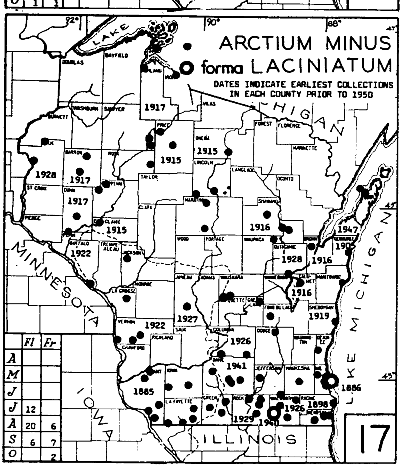
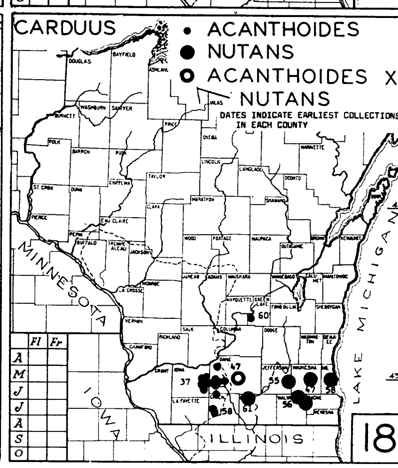
VERNONIA
FASCICULATA
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
16


LAKE
• ARCTIUM MINUS
O forma LACINIATUM
DATES INDICATE EARLIEST COLLECTIONS IN EACH COUNTY PRIOR TO 1950
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
17


CARDUUS
• ACANTHOIDES
● NUTANS
O ACANTHOIDES X NUTANS
DATES INDICATE EARLIEST COLLECTIONS IN EACH COUNTY
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
18

CC. Involucral bracts with flattened spiny tips, not glutinous; pappus barbellate to capillary.

D. Leaves and stem wings glabrous or nearly so; pappus capillary; receptacle bristly __47. CARDUUS.

DD. Leaves and stem wings densely cottony-velutinous; pappus barbellate; receptacle fleshy, not bristly ______________________________49. ONOPORDUM.

AA. Achenes obliquely attached to the receptacle; marginal flowers often enlarged and ray-like; bracts often deeply cleft on margins of tip (laciniate), the tip occasionally spiny; pappus mostly less than 3 mm long or lacking ____50. CENTAUREA.

46. ARCTIUM L. Burdock

Robust biennials with large long-petioled ovate-cordate leaves pilose-villous and atomiferous beneath. Heads numerous, the purple flowers tubular and perfect, the involucre globose with the firm, lanceolate bracts *terminated by a hook, the whole head breaking off as a bur.* Achenes flattened, irregularly furrowed; pappus of minute coarse bristles. Old World genus; all our species introduced weeds.

Key to Species

A. Heads 1–1.6 cm high, (1.5–)2–2.5 cm wide, subsessile or short pedunculate, in a racemose inflorescence; common weed ____ ____1. *A. MINUS.*

AA. Heads 1.5–2.5 cm high, 1.5–2.5 cm wide, long pedunculate, in a corymbose inflorescence; rare weeds.

B. Heads 1.5–1.7 cm high. 1.5–2.1 cm wide, the bracts densely cottony-pubescent _______________2. *A. TOMENTOSUM.*

BB. Heads ca. 2.5 cm high, 3–3.5 cm wide, the bracts glabrous ___________________________________3. *A. LAPPA.*

1. Arctium minus (Hill) Bernh. Common Burdock. Map 17.

Coarse robust biennials, 2 m tall or more, branched above. Basal rosette leaves large, broadly ovate-cordate, cottony and frequently atomiferous to glabrate beneath, glabrous to floccose above, entire. Heads numerous, crowded on mostly very short peduncles; corolla rose to purple. Involucre 1–1.6 cm high, (1.5–)2–2.5 cm. wide (from tip to tip of bracts); bracts glabrous or arachnoid, linear, rigid, with hooked tips, usually exceeding the corollas. Achenes 4.5–5 mm long, irregularly rugulose. 2n=32 (Wulff 1937, ex Darlington 1955).

Native to temperate Europe and east to the Caucasus, naturalized in Wisconsin as a weed indicative of nitrogenous soils (Curtis 1959), common in roadside communities, abandoned fields, heavily grazed pasture, and often along cow paths and other disturbed habitats where relatively free from competition. Flowering from July through September (–November), fruiting from August through November.

ARCTIUM MINUS forma LACINIATUM Clute, rare in Wisconsin, has abnormal leaves variously lobed, cleft, irregularly toothed, or reduced to the midrib, and immature sterile heads, and is evidently caused by a virus infection. That such plants may reoccur in the same area for consecutive seasons is shown by *Wadmond s.n.*, Sept. 3, 1940 and August 9, 1942, both from the same vacant lot in Delavan.

2. ARCTIUM TOMENTOSUM Mill. Hairy Burdock.

Similar to *A. minus,* but inflorescences corymbose, the bracts densely cottony-pubescent. 2n=36 (Poddubnaja 1944, ex Darlington 1955).

Native to temperature Europe, Caucasus and Siberia (Hegi), in the United States more common to the south and east. Collected three times in Wisconsin: Ashland Co.: Weed at Berkshire Mine, Mellen, Sept. 7, 1927 [fr], *Fassett 10084* (WIS); Town of Morse, Aug. 31, 1939 [fl], *McIntosh c-812* (MIL, WISM). Fond du Lac Co.: Campbellsport, near railroad sta., Aug. 1911 [fr], *Ogden 24994* (MIL).

3. ARCTIUM LAPPA L. Great Burdock.

Similar to *A. minus, but with larger glabrous heads 3–3.5 cm wide,, 2.5–3 cm high, on long peduncles in corymbose inflorescences.* 2n=32 (Darlington 1955).

Native of temperate Eurasia, collected but twice in Wisconsin: Iowa Co.: Roadside, July 27, 1961 [fl], *Brady & Maduewesi s.n.* (WIS). Lincoln Co.: Abandoned farm, Harrison Twp. *Seymour 12693* (WIS).

47. CARDUUS L. PLUMELESS THISTLE

Spiny-leaved herbs closely resembling *Cirsium,* but distinguished by the non-plumose, capillary pappus.

KEY TO SPECIES

A. Involucre 2.8–3 cm high, the heads solitary; peduncles wingless immediately beneath the head ---1. *C. NUTANS var. LEIOPHYLLUS.*

AA. Involucre 1.5–1.7 cm high, the heads clustered; peduncles winged immediately beneath head ----2. *C. ACANTHOIDES.*

1. CARDUUS NUTANS L. var. LEIOPHYLLUS (Petrovic) Arenes
Smooth Nodding Thistle; Musk Thistle. Map 18.

Robust biennial 1–2 m tall, the *large solitary heads with showy purple corollas.* Leaves lanceolate to oblanceolate, shallowly to deeply undulate-pinnatifid, *the primary and secondary lobes obtuse, armed with stout, white spines,* glabrous, the bases decurrent forming *spiny wings along the stem except on the cottony peduncles.* Heads 5–8 cm wide; involucre 1.5–3 cm high; bracts glabrous, *wide above, contracted near the base and reflexed,* tapering to a stout spine. Achenes ca 3.5 mm long, yellowish, slightly furrowed. 2n=16 (Poddubnaja 1931, ex Darlington 1955).

Native to Europe, Asia and Northern Africa, in SE Wisconsin a recent introduction (see map), rare though locally abundant in Jefferson, Waukesha and Walworth counties, where it may produce impenetrable stands in abandoned hog pastures [cf. *Johnson, Beery, & F. S. Iltis* 27–61 (WIS) from near Troy], and sporadic in disturbed fields or roadsides, Flowering from mid-June to early July; fruiting from mid-June to August.

The typical variety, not known from Wisconsin, has pubescent leaves, smaller heads and cobwebby involucral bracts.

2. CARDUUS ACANTHOIDES L. Plumeless Thistle. Map 18.

Very spiny annuals or biennials, usually less than 1 m tall. Leaves lanceolate, deeply undulate-pinnatifid, the acuminate lobes armed with stiff yellowish spines, glabrous to sparsely pilose beneath, *the bases decurrent, forming several conspicuous spiny wings along the entire stem. Heads clustered;* involucres 1.5–1.7 cm high, *the bracts narrow, erect,* the corollas bright rose-purple. Achenes 2.5–2.7 mm long, tannish and shallowly furrowed. 2n=22 (Poddubnaja 1931, ex Darlington 1955).

Native of Europe and Southern Russia (Hegi), very recently introduced and only locally abundant in south-central Wisconsin where becoming a serious pest, mainly in valley bottom pastures and grazed calcareous hillsides in Iowa and Green Co's., on railroads and prairies in Dane Co., and near Marquette [Green Lake Co.:

Ugent s.n. (WIS)] in open oak-maple woods, on thin soil at base of granite outcrops, with *Oenothera biennis, Celastrus scandens, Circaea quadrisulcata,* and *Geum canadense!* Flowering from mid-July to early August; fruiting to September.

Resembling *Cirsium vulgare* and *C. palustre* in the spiny stem wings, but differing from *C. vulgare* by less spiny involucres and the capillary pappus, and from *C. palustre* by larger, less clustered heads and the capillary pappus.

3. CARDUUS ACANTHOIDES L. X CARDUUS NUTANS L. Map 18.

Plants pilose to cottony above, the leaves sparsely pilose at least on the lower midrib, deeply pinnatified, the lobes terminated by yellowish spines, the bases decurrent, *forming wings immediately below the head on one peduncle (branch), but with wings absent below the other heads of the plant;* heads somewhat clustered, the involucre ca. 2 cm high.

This description is based on *Zimmerman 1879* from a Dane Co. pasture (T6N, R9E, S.3), Aug. 3, 1947 (WIS), the only Wisconsin collection.

Moore and Mulligan (1956) determined hybrid populations naturally occurring in Canada by evaluating morphological variation and erecting the following hybrid index:

CARDUUS ACANTHOIDES		ZIMMERMAN 1879	CARDUUS NUTANS	
Heads clustered	0	1	Heads solitary	2
Heads erect	0	2	Heads nodding	4
Peduncles spiny-winged	0	2	Peduncles not spiny winged	4
Phyllaries spreading	0	2	Phyllaries reflexed	4
Phyllaries marked	0	1	Phyllaries unmarked	1
Phyllaries not contracted	0	2	Phyllaries contracted at base	4
	0	10		19

Using this hybrid index, "typical *C. acanthoides* has an index of O and typical *C. nutans* has an index of 19 points. Hybrids would have intermediate values. First generation hybrids might be expected to have an index in the middle of the range, for example 7–11; later generations or backcross hybrids might have an index approaching that of one of the parental species." The hybrid index value suggests that the Wisconsin specimen is a first generation hybrid.

48. CIRSIUM Mill. THISTLES

Spiny biennials or perennials. Leaves alternate, sessile, usually pinnatifid and spiny. Flowers all tubular, perfect, or (in *C. arvense*) dioecious, rose to purple, rarely white or cream. Involucral bracts imbricated in many rows, at least the outer ones tipped with a spine or mucro, often with a glutinous dorsal ridge. Pappus plumose. Name from the Greek, applied by Dioscorides to a thistle used as a reputed remedy for varicose veins.

KEY TO SPECIES*

A. Involucral bracts distinctly spine-tipped (at least the outer and middle), the spine usually more than 2 mm long, but when very short the larger involucres 20 mm or more in diameter.

B. Leaves scabrous-hispid or crisped-hispid and also sometimes silky-pubescent above, more or less cobwebby and sometimes crisped-hispid or tomentose beneath.

C. Leaves scabrous-hispid above, sparsely to densely cobwebby beneath, the cauline conspicuously decurrent;[7] involucral bracts herbaceous, spreading, gradually tapered into elongate spiny tips, lacking a dorsal glutinous ridge; common introduced weed __1. *C. VULGARE.*

CC. Leaves crisped-hispid with multicellular hairs and also sometimes sparingly silky-pubescent above, not decurrent, the stems not winged; involucral bracts not herbaceous, appressed, with a dorsal glutinous ridge.

D. Leaves crisped-hispid on both surfaces, green; involucral bracts with an erect apical spine; involucres 30–50 mm high; stem 3–5 dm tall, from persistent basal rosettes; dry or mesic prairies, rare. ______________________________2. *C. PUMILUM*

DD. Leaves crisped-hispid above, white-tomentose beneath; involucral bracts with an abruptly spreading apical spine; involucres 25–35 mm high; stem mostly 6–15 dm tall, the basal rosettes not persistent.

E. All leaves deeply lobed (except in juvenile forms), the lobes linear-acuminate, terminating in stout spines, the thickish margins involute; involucral spines 3–7 mm long; plants mostly of open places ______________3. *C. DISCOLOR.*[8,9]

EE. Leaves shallowly lobed, irregularly dentate, serrate or entire, with small, weak spines, the margins thin, not involute, the lower leaves (and

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* In the construction of this key, the help of Dr. Gerald Ownbey is gratefully acknowledged.

[7] See also *Carduus acanthoides.*

[8] F_1 hybrids with *C. muticum* have involucral spines averaging 1.3 mm long, intermediate corolla color, and very low fertility (see text).

[9] *Cirsium discolor* also hybridizes with *C. altissimum* (see text).

those of juvenile forms) sometimes deeply lobed, then lobes wide, broadly acute; involucral spines 2.5–4.5 mm long; plants mostly of woods ____________________________4. *C. ALTISSIMUM.*[9]

BB. Leaves white-tomentose on both surfaces, often more thinly so above, totally lacking hispidity; dorsal glutinous ridge present on involucral bracts.

F. Leaves not decurrent on stem or only very shortly so (to 1 cm), the lobes lanceolate or deltoid; corollas purple or lavender, rarely white; rare introduced weeds.

G. Leaves narrowed to the base, rarely clasping; anthers 6.5–11.8 mm, florets 21–36 mm long, achenes 3.5–5 mm long, yellowish brown with apical yellow band ca ½ mm wide; involucres 20–27 mm high, the bracts narrow and slender; leaves lobed nearly to midrib, the lobes narrowly triangular, usually less than 7 mm wide at base; plants strongly perennating by root sprouts. __________5. *C. FLODMANII.*

GG. Leaves broadest near the base, partially clasping; anthers 9.4–13.3 mm, florets 27–40 mm long, achenes 5–7 mm long, brown, the yellow apical band lacking or very narrow; involucres 30–35 mm high, the bracts broad and stout; leaves shallowly lobed, the lobes broadly triangular, usually more than 7 mm wide at base; plants weakly perennating by root sprouts. __________________6. *C. UNDULATUM.*

FF. Middle cauline leaves conspicuously decurrent, the narrowly linear to oblong lobes very distant, the leaf blade divided nearly to the midrib, the decurrent wing often similarly lobed; corollas cream-colored; plants not conspicuously spinescent; dunes of Lake Michigan ______________________________________7. *C. PITCHERI.*

AA. Outer and middle involucral bracts with at most a short spine or mucro, this up to 1 mm long (and then involucre about 10 mm in diameter).

I. Biennials (at least monocarpic); flowers perfect; plants of moist habitats.

J. Leaf bases strongly decurrent into prominent wings on stem; heads many, sessile or sub-sessile, crowded into a dense terminal inflorescence; involucre 9–12 mm high, the bracts neither conspicuously glutinous nor cobwebby; rare, N. Wisconsin _______________10. *C. PALUSTRE.*

JJ. Leaf bases not decurrent; heads solitary or several, pedicellate, not crowded; involucre 22–27 mm high, 12–19 mm wide at base when in flower, cobwebby with prominent glutinous dorsal ridge; wet prairies and sedge meadows, common ....9. *C. MUTICUM.*[8]

II. Perennials from proliferating underground parts; heads numerous, crowded in 2's to 4's or short pedunculate; involucre 10–20 (–26) mm high, 8–11 mm wide at base when in flower, the bracts usually glabrous and with a narrow dorsal glutinous ridge; very common weed ....11. *C. ARVENSE.*

1. CIRSIUM VULGARE (Savi) Airy-Shaw Bull Thistle. Map 19.
Cirsium lanceolatum (L.) Scop.

Very spiny robust biennials 1–2 m tall, with taproots. Leaves oblong-lanceolate to obovate, white-arachnoid to subglabrous and green beneath, *scabrous-hispid and appressed-spinulose above, undulate-pinnatifid,* the lobes and tip acuminate with firm, straw-colored spines, *the bases decurrent into conspicuous spiny wings.* Corollas deep rose-purple; involucre 2.5–3.5(–4) cm high, *the herbaceous bracts widely divergent from near or below the middle,* all long-attenuate into a stout spine. Achenes 3–4 mm long, yellow-brown, finely striped with black. 2n=68 (Löve & Löve 1948).

An abundant aggressive weed throughout Wisconsin, on roadsides, grazed pastures, and disturbed open or wooded areas, becoming less abundant in wet to mesic prairies, marshes, bogs or swampy woods. Flowering from mid-July to early October; fruiting from late July to mid-October.

2. CIRSIUM PUMILUM (Nutt.) Spreng. Small Prairie Thistle; Hill's Thistle. Map 20.
Cirsium Hillii (Canby) Fernald

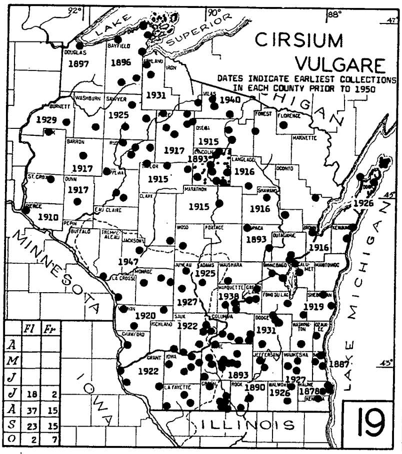
Stout stocky spiny perennials 2–5 dm tall, from a deep, hollow taproot, to 7 dm long. *Stem prominently and densely white-pilose,* each of the 1–3(–5) branches terminated by a *single large purple-flowered head.* Cauline and basal rosette leaves green, sparsely crisped-hispid above and beneath, oblanceolate, repand to shallowly or deeply undulate-pinnatifid, the lobes oblong, rounded to acute with spiny margins. Heads light rose-purple; involucre (3–)3.5–4.6 cm high, the bracts lanceolate, with a dark glutinous dorsal ridge (difficult to determine in old heads), loosely appressed, the outer tipped by short spines. Achenes (3–)3.5–5 mm long, light brown, yellow at the base of pappus. 2n = 30 (Ownbey and Hsi 1963).

S. and SW. Wisconsin, now rare and local on dry, steep, calcareous hill prairies, as well as in deep soil or sandy prairie relics along railroads, apparently introduced in Douglas and Racine Counties and probably also in Marinette County. Flowering from mid-June through July (–August); fruiting from late July to mid-August (–September). This beautiful and very characteristic species of dry prairies needs protection from extinction.

C. pumilum, the name long applied to the eastern population, has been adopted for ours as well, since the supposed differences between it and *C. hillii* seem rather trivial. Frankton and Moore annotated all our material in 1962 with this name. However, Ownbey and Hsi (1963) state that "*C. hillii* is perennial by means of root and crown spouts and this has been and still remains the most useful way to distinguish it from its closest relative, *C. pumilum* (Nutt.) Spreng., a biennial." Whether these differences are ecotypic (genetic) or phenotypic (enviromental) remains to be seen. It is of interest to compare this situation with that in *C. canescens* (cf. Ownbey and Hsi 1963), where the monocarpic form (*C. plattense*, which blooms once after two or three years and then dies) is restricted to the open, unstable sandy habitats of Nebraska's "Sandhills", while the perennial form (*C. canescens s.s.*) is more widespread westward and north; i.e. the monocarpic form occurs in the ecologically open habitat, while the perennial form in the more closed prairie communities, communities which are characterized by plants of perennial habit. and have very few annuals or biennials. Perhaps *C. pumila* exhibits a homologous variation in growth form, in that the plants (ecotypes) adapted to the prairie habitat (i.e. *C. hillii*) have been selected towards the perennial habit, thus circumventing the yearly difficulties of establishment in a closed community, while the mostly eastern populations (*C. pumilum sensu stricto*), growing in sand, fields or other ecologically open habitats, can "afford" to be biennial (monocarpic).

3. CIRSIUM DISCOLOR (Muhl.) Spreng. Prairie Thistle Map 21.

Very spiny biennials 1–3 m tall, with taproot and spreading fibrous lateral roots. Stem deeply ridged, sub-glabrous to glabrous, much branched. Leaves ovate to lanceolate, 11–40 cm long, *all deeply undulate-pinnatifid, the caudate-acuminate primary and secondary lobes tipped by elongate yellow spines, the margins more or less strongly revolute, densely white-woolly beneath,* crisped-hispid to subglabrous above. Heads with *rather light rose-purple corollas* [white in the rare *forma* ALBIFLORUM (Britt.) House], usually solitary at the end of leafy branches. Involucre 2–3.5 cm long, the *bracts lanceolate* with narrow glutinous ridge, *acute, the outer abruptly contracted into slightly reflexed or divergent slender*


CIRSIUM
VULGARE
DATES INDICATE EARLIEST COLLECTIONS IN EACH COUNTY PRIOR TO 1950
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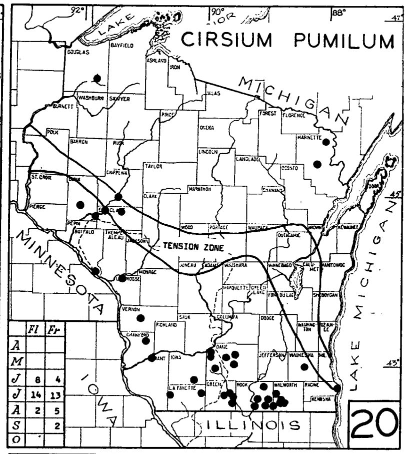
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
19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TENSION ZONE
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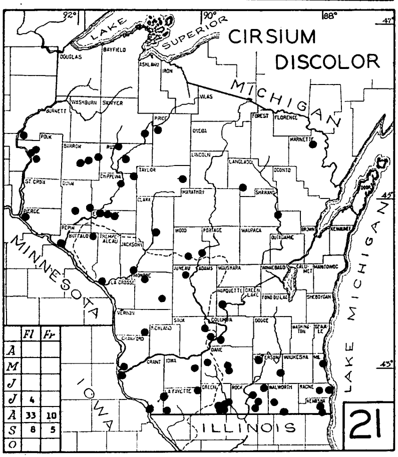
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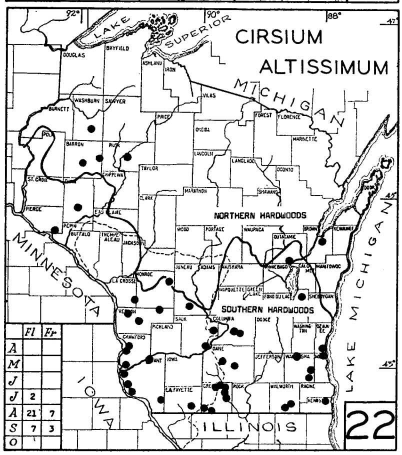
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ALTISSIMUM
NORTHERN HARDWOODS
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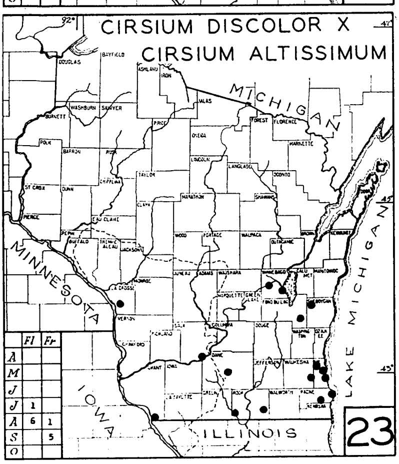
22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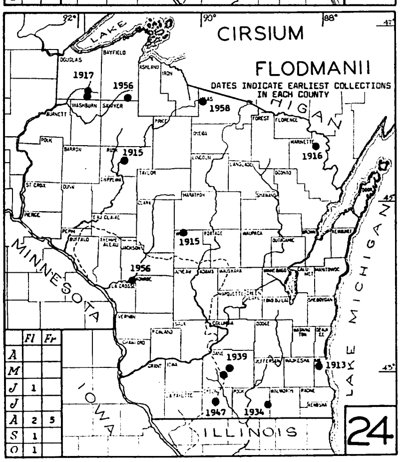
LAKE MICHIGAN
23


CIRSIUM
FLODMANII
DATES INDICATE EARLIEST COLLECTIONS IN EACH COUNTY
LAKE
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
24

spines 3–7 mm long, the inner with erose-scarious tips. Achenes 4–5 mm long. 2n=20 (Ownbey 1951).

Not uncommon in S and SW Wisconsin in sunny habitats, in wet to mesic-dry-prairies, an indicator of mesic prairie (Curtis 1955, 1959), often on railroads, lake shores, in sedge meadows, and occasionally weedy in roadside ditches and well-drained, light soil. Flowering from mid-July to early September; fruiting from early August through September.

This species hybridizes with *Cirsium altissimum.*

4. CIRSIUM ALTISSIMUM (L.) Spreng. Wood Thistle. Map 22.

Robust biennials 1–3 m tall, the stems pilose-puberulent, weakly ridged, mostly unbranched except in the inflorescense. *Leaves broadly oblanceolate to elliptic, unlobed and serrate or shallowly lobed,* the large lower basal ones rarely pinnatifid, especially at the base of blade, the lobes wide and broadly acute, 9–40(–70) cm long (including long petiole of basal leaves), 3–19 cm wide, *the margins with weak prickles, densely white-tomentose beneath,* glabrate to pilose and crisped-hispid above. Heads nearly identical to those of *Cirsium discolor,* one to several on leafy peduncles; corollas pink-purple; involucre 2–2.7 cm high, *each outer bract with a dark glandular ridge, obtuse, abruptly contracted into a slender spine 2–4 mm long,* the inner-most bracts attenuate, with scarious, entire tip. Achenes 3.5–5 mm long. 2n = 18, 20 (Ownbey and Hsi 1963).

Mostly in the southern Wisconsin hardwood forests, reaching greatest abundance in the southern dry-mesic forest (Curtis 1959), in Red, Black and White Oak communities, in E. Wisconsin frequently in maple-beech woods and shady wooded ravines, occasionally along roadsides and railroads. Flowering from (mid-July) August through September; fruiting from mid-August through September.

Similar to *Cirsium discolor* in its heads, leaf pubescence and spine-tipped involucral bracts (which average a little shorter), but differing in the mostly unlobed leaves (especially the upper), and a preference for mesic woods.

The morphological intergradation between these species is probably due to introgressive hybridization. Specimens of *Cirsium altissimum* (Map 23) with at least some leaves pinnatifid and bearing longer prickles resemble *C. discolor,* and lend support to Cronquist's (1952) suggestion that these two species are part of one continuum. Most floras recognize two species, however. Both Ownbey and Davidson (1963), the latter in a very careful study, have detailed evidence of hybridization, the former stating that he had "conclusive proof that *Cirsium discolor* and *Cirsium altissimum* hybridize in Wisconsin. On the basis of herbarium specimens one may, however, encounter considerable difficulty in distinguishing the putative hybrids from more extreme forms of *Cirsium altissimum*".[10]

5. CIRSIUM FLODMANII (Rydb.) Arthur Flodman's Thistle
Cirsium canescens sensu Gleason 1952, not Nutt. Map 24.

Slender woolly-stemmed perennial 3–6(–9) dm tall, spreading prolifically by root sprouts. Leaves lanceolate, *densely permanently white-woolly beneath,* less so and often glabrate above, subentire to deeply undulate-pinnatifid (then very spiny), the *lobes narrowly lanceolate to triangular, usually less than 7 mm wide at the base* (rarely wider in rosette leaves), ending in firm yellow spines. *Heads with bright purple corollas,* the involucre 2–2.7 cm high, *the narrow bracts to 2.5 mm wide, glutinous-ridged and flocculose,* the outer abruptly contracted, the apical spines divergent, the inner acuminate. Achenes 2.5–3.5 mm long, *light brown with a distinct yellow apical band more than ½ mm wide.* 2n=22 (D. Löve, ex Frankton 1955).

Native of the Great Plains, recently introduced in Wisconsin on sandy roadsides, along railroads, and disturbed areas, and rarely established in native prairie [*Shinners 1173,* Dane Co. (WIS)]. Flowering from late June to early October; fruiting from August through October. This species is very similar to the more robust *C. undulatum.* A careful analysis of their differences may be found in Frankton and Moore (1961).

6. CIRSIUM UNDULATUM (Nutt.) Spreng. Map 25.
Cirsium undulatum (Nutt.) Spreng. var. *megacephalum* (Gray) Fern.

Stout, white-woolly stemmed perennials 3–7 dm tall. Leaves lanceolate to oblanceolate, *tomentose beneath,* more thinly so above, *shallowly lobed to undulate-pinnatifid, the lobes broadly triangular, usually more than 7 mm wide at base,* ending in a short, firm spine, *the lower midrib conspicuous.* Heads solitary to several with pink-purple corollas; involucre 3–3.5 cm high; *bracts 2–4 mm wide, glutinous-ridged, woolly on the margins, the outer obtuse with a flattened broad-based spine,* the innermost attenuate into erose tips. *Achenes with very narrow yellow apical band.* 2n=26 (Frankton & Moore 1961).

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[10] Using a pollen stain technique, Ownbey recognized one intermediate specimen from Wisconsin [Racine Co.: Clay soil, brush-covered bluff of "Cedar Bend" of Root River, Aug. 24, 1906, *Heddle 279* (WIS)] as "certainly a hybrid, and probably an F_1, as all the pollen in the preparation made was abortive."

Often confused with *Cirsium flodmanii,* but with more shallowly and wider lobed leaves, the middle cauline half-clasping, larger heads, longer florets and anthers, and wider involucral bracts.

Native of the western Great Plains (cf. Frankton & Moore 1961), rarely adventive eastward, in Wisconsin local, very sporadic mostly along railroads and probably not anywhere permantly established. Flowering in June and July; fruiting in August.

CIRSIUM OCHROCENTRUM Gray, a western Great Plains species, is represented by two sheets (WIS), one from "Prairie du Chien, 1921," and the other from "Marshfield, 1915," both collected by *Chas. Goessl* and appearing as if they came from the same plant. The species, a perennial, resembles *C. undulatum* but with heads like *C. pumilum.* These collections are probably not from Wisconsin.

CIRSIUM CANESCENS Nutt., another Great Plains species, was collected once, by *Chas. Goessl* (*s.n.* & no date, in WIS), in a "R. R. yard, Sheboygan." Like in the above species, this collection was probably not made in Wisconsin either.

7. CIRSIUM PITCHERI (Torr.) T. & G. Dune Thistle. Map 26.

Densely white-woolly biennial (or at least monocarpic) to 7 dm tall, *from a very long straight taproot* to over 20 dm long! Leaves long-petioled, the bases at times decurrent on the stem, *densely woolly beneath,* less so above, *lobed to the midrib, the lobes distant, linear to narrowly oblong,* entire, or rarely with a lateral lobe near base, *terminated by a minute brown bristle. Heads with pale yellow or cream corollas,* solitary to several crowded on the branches. Involucre 2–2.5(–3) cm high, the outer bracts ovate-lanceolate, terminated by short firm spines, the inner lanceolate, terminated by weak spines. *Achenes 6–6.6 mm long,* light brown. 2n = 34 (Ownbey and Hsi 1963).

A beautiful species, endemic to the outer dunes of the Great Lakes, in Wisconsin restricted to those of Lake Michigan. Flowering from mid-June through July; fruiting from (late June–) July through August (–September).

On the loose sand of the outer dunes, *Cirsium Pitcheri* is often associated with other endemics (mostly neo-endemics) of the dunes, such as *Agropyron psammophilum* Senn & Gillett (=*A. dasystachyum* of Fassett 1951) and *Calamovilfa longifolia* var. *magna,* as well as with *Elymus canadensis, Ammophila breviligulata, Agropyron trachycaulon, Artemisia caudata, Lathyrus maritimus, Oenothera parviflora, Potentilla anserina, Juncus balticus* and occasionally *Cakile edentula,* vars. *edentula* and *lacustris* (cf. Patman & Iltis 1961) and *Corispermum hyssopifolium,* the latter two genera more on the periodically inundated flat beach, where *Cirsium Pitcheri* is rarely found.

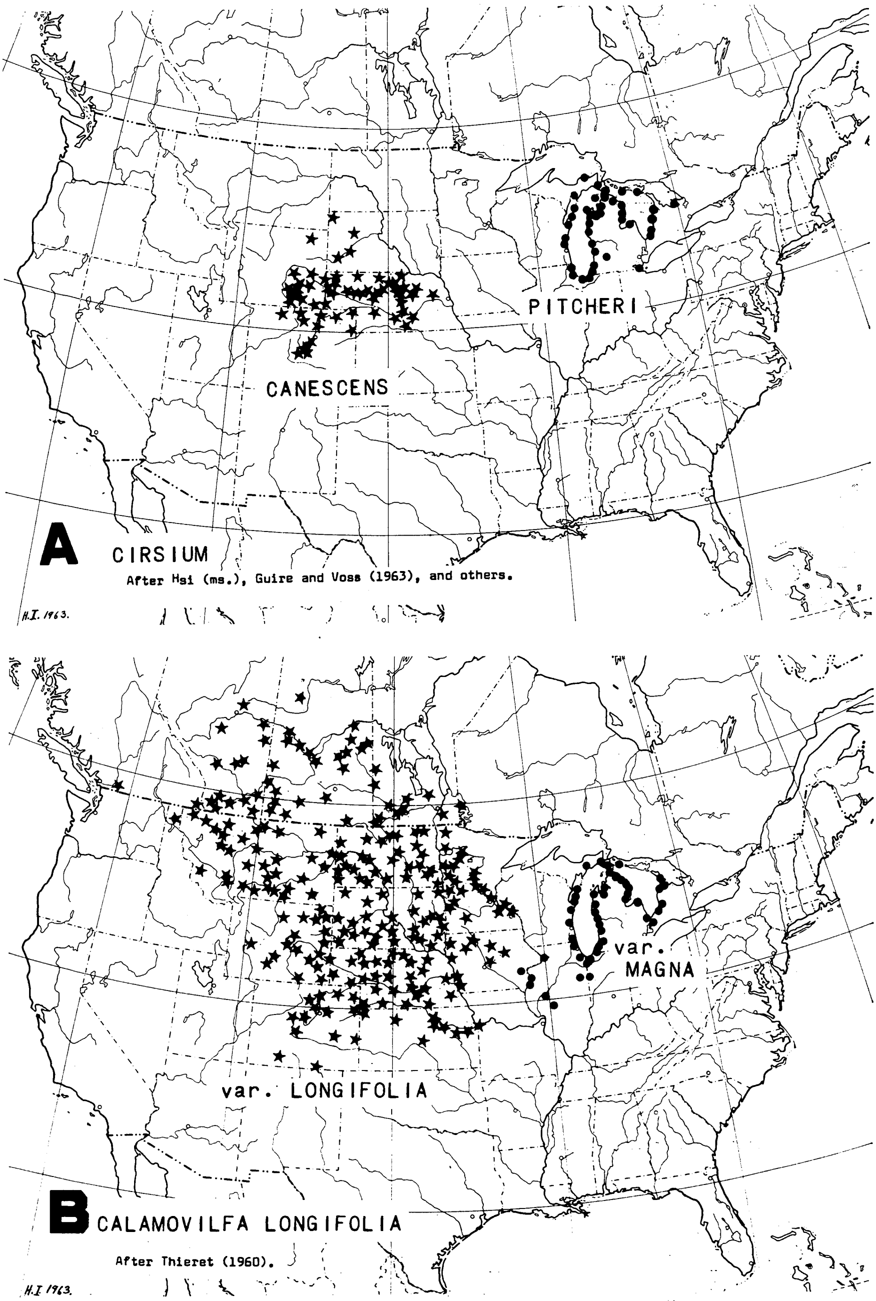
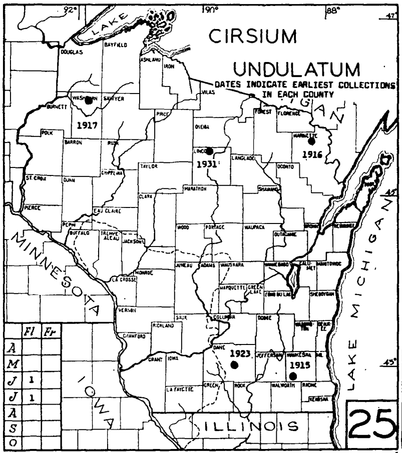


FIG. 2. A DISTRIBUTION OF *Cirsium canescens* AND *C. pitcheri*. (DATA COURTESY OF DRS. EUGENE HSI AND GERALD OWNBEY) B. DISTRIBUTION OF *Calamovilfa longifolia* AND ITS VAR. *magna*. (DATA COURTESY OF DR. JOHN W. THIERET)

Cirsium Pitcheri and the endemic grasses listed above show western affinities. Ownbey (personal communication) is of the opinion that *C. Pitcheri* and certain biotypes of *C. canescens* are closely related. Both have a rather similar ecology,[11] the relevant monocarpic biotypes of *C. canescens (Cirsium plattense* (Rydb.) Cock. ex Daniels) being mostly restricted to the rather unstable sand of the Nebraska "Sandhills" region, and *C. Pitcheri* to the dunes of the Great Lakes. Almost exactly the same relationship holds for the *Calamovilfa* varieties. As a matter of fact, in the Nebraska Sandhills, *Cirsium canescens* commonly grows together with *Calmovilfa longifolia* var. *longifolia,* just as their derived taxa do in Wisconsin. Both thistles die following fruiting. Assuming this relationship, *it is evident that C. Pitcheri must have evolved since the last glaciation about 10,000 years or less ago.* One may postulate that a small, isolated, inbreeding population of *C. canescens,* perhaps only a single seed, was brought to the shores of the Great Lakes sometime after the final glacial recession and became established in this ecologically receptive habitat. With limited genetic material, and lacking opportunity for introgression, this "founder population" (E. Mayr, cf. Goodhart 1963) differentiated rapidly into the strikingly distinct *C. Pitcheri.* The uniformity and environmental severity, as well as the "openess" of the beach habitat need also be considered to account for the rapid speciation and uniformity of this species, as well as for that of the endemic *Calamovilfa, Agropyron* (cf. Senn and Gillett 1961), *Iris lacustris,* and *Hypericum Kalmianum* (cf. also pp. 267–268 of this study).

Even though the historical evidence is circumstantial, considering the glacial history of the Great Lakes and the highly peculiar ecological situation of the lakeshores, these species do furnish the evolutionist with the rare opportunity to evaluate accurately evolutionary rates, in this case rapid speciation. The Dune or Pitcher's Thistle is therefore *one of Wisconsin's most interesting species, deserving protection from eradication,* especially from the well-meaning but botanically uneducated owners of lakeshore cabins, and from unsophisticated weed specialists and county agents, to whom any thistle is a "weed." Unless protection is given to its last remaining colonies in Door County, the Dune Thistle will, like many other of Wisconsin's native plants, become extinct, its beauty and interest notwithstanding. And that would be a pity!

[11] However, "There is something very peculiar about the habitat of *C. Pitcheri.* Why is it confined to the unstable dunes just back of the shore line? *Cirsium canescens,* even in the sandhills, is not so restricted to actively moving sand dunes." (Ownbey 1961, personal communication.) See also the interesting comment on *C. pitcheri* in cultivation by Deam (1940: 1001). We wish to thank Dr. Eugene Hsi, Northland College, Ashland, for the privilege of using his manuscript map of *Cirsium pitcheri.* The map in Guire and Voss' (1963) interesting study of Great Lakes shore plants is nearly identical.


CIRSIUM
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DATES INDICATE EARLIEST COLLECTIONS IN EACH COUNTY
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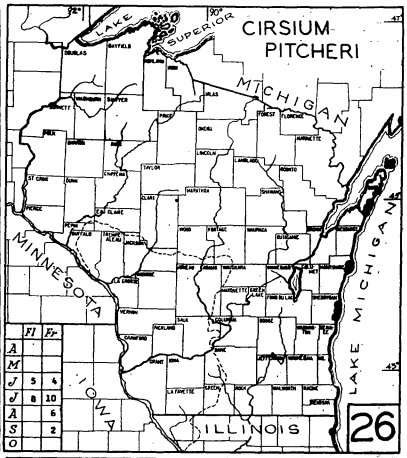
IOWA
ILLINOIS
LAKE MICHIGAN
25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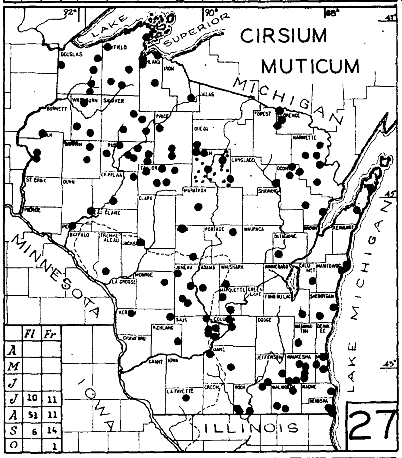
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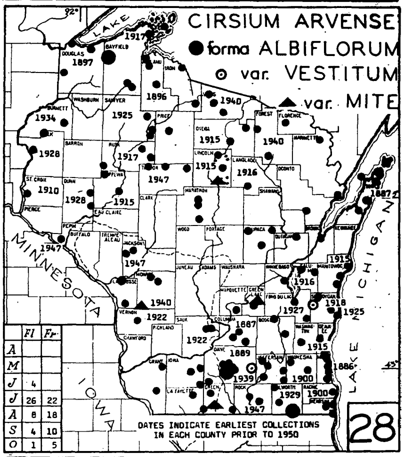
27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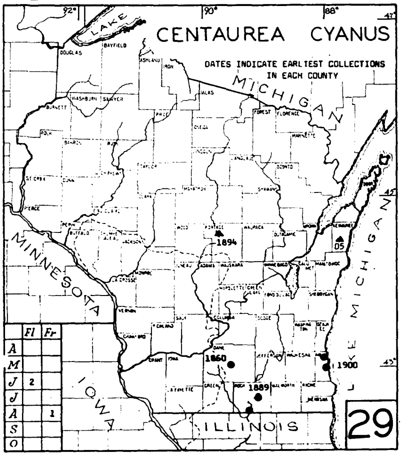
forma ALBIFLORUM
var. VESTITUM
var. MITE
DATES INDICATE EARLIEST COLLECTIONS IN EACH COUNTY PRIOR TO 1950
MINNESOTA
IOWA
LAKE MICHIGAN
28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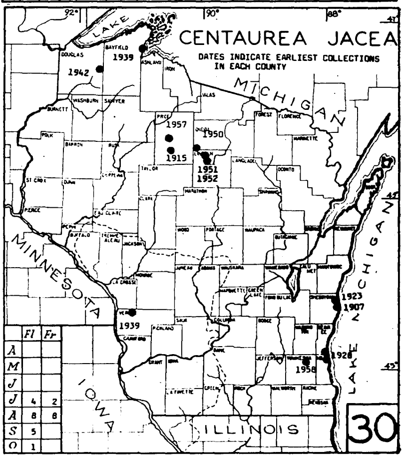
IOWA
ILLINOIS
LAKE MICHIGAN
29


CENTAUREA JACEA
DATES INDICATE EARLIEST COLLECTIONS IN EACH COUNTY
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
30

8. CIRSIUM MUTICUM (Muhl.) Spreng. X CIRSIUM DISCOLOR Michx.

Morphologically intermediate between the parental species. Stem slender, slightly ridged, subglabrous, branching above or simple. Leaves lanceolate to oblanceolate, pinnatifid, *the primary lobes*

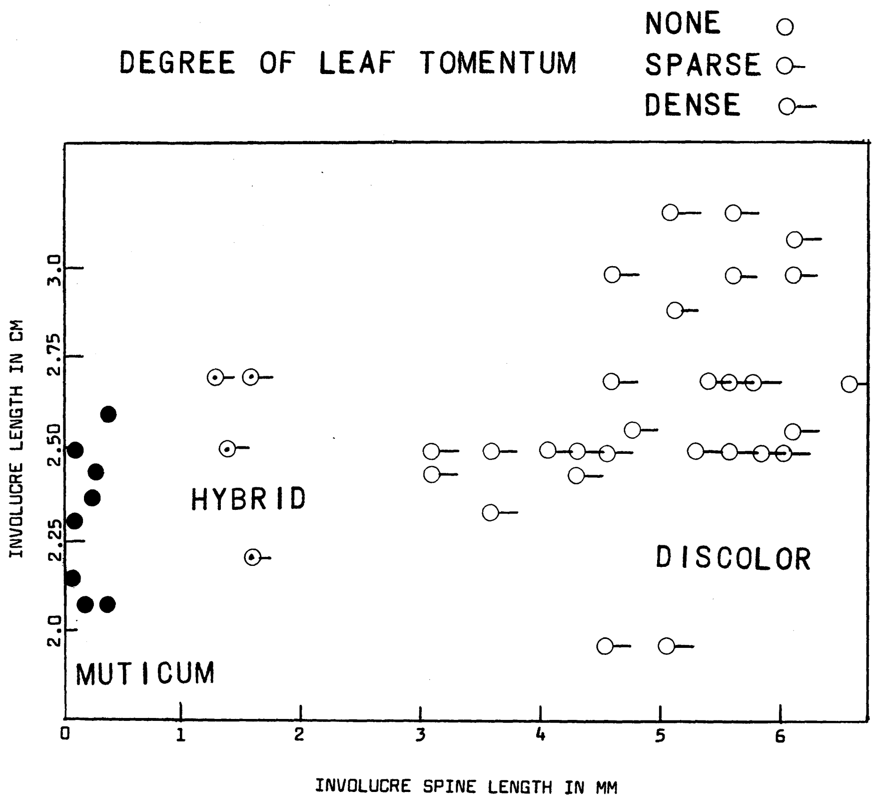


FIG. 3. HYBRIDIZATION BETWEEN *Cirsium muticum* AND *Cirsium discolor*.

lanceolate to cuneate, usually with opposite cuneate to lanceolate secondary lobes, all with short, firm spines, the *pubescence beneath sparsely cobwebby,* sub-glabrous above. Heads *lavender, intermediate between the parental colors.* Involucre 22–27 mm high, *the outer bracts glutinous, short, obtuse, terminated by spines only 1.2–1.5 mm long,* the inner ones elongate-acuminate. Achenes brown, 4–4.5 mm long.

The hybrids are intermediate between the parents in leaf pubescence, flower color, and length of involucral bract spines, as can be seen in Fig. 3. Almost all achenes in the Wisconsin collections are aborted, indicating hybridity. Though their overall ranges overlap, the parents are ecologically isolated, *C. muticum* occurring in wet prairies, *C. discolor* in mesic or dry prairies. Ownbey (1951) showed that in Minnesota the parental species (and with them numerous hybrids) grow sympatrically only where the habitat was disturbed by roadbuilding operations. The Wisconsin hybrids cited below give no indication of any association with the parental forms, though this must be assumed: Dane Co.: Dry hillside, C. & NW. RR, 4 mi. SW. of Madison, Sept. 24, 1939 [fl], *Shinners 1173* (WIS, WISM). La Crosse Co.: Moist acid meadow, Sept. 7, 1956 [fr], *Hartley 3114* (WIS). Marquette Co.: Germania, *Hartwell s.n.* (WIS).

9. CIRSIUM MUTICUM Michx. Swamp Thistle. Map 27.

Robust to slender biennials 8–18(–20) dm tall, with a shallow lateral root system and weak ephemeral taproot. *Stem hollow,* pubescent at base, glabrate above. *Leaves thin,* ovate to lanceolate, 10–30 cm long, *green and sparsely crisped-hispid above, tomentulose beneath, deeply pinnatifid, the lobes lanceolate to oblong-ovate, often with alternate secondary lobes,* tipped with short spines and with prickly margins. Heads with *deep purple corollas* (white in forma LACTIFLORUM Fern.), rather few, mostly solitary or rarely clustered on cobwebby peduncles. Involucre 22–27 mm high, the bracts *cobwebby with very prominent glutinous ridges and without mucronate tips* (or these only 0.1–0.3 mm long [10X]), the outer bracts obtuse, the inner lanceolate with erose tips. Achenes 3.3–4.5 mm long, black. 2n=20 (Ownbey 1951).

Throughout Wisconsin in open moist habitats, most prevalent, especially in the south, in open wet prairies and rather rare in wet-mesic and mesic prairies (Curtis 1955), common in poorly drained soil at the edge of bogs, in wet sedge meadows, there with *Carex* spp., *Solidago uliginosa, S. patula, S. gigantea* and *Spiraea tomentosa,* around springs, and in tamarack swamps, in N. Wisconsin often in most spruce-fir-White Cedar or aspen-Paper Birch woods, usually in highly organic, mucky soil, rarely as a roadside weed in burned, second-growth, sandy woods. Flowering from mid-July to mid-September; fruiting from mid-August to early October.

This species hybridizes with *Cirsium discolor.*

10. CIRSIUM PALUSTRE (L.) Scop. European Swamp Thistle.

Mostly unbranched biennials, 1–2 m tall, with *decurrent leaf bases forming conspicuous green, spiny wings on the stem.* Leaves scattered, lanceolate, pilose beneath, pilose to glabrous above, deeply pinnatifid, the lobes obtuse to lanceolate, terminated by a short, firm spine. *Heads numerous and very crowded,* usually sessile or subsessile, or occasionally on cobwebby peduncles; involucres 9–12 mm high, *the bracts without spine tips,* or the outer and middle with a spine 1 mm or less long; corollas purple. Achenes 2–3 mm long, white. 2n=34 (ex Löve & Löve 1948).

Native of temperate Europe to W. Siberia, weedy in the NE. United States, recently spread to Wisconsin, probably from Northern Michigan, where it has been known since 1935 (cf. Voss 1957: 97). Collected once in Vilas Co.: edge of *Larix laricina, Picea mariana, Ledum groenlandicum, Sarracenia purpurea, Calopogon pulchellus, Vaccinium oxycoccus* sphagnum bog and in adjoining moist to wet roadside ditches, east end of Lac Vieux Desert on Michigan border at entrance to Simpson Estate, July 16, 1961 [fl & fr], *Iltis 18212* (WIS) and seen there again in 1962.

11. CIRSIUM ARVENSE (L.) Scop. Canada Thistle; Creeping Thistle. Map 28.

Spiny perennials from *spreading, extensively creeping underground roots.* Stem slender, 5–10 dm tall, sub-pilose to glabrous. Leaves lanceolate to oblong, generally pinnatifid, the lobes acuminate and spiny margined, tipped by a firm straw-colored spine, or entire with few, short slender spines [in var. MITE Wimm. & Grab.], generally glabrous to woolly-pubescent beneath [in var. VESTITUM (Rand & Redf.) R. Hoffm.]. *Heads most often with pale purple corollas,* rarely white [in forma ALBIFLORUM (Rand & Redf.) R. Hoffm.], *usually crowded in 2's, 3's or 4's on cobwebby, often leafy peduncles, imperfectly dioecious,* the female heads with short corollas and long pappus, the male with long corollas and shorter pappus. Involucre 1–2(–3) cm high, *the bracts numerous, appressed, generally spineless or the outermost with short spines.* Achenes 2–3 mm long. 2n=34 (Ehrenberg 1945, ex Darlington 1955).

A native of Asia and Europe, *not of Canada* (cf. Hegi), in Wisconsin a terrible and ubiquitous weed especially in good, deep agricultural soil. The forms and varieties of this highly variable species are distributed without any apparent geographic pattern. Flowering from late June to early August (to early October); fruiting from early July through late October.

49. ONOPORDUM L.

1. ONOPORDUM ACANTHIUM L. COTTON OR SCOTCH THISTLE.

Robust, sparsely branched *giant* biennials or perennials 1–3 m tall, *cottony-velutinous* and prickly throughout. *Leaves* ovate-elliptic, 10–40 cm long, 4–16 cm wide, *shallowly undulate-pinnatifid, the lobes broadly triangular* with firm terminal spines, *the bases decurrent into very prominent broad spiny wings on the stem. Heads large and solitary, the corollas bright purplish-blue;* involucre 2–3 cm high, the bracts flocculose, tapered to a spine tip. *Pappus barbellate, reddish.* 2n=34 (ex Darlington and Wylie 1955).

Native of Europe and E. Asia, sparsely naturalized over much of the United States, collected once in Wisconsin: Fond du Lac Co.: pasture 2 mi. S. of Waucousta, July 11, 1941 [fl & fr], *Fuller F-41-9* (MIL). Chas. Goessl (WIS) grew it in his Sheboygan garden in 1919.

50. CENTAUREA L. Star Thistle; Bachelor's Button

Annuals, biennials or perennials with alternate, entire to pinnatifid, non-spiny leaves and solitary rose-purple, blue (rarely white or yellow) heads. *Flowers all discoid and perfect,* though the marginal ones at times enlarged, ray-like and sterile. Involucre imbricated, the *bracts tipped with spines or various apical appendages with conspicuous colored or laciniate margins.* Achenes attached laterally to the bristly receptacle.

A large and difficult genus, chiefly Mediterranean, not native to Wisconsin.

Key to Species

A. Involucral bracts tipped by long divergent spines; leaf bases conspicuously decurrent on the more or less winged stem; heads yellow; rare.

B. Central spines of bracts stout, 17–20 mm long, with minute secondary spinules near the terete base -- 1. *C. SOLSTITIALIS.*

BB. Central spines of bracts very slender, 4–6(–9) mm long, with conspicuous secondary spines near their flattened base ---------------------------- 2. *C. MELITENSIS.*

AA. Involucral bracts variously laciniate, but not spine-tipped; leaf bases not decurrent; heads rose-purple, blue or white.

C. Leaves, at least lower, pinnatifid with linear-elliptic lobes; involucral bracts longitudinally striate, the black-brown acute appendages fringed with 10–14 delicate white to brown teeth; gray-green perenials with rose-purple (rarely white) flowers; common weed -------- 8. *C. MACULOSA.*

CC. Leaves generally not pinnatifid, but repand, toothed, or entire, the lobes broad; involucral bracts not striate, stramineous to brown, variously fringed.

D. Plants annual; flowers blue or rose-purple.

E. Flowers usually deep blue; involucres 10–15 mm high, ovoid to cylindrical, on slender, mostly leafless peduncles; upper leaves linear, flocculose-pubescent. entire; pappus only 2–3 mm long; common in cultivation ______________________ 3. *C. CYANUS.*

EE. Flowers rose-purple; involucre 15–30 mm high, subglobose, on very leafy peduncles pronouncedly inflated at the top; leaves broadly lanceolate to oblong-lancelate, scabrous-puberulent, subentire to entire; pappus well developed, 6–10 mm long; rare adventive __________________ 9. *C. AMERICANA.*

DD. Plants perennial; flowers rose-purple.

F. Involucre yellowish-white or yellowish-green, the outer bracts entire, orbicular, the inner linear-lanceolate with soft plumose tips; pappus capillary, generally 5–11 mm long; involucre 9–12 mm high __ ________________________________ 4. *C. REPENS.*

FF. Involucre brown to black, the outer bracts laciniate to pectinate, the inner various, but not plumose; pappus of very short bristles or none; involucre (10–)13–18 mm high.

G. Outermost involucral bracts deltoid to deltoid-ovate, the dark appendages deeply and regularly cut (pectinate); pappus very short (ca 1 mm) or none.

H. Outer involucral bracts green, the dark triangular pectinate appendage ca 1–3 mm long, not obscuring the inner bracts ____________ _____________________ 7. *C. VOCHINENSIS.*

HH. Outer involucral bracts dark brown to nearly black, the dark broadly triangular pectinate appendage 3–4 mm long, obscuring the inner bracts ______________________ 6. *C. NIGRA.*

GG. Outermost involucral bracts rounded to rounded ovate, the light brown scarious appendages entire or irregularly toothed to laciniate with very fine irregular cilia; pappus none __ 5. *C. JACEA.*

1. CENTAUREA SOLSTITIALIS L. Yellow Star Thistle; St. Barnaby's Thistle.

Coarse, canescent biennials (or annuals) ca. 5 dm or more tall. Basal leaves repand to pinnatifid, the upper entire, cottony above and beneath, *the winged bases decurrent into undulate wings on stem and smaller branches. Heads yellow; involucre globose, 12–15 mm high;* outer bracts *each terminated by a stiff yellowish spine 17–20 mm long.* 2n=16 (Heiser & Whitaker 1948, ex Darlington 1955).

Native of S. and SW. Europe to W. and central Asia (Mediterranian-Asiatic steppe element, *fide* Hegi), local in the United States along both coasts and inland as far as Iowa. Collected once in Wisconsin: Crawford Co.: East of De Soto, Freeman Township, Sect. 24, W. L. Hanson farm, "the only plant the farmer saw," Aug. 1958 [fl & fr], *Richards s.n.* (WIS).

2. CENTAUREA MELITENSIS L.

Branched, gray-villous annual resembling *C. solstitialis,* but with *more slender involcural spines 4–6(–9) mm long, these with conspicuous paired secondary spines at the base.* Collected once in a meadow near Falk's Brewery, Milwaukee County [ca. 1900], *Runge s. n.* (MIL). Native to Europe and the Mediterranean area, established in California. 2n=22 (Darlington 1955).

3. CENTAUREA CYANUS L. Blue Bottle; Bachelor's Button; Corn Flower. Map 29.

Slender, gray-villous to cottony annuals 2–8 dm tall. Leaves sessile, the upper *lanceolate to linear-elliptic,* the lowest lyrate-pinnatifid, entire, *woolly beneath, cottony to sub-glabrous above.* Heads showy, *the outer flowers deep blue* (rarely pink or white), *large and ray-like, the inner reddish-purple and more discoid.* Involucre ovoid to cylindrical, 11–15 mm high; *outer bracts acute and with a decurrent tip cut into sharp silvery to black scarious marginal teeth, the inner with erose scarious tips and entire margins.* Achenes ca 3.5 mm long, grayish to brown, the pappus shorter, reddish-brown to white. 2n=24 (Clapham et al. 1952).

Native to Europe and the Middle East (a common weed in rye fields, hence "Corn Flower," *"Korn"* being commonly applied to rye in German), now often cultivated as "Bachelor's Button," in Wisconsin rarely escaping and temporarily established especially on weedy railroad embankments.

4. CENTAUREA REPENS L. Russian Knapweed.

Pilose to sub-glabrous perennials ca 1 m tall, from a deep root. Lower leaves petioled, lanceolate to ovate-lanceolate, coarsely lobed, the upper sessile, toothed to entire, all pilose when young, glabrate. Heads rose to purple, terminating the *numerous stiffly ascending* *leafy branches. Involucre ovoid to cylindrical,* 9–12 mm high, *the outer bracts broadly rounded,* light green with broad, scarious, erose to entire, *yellowish margins, the inner with white-plumose tips.* Achenes ca 3 mm long, whitish, the pappus deciduous. 2n=26 (Moore & Frankton 1954, ex Darlington 1955).

Native of the Caucasus, introduced with alfalfa to the United States and reportedly spread from the West Coast inland to Michigan, collected once in Wisconsin: Milwaukee Co.: R. R. at House of Correction, North Milwaukee, July 26, 1940 [fl & mature fr], *Shinners 2331* (MIL, WIS, WISM).

5. CENTAUREA JACEA L. Brown Knapweed. Map 30.

Robust, glabrous, flocculose, or sparsely scabrous perennials 4–12 dm tall. Leaves sessile, entire to subentire, linear to lanceolate-ovate, scabrous at least on the margins. Heads rose-purple, often subtended by a "whorl" of reduced leaves, the outer flowers large and ray-like. *Involucre globose, brown, 10–18 mm high, the rounded scarious bract-appendages large, light brown, irregularly toothed to deeply (but usually irregularly) laciniate or rarely pectinate* (in var. PECTINATA Neilr.). Achenes 2.5–3 mm long, whitish; *pappus completely lacking.* 2n=44 (Marsden-Jones and Turrill 1954).

Native of Europe, N. Africa and N. to W. Asia, very sporadic in Wisconsin (first collected in 1915) along sandy roadsides, railroads, in fields and disturbed wooded places, in "Fairy Chasm" (Ozaukee Co.) collected regularly since 1928. Flowering from mid-July to early October.

Intergrading with *C. nigra,* both species being aggregates of great taxonomic complexity. *Centaurea jacea* generally has thin-papery, round, irregularly cut, brown appendages, the outer sometimes with *very fine* fringes; *Centaurea jacea* var. *pectinata* has appendages much more deeply and regularly cut, their strong resemblance to forms of *C. nigra* suggesting hybridity, which is known from Europe (Hegi).

6. CENTAUREA NIGRA L. Black Knapweed. Map 31.

Coarse, stiffly branched perennials. Basal leaves petioled, spatulate, coarsely lobed, the upper ones sessile, lanceolate, entire, all pilose-scabrous. Heads red-purple, the marginal florets often enlarged and sterile. Involucre sub-globose, 15–17 mm high, *the dark brown to black triangular appendage of the outer bracts 3–4 mm long and with sharply and regularly cut pectinate margins. Achenes light brown to gray; pappus of 1 mm long white bristles.* 2n=44 (Marsden-Jones and Turrill 1954).

Typical *C. nigra* has been collected once, in Milwaukee Co.: St. Frances, June 23, 1911 [fl], *Katze-Miller s.n.* (MIL).

CENTAUREA NIGRA var. RADIATA DC., differing from the typical form by light brown, rather than black, involucral bracts, is known from Dodge Co.: Fox Lake, Aug. 26, 1908 [fr] *Ward s.n.* (MIL); Sheboygan Co.: Terry Andrae State Park, July 5, 1938 [fl], *Throne 4941* (WISM), July 4, 1925 [fl], *Fuller 432* (MIL, WIS), and [ca 1920] *s.n.* (WIS).

Very similar to *C. jacea,* but with darker, more deeply and regularly cut involucral bract appendages and short, bristly pappus.

7. CENTAUREA VOCHINENSIS Bernh.

Robust, pilose-hirsute to glabrous perennials similar to *C. jacea* or *C. nigra*. Basal leaves long-petioled, obovate, repand to lobed, the upper ones sessile, oblanceolate to lanceolate, entire, all scabrous beneath or at least on the margins. Heads solitary or clustered, rose-purple; involucre cylindrical to campanulate, 13–15 mm high; bracts weakly ribbed, the dark triangular appendages ca 1(–5) mm long, not obscuring the bracts proper, the margins laciniate. Achenes 2.5–3 mm long, gray-white.

A native of Europe, established in the United States E. and S. of Wisconsin, here collected but four times: Dane Co.: fire lane 200 yards SE. of headquarters area, U. of Wis. Arboretum, Madison, Aug. 17, 1952 [fl], *Greene s.n.* (WIS). Milwaukee Co.: Menomonee Valley, Wauwatosa, sandy loam meadow, Aug. 31, 1938 [fl], *Pohl 1212* (WIS, MIL); City Dump, Wauwatosa, Aug. 25, 1934 [fl], *Pohl s.n.* (MIL), Aug. 31, 1938 [fl & fr], *Shinners s.n.* (WISM). Walworth Co.: Delavan, Sept. 20, 1908 [fl & fr], *Wadmond 4509* (MIN, WIS). The last cited collection, placed here with trepidation, differs from Wisconsin plants in the long-arching bract appendages, but closely resembles *Blake 10642* (WIS) from Clarendon, Virginia, determined as *C. vochinensis* by the collector.

8. CENTAUREA MACULOSA Lam. Spotted Knapweed Map 32.

Coarse, stiffly branched, gray-pubescent biennials or short-lived perennials 3–13 dm tall. Leaves sessile, cobwebby when young, glabrate, black-punctate, *deeply pinnatifid below, entire and greatly reduced above.* Heads light reddish-purple or rose, rarely white (in forma ALBIFLORUM J. Wagner: gravel roadside, Poynette, Columbia Co., July 19, 1961 [fr], *Johnson, Iltis, & Beery 44–61* [WIS]), the outer flowers enlarged and ray-like. Involucres cylindrical-campanulate, 10–14 mm high, *the outer bracts with 3(–5) longitudinal ribs, acute, the black-brown tips bearing short black, brown or white filiform teeth, the inner bracts longer, obtuse with lighter, erose tips.* Achenes 2.4–3 mm long, gray to brown, the white pappus, 0.5–

2.7 mm long. 2n=36 (Moore and Frankton 1954, ex Darlington 1955); 2n=18 (Löve & Löve 1961).

Native of Europe to W. Siberia and the Caucasus, on limestone, loess, and in *Stipa* grassland (cf. Hegi), in Wisconsin locally abundant in sandy or gravelly (probably mostly calcareous) roadsides, dry abandoned or unplowed sandy fields, and in pastures, rarely in deep soil prairies and in Jack Pine stands, in Door Co. on thin soil over dolomite, the earliest collections dating from 1915 (Vilas County) and 1925 (Iowa County), since the 1930's rapidly spreading. Flowering from mid-July through mid-October; fruiting from August through October.

Hegi distinguishes three subspecies native to Europe, based on head size, shape and relative size of bract tips and appendages, and size of pappus in relation to the achene. Most wide-spread in Europe is *Centaurea maculosa* ssp. *rhenana* (Boreau) Gugler, a name applied to Wisconsin plants. Wisconsin plants, however, do not have the characters in the appropriate combinations as used by Hegi, and thus are yet to be identified with the proper Eurasian subspecies.

9. Centaurea americana Nutt. American Basket Flower.

Smooth to scabrous, slender to robust, sparingly branched annuals; *stem conspicuously enlarged beneath the terminal, solitary rose-purple heads.* Lower leaves petioled, ovate, the upper sessile, ovate-lanceolate, becoming clustered beneath the head, all pilose to glabrous, sparsely toothed to entire. *Involucre globose,* 1.5–1.7 cm high, *the outer bracts much shorter than their deeply laciniate scarious appendages,* the inner with spatulate erose tips.

Native to the S.W. and S.-central United States and Mexico, rare N.E. of the Great Plains. Collected once in Wisconsin: Waukesha Co.: Waukcowis Farm, Big Bend, July 13, 1929 [fl], *Wadmond s.n.* (WIS).

TRIBE X. CICHORIEAE Spreng.

Milky-juiced annuals, biennials or perennials with basal or alternate leaves. Heads yellow, orange, red-orange, blue, rarely creamy, white, pink or purplish, the *flowers all ligulate (flat, strapshaped) and perfect.*

Key to Genera

A. Pappus absent ____________________________ 60. LAPSANA.

AA. Pappus present.

B. Pappus of numerous simple hairlike (capillary) bristles only.

C. Achenes flattened or compressed.

D. Achenes beaked or unbeaked, but enlarged at the tip; heads blue or yellow, with relatively few flowers ________________________56. LACTUCA.

DD. Achenes not beaked, not enlarged at the tip; heads yellow with many flowers ________55. SONCHUS.

CC. Achenes cylindrical, fusiform, or terete, not flattened.

E. Stems branched or unbranched and leafy or subscapose; achenes truncate or tapered, rarely short-beaked; pappus pale yellow, red-brown, tannish or white; involucral bracts uni- or biseriate.

F. Perennials; cauline leaves lanceolate to palmately lobed, or unlobed and dentate to entire; inflorescences branched racemes, panicles of cylindrical drooping heads, or corymbs with erect campanulate heads; pappus tawny to brown, not pure snowy white; main involucral bracts biseriate.

G. Leaves lanceolate to palmately lobed; heads cylindrical, nodding; corolla pink, purplish to yellow or white; pappus pale yellow to red-brown; plants sometimes tomentose, not glandular ____________51. PRENANTHES.

GG. Leaves spatulate to oblanceolate, not lobed; heads campanulate, erect; corolla yellow to red-orange; pappus tannish; plants usually glandular-pubescent _____52. HIERACIUM.

FF. Annuals or biennials with well developed, usually pinnatifid basal leaves; inflorescences open corymbs or panicles of yellow campanulate heads; pappus white; main involucral bracts uniseriate _______________________53. CREPIS.

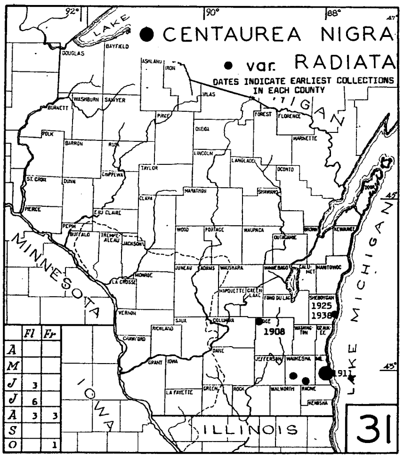
EE. Plants scapose; achenes beaked, or tapered and the beak lacking; pappus white; involucral bracts in more than one series.

H. Achenes tuberculate-muricate above with a long filiform beak; heads many flowered on hollow scapes; leaves variously runcinate-pinnatifid. __________________________54. TARAXACUM.

HH. Achenes not tuberculate-muricate above, slightly tapered, but not beaked; heads many flowered on solid scapes; leaves grasslike, the margins pubescent ___________________58. MICROSERIS.

BB. Pappus of plumose bristles, scales mixed with bristles, or scales only.

I. Pappus of plumose (feathery) bristles only.


CENTAUREA NIGRA
var. RADIATA
DATES INDICATE EARLIEST COLLECTIONS IN EACH COUNTY
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MINNESOTA
IOWA
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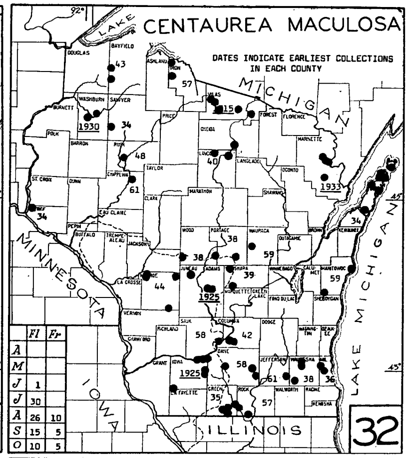
CENTAUREA MACULOSA
DATES INDICATE EARLIEST COLLECTIONS IN EACH COUNTY
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MINNESOTA
IOWA
ILLINOIS
Fl Fr
A
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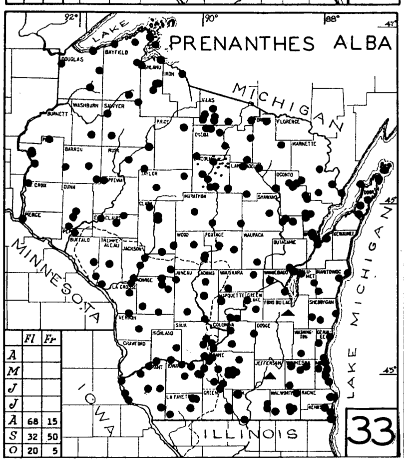
J 1
J 30
A 26 10
S 15 5
O 10 5
32


PRENANTHES ALBA
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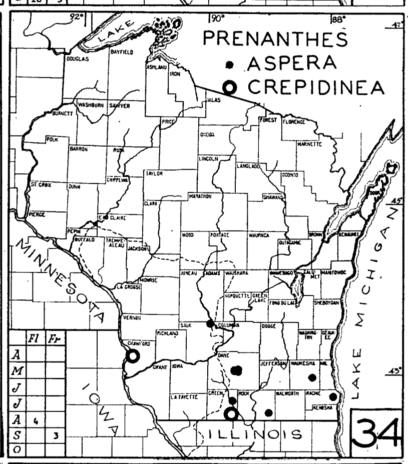
33


PRENANTHES
ASPERA
CREPIDINEA
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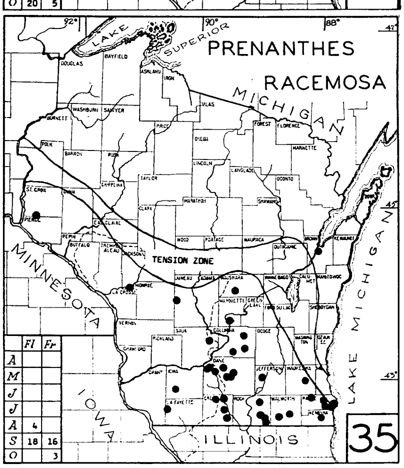
PRENANTHES
RACEMOSA
LAKE SUPERIOR
MICHIGAN
TENSION ZONE
MINNESOTA
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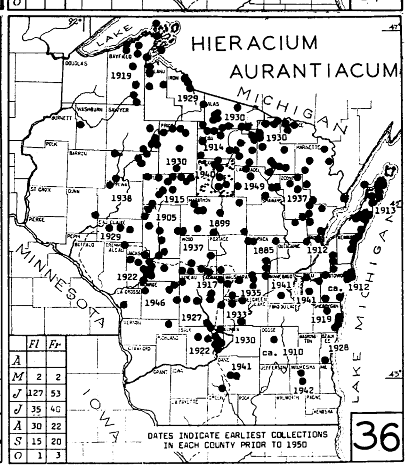

HIERACIUM
AURANTIACUM
DATES INDICATE EARLIEST COLLECTIONS IN EACH COUNTY PRIOR TO 1950
LAKE MICHIGAN
MINNESOTA
IOWA
Fl Fr
A
M 2 2
J 127 53
J 35 40
A 30 22
S 15 20
O 1 3
36

J. Plants scapose, scaly bracted above; leaves basal, coarsely dentate ________________61. LEONTODON.

JJ. Plants leafy stemmed, branched, not scaly-bracted above; leaves cauline, grasslike _62. TRAGOPOGON.

II. Pappus of scales mixed with bristles or scales only.

K. Pappus of 5 to numerous outer scales alternating with 5 to numerous scabrous hairs; plants scapose or sub-scapose, branched or not branched; corolla yellow ________________________________59. KRIGIA.

KK. Pappus of numerous minute scales; plants profusely branched; corolla blue, rarely pink or white ______ ______________________________57. CICHORIUM.

51. PRENANTHES L.[12] WHITE LETTUCE

Perennial caulescent herbs with fusiform roots. Leaves deltoid, spatulate or lanceolate and often palmately lobed. Inflorescence a racemose panicle (thyrse) or open panicle, the nodding cylindrical heads subtended by an inner uniseriate involucre of bracts about 4 times the length of the outer secondary bractlets. Corolla pink, purplish, white or yellow. Achenes columnar, longitudinally grooved, slightly constricted at the summit or truncate. Pappus of pale yellow to red-brown capillary bristles. Name from the Greek *prenes* (drooping) and *anthes* (flower), in reference to the nodding heads.

KEY TO SPECIES

A. Inflorescence an open panicle; leaves, at least the lower, long-petiolate, broadly ovate, deltoid to sagittate, or hastate.

B. Basal leaves deeply palmately lobed; plants glabrous or nearly so; involucral bracts purplish; pappus rich red-brown; very common throughout ___________1. *P. ALBA*.

BB. Basal leaves coarsely and irregularly dentate; plants pubescent in inflorescence; involucral bracts green; pappus pale yellow to brown; rare, S. Wisconsin __2. *P. CREPIDINEA*.

AA. Inflorescence a dense, strict, elongate racemose panicle (thyrse); leaves, at least the lower, spatulate, the rounded blades gradually attenuate into the petiole; uncommon species of prairies.

C. Leaves of inflorescence with broad sessile auriculate bases; flowers 8–13 mm long, white to purplish; leaves and stem glabrous and glaucous except in the uppermost inflorescence; S. and W. Wisconsin __________3. *P. RACEMOSA*.

[12] Based in part on an unpublished manuscript of W. L. Milstead, Purdue University.

CC. Leaves of inflorescence lanceolate, with attenuate narrow bases; flowers (8–)11–15(–19) mm long, yellow; stem, at least the upper parts, and leaves scabrous, not glaucous; S. Wisconsin ____________________________4. *P. ASPERA.*

1. PRENANTHES ALBA L. White Lettuce; Rattlesnake Root; Lion's Foot Map 33.

Glabrous perennials 3–10 dm tall. Lower leaves *ovate or deltoid to cordate, entire to deeply palmately lobed* with dentate and deeply incised margins, *the petioles winged,* the upper oblong, entire to dentate. Panicle open to elongate; heads 10–14 mm long, *the 6–8 primary bracts glabrous, glaucous, usually purplish.* Flowers (7–)10–11(–13) per head, whitish to purplish-white; *pappus brown to red-brown.* 2n=32 (Babcock 1947, ex Darlington 1955).

Very common throughout Wisconsin in many habitats, most abundant and prevalent in the southern dry-mesic, dry, and mesic forests (Curtis 1959), as well as in low woods, also abundant in lowland prairie where ". . . the high level of soil moisture [may] compensate in some way for the great evaporation and insolation of the prairie . . ." when compared to that of the forest (Curtis 1959: 285–6), often on roadsides, limestone bluffs, sandy shores, less common in northern coniferous forests and deer yards, Jack Pine woods, alder thickets and white cedar-hardwoods. Flowering from early August to early October; fruiting from mid-August through October.

2. PRENANTHES CREPIDINEA Michx. Map 34.

Perennials 1–2 m tall, *glabrous except in the inflorescence. Leaves with long winged petioles,* the lower generally *deltoid to sagittate or hastate, coarsely and irregularly dentate,* the upper elliptic to ovate, entire. *Panicle large and open;* heads 10–14 mm long, the *primary bracts usually 13, pilose,* green. *Flowers 20–35/head,* white; pappus light brown.

A very rare and distinctive species of the wet-mesic prairie, collected twice: Crawford Co.: Lynxville, Sept. 1, 1915 [fl & full fr], *Denniston s.n.* (WIS). Green Co.: dense community of tall perennials, low wet prairie in ditch along railroad, 5 mi. WSW of Brodhead, Aug. 15, 1956 [early fl], *Greene s.n.* (WIS).

3. PRENANTHES ASPERA Michx. Rough White Lettuce. Map 34.

Perennials 3–10 dm tall, from thickened *roots, the unbranched strict stem rough pilose to hirsute at least in the upper half.* Lower leaves sessile or petioled, *oblanceolate to spatulate, entire to coarsely dentate, scabrous beneath and on the margins, those of the inflorescence mostly lanceolate and narrow at base.* Panicle (thyrse) a *dense raceme; heads (8–)11–15(–19) mm long,* and 8–10 primary *bracts pilose,* yellow-green. *Flowers 11–19/head, yellow;* pappus pale yellow.

A very rare prairie species strongly resembling *P. racemosa,* collected last in Dunn Co.: Caryville, Aug. 15, 1920, *Wadmond 1927* (MIN); Rock Co.: along right-of-way, C. M. St.P. & Pac. RR., Clinton, Sept. 5, 1927, *Wadmond s.n.* (ILL, MIN); and Green Co.: low prairie, railroad right-of-way, Albany twp., 1948, *Curtis & Greene s.n.* (WIS). The following collection was seen by Milstead; Sauk Co.: vicinity of Kilbourn, on Wisconsin R., no date, *Steele 59* (US).

4. PRENANTHES RACEMOSA Michx. Glaucous White Lettuce. Map 35.

Perennials 3–15 dm tall from deep, occasionally thickened taproots, the unbranched strict *stem glabrous except in the uppermost inflorescence.* Leaves *glabrous and glaucous,* the lower mostly spatulate, entire or irregularly dentate, wing-petioled, the upper ones and *those of the inflorescence sessile, oblong to deltoid with auriculate clasping bases. Panicle* (thyrse) *a dense raceme, the heads 8–13 mm long,* the 7–17 *primary bracts pilose,* green or purplish. *Flowers 11–24 per head,* white to purple; pappus pale yellow.

At one time a prevalent species of deep soil, wet-mesic to dry-mesic prairies (Curtis 1959), now restricted to relic prairies mostly on railroad rights-of-way south of the "Tension Zone." Flowering from late August or early September through September, about three weeks later than *P. aspera;* fruiting from mid-September to mid-October.

Prenanthes racemosa, though very similar to *P. aspera,* can be distinguished by broader inflorescence leaves, glaucousness and smaller flowers. There are no intermediates known from Wisconsin, the species probably seasonally isolated. The few dated collections of *P. aspera* indicate full bloom from the first to the third week in August and very rarely into early September, while *P. racemosa,* though occasionally in bloom by the end of August, often doesn't begin to bloom until after the first week of September. While this does not apply to the flowering of the species in Maine, for example, where *P. racemosa* blooms from the middle of August, it holds true in Wisconsin and nearby Indiana (cf. Deam 1940: maps 2234, 2235, pp. 1015–6). Both species have been collected on Sept. 5, 1927 in the prairie along the railroad right-of-way at Clinton, Rock Co., by *Wadmond* (MIN). At that time, *P. aspera* was mostly past flowering except for a few heads on the lowest branches, while *P. racemosa* (ILL, MIN) was still in bud except for the top two of the 16 branches.

Both species are rare and, like P. crepidinea, on the verge of extinction, no doubt because the mesic, deep soil prairies, where they could survive, have all been plowed.

52. HIERACIUM L.[13] Hawkweed

Scapose or leafy stemmed, often pubescent and glandular, slender perennials with fibrous roots from horizontal rootstocks. Leaves in basal rosettes or alternate, entire to dentate, pubescent. Inflorescence paniculate-corymbiform, commonly of several to numerous orange to yellow heads, rarely of one. Achenes 2–3 mm long, cylindrical. Pappus of one series of tawny to nearly white simple bristles.

Name referring to the Greek legend in which hawks, soaring high, would focus their eyes on these bright flowers, thereby strengthening their vision. A large genus with few well-defined species, especially difficult in Europe where "... technical specialists with eyesight stimulated beyond that of the ancient hawks . . ." (Fernald, 1950:1562) have split the genus into ca 20,000 species, subspecies, varieties, and forms based mostly on the degree and character of the pubescence. Many species are apomictic.

Key to Species

A. Plants scapose; leaves clustered at base, linear to spatulate or oblanceolate, sessile, pilose or glabrous, entire; heads red-orange or yellow; hairs less than 1 cm long or absent; introduced weeds.

B. Flowers bright red-orange; involucre densely covered with black-glandular and eglandular hairs; leaves spatulate to oblanceolate, with rusty-red pubescence; stolons present ---------------------------------- 1. *H. AURANTIACUM.*

BB. Flowers yellow; leaves oblanceolate to spatulate.

C. Leaves narrowly oblanceolate to spatulate, essentially glabrous, stolons lacking, short rhizomes present; peduncles minutely white-stellate ---------------------------------- 2. *H. FLORENTINUM.*

CC. Leaves oblanceolate with tawny-white hairs on both surfaces; stolons erect or arching with abundant fine

[13] Many of the Wisconsin collections have been checked by Father Ernest Lepage, Ecole d'Agriculture, Rimouski, Quebec, Canada.

pubescence; rhizomes lacking or inconspicuous; peduncles glandular hirsute --------3. *H. CAESPITOSUM.*

AA. Plants not scapose; leaves not clustered at base, or if so, then plants with abundant hairs 7–20 mm long; leaves lanceolate to elliptic or spatulate, petioled or sessile-clasping, pilose to glabrous, the margins dentate to denticulate or subentire; rhizomes and stolons lacking (except *H. vulgatum*); North American natives (except *H. vulgatum*).

D. Leaves chiefly basal, abruptly reduced upward; plants, except the inflorescence, densely long-pilose, the hairs (7–) 10–20 mm long; peduncles with yellow-orange gland-tipped hairs; prairies, S. and central Wisconsin --8. *H. LONGIPILUM.*

DD. Leaves often cauline; plants with hairs to 3 mm long or glabrous; peduncles glabrous, scabrous, stellate or appressed-pubescent, sometimes glandular.

E. Leaves broadly elliptic, tapering to long and villous petioles, coarsely dentate; involucres 6–8 mm high, the hairs stellate; stem glabrous; rare introd. weed ------------------------------------4. *H. VULGATUM.*

EE. Leaves various, tapering to shorter petioles or sessile, toothed to subentire; involucres 5–13 mm high, glabrous to glandular; stem glabrous or hairy; common.

F. Leaves spatulate, the upper sessile, the lower petioled subentire; involucres (and peduncles) black-glandular, 5–8 mm high; stem setose ---------------------------------------7. *H. SCABRUM.*[14]

FF. Leaves lanceolate to oblanceolate, sessile, toothed; involucres (and peduncles) rarely glandular, 8–13 mm high; stem glabrous to villous-hispid or setose below.

G. Lower leaf surface or margin pilose to glabrous, never scabrous; peduncles stellate, not scabrous; stems glabrous to setose below -5. *H. KALMII.*[14]

GG. Lower leaf surface and especially margin scabrous; peduncles scabrous and stellate; stem glabrous to pilose below ------------------------------------6. *H. SCABRIUSCULUM.*[14]

1. HIERACIUM AURANTIACUM L. Orange Hawkweed; Devil's Paintbrush; Grim-the-Collier; Red Daisy. Map 36.

Hairy-glandular scapose perennials 1–6(–8) dm tall with arched, horizontal, leafy or subterranean, slender stolons. *Leaves basal*

[14] Hybrids between species 5, 6 and 7 are not uncommon (see p. 317).

(rarely one or two cauline), *spatulate to oblong,* 10–35 mm wide, *densely covered with long reddish-brown to white hairs.* Inflorescence a compact corymb, becoming open with age, the few to many *heads bright red-orange.* Involucres 4–6(–7) mm high, *densely covered with long black and short glandular hairs.* 2n=36 (cf. Löve & Löve 1961); apomictic (Christoff 1942).

Very weedy, aggressive and common throughout all but NW and S Wisconsin; though beautiful, one of the most troublesome weeds, occurring most often in sandy roadsides, abandoned fields and overgrazed pastures, often in cut-over Northern Hardwoods and sandy open Jack Pine woods. Flowering from late May to late September; fruiting from mid-June to October.

The ability of *H. aurantiacum* to compete is believed to stem from a potent antibiotic produced by the roots, which kills all but a few species such as Bracken Fern *(Pteridum)* (Curtis 1959: 316). A specimen from the Chicago Natural History Museum carries the following information: "Species rapidly spreading; rare a quarter century ago in region of Mishicot (Manitowoc Co.), June 21, 1938" *(Benke 5918).* The *Brillion* (Calumet Co.) *News* of July 5, 1929, printed a front page story reporting that in the late 1890's and early 1900's *H. aurantiacum* was rare or unknown in Calumet and Manitowoc Counties. The first colony was seen near Denmark (Brown Co.) and sometime later east of Maribel (Manitowoc Co.). Its spreading ability was attributed to the runners, numerous viable seeds, and basal rosettes which choke most competitors. This species very rarely hybridizes with No. 2.

2. HIERACIUM FLORENTINUM All. Yellow Devil's Paintbrush; King Devil. Map 37.

Perennials from a short stout erect rhizome, the basal off-shoots many, but very short, not stoloniferous; stems 3–9 dm tall, *sparsely glandular-pubescent and setose above. Leaves in a basal rosette,* 1–3 on the scape, narrowly oblanceolate, 6–18 cm long, *6–18 mm wide,* glabrous except *sparingly pilose* on margin and midrib below, *entire.* Inflorescence, when old, an open corymb; *heads yellow,* several to many, the involucre cylindrical-campanulate, the bracts 5–7 mm high, more or less black-glandular hairy and white-margined.

Locally very common in N. Wisconsin, often with *H. aurantiacum,* mostly along sandy roadsides (with *Salix, Pteridium, Populus,* and *Pinus*), gravelly-sandy lake shores, lawns, sandstone cliffs (Ashland Co.), railroad yards, marshes and open fields. Flowering from early June through September, fruiting from mid-June through September.

Often confused with *H. caespitosum,* but distinguished by short erect rhizomes, lack of stolons, essentially glabrous stems and leaves, and smaller heads.

This species was first noted as a weed in a hayfield at Cutler, Maine, occurring as a small patch only a few feet in diameter (Hansen 1922). Now, in Wisconsin, it is actively spreading (see Map 37).

3. HIERACIUM CAESPITOSUM Dumort. King Devil. Map 38.
Hieracium pratense Tauch.

Glandular-hirsute scapose perennials, 4–6 dm tall, *with a short erect rootstock, often with arched or erect leafy stolons. Leaves all basal* (or rarely with 1–3 well-developed scape leaves), oblanceolate, (7–) 9–19 mm long, *(11–)15–24 mm wide, setulose to pilose, entire.* Inflorescence a compact to open corymb; *heads yellow;* involucres cylindrical, 6–8 mm high, the bracts dark green with black midrib and with long white or brown, short glandular hairs. Mature achenes truncate, the pappus 5 mm high, white to sordid. 2n=36 (cf. Löve & Löve 1961).

Native of N. Eurasia, scattered in N. Wisconsin in patches of weeds, sedges and rushes, wet sedge meadows, bogs, sand, and along roadsides. In Juneau Co., *Hieracium caespitosum* has been collected in 1940 (earliest record), and again in 1961 and 1962, on a moist cut-over meadow and roadside in abundance with weedy *H. aurantiacum,* the continual cutting apparently having no disadvantageous effect on either species. In Forest Co., one collection dates from 1941, all others from 1959, the species evidently persisting. Flowering from mid-June to August.

4. HIERACIUM VULGATUM Fries.

Slender perennials ca 6–7 dm tall, *the few leaves on the lower half of the stem. Leaves elliptic-ovate, 10–15 cm long, distantly toothed except toward apex, the lower ones often purplish.* Inflorescence a few-headed, open corymbose, glandular to glabrous panicle.

Native of Europe, collected once in Wisconsin: Walworth Co.: Woods, Covenant Harbour, Lake Geneva, July 4, 1953, *Swink 2287* (F).

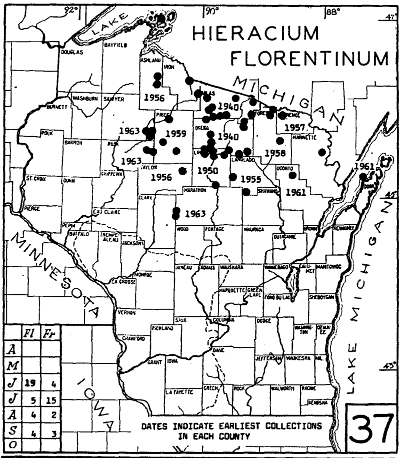
Gray's Manual (1950) and Gleason (1952) do not list *H. vulgatum* from Wisconsin, the species reported from Newfoundland to Michigan. Because of its many gardens, various interesting adventives occur in the Lake Geneva region, e.g. *Lysimachia clethroides* (Iltis & Shaughnessy, 1960).

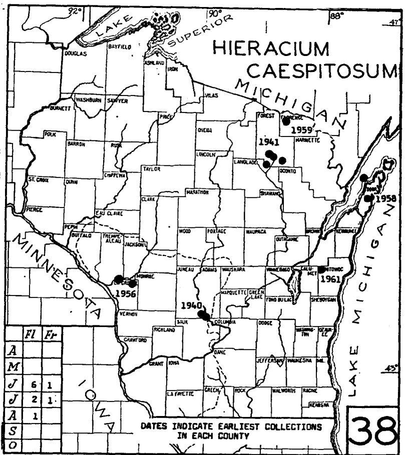
5. HIERACIUM KALMII L. Kalm's Hawkweed. Map 39.

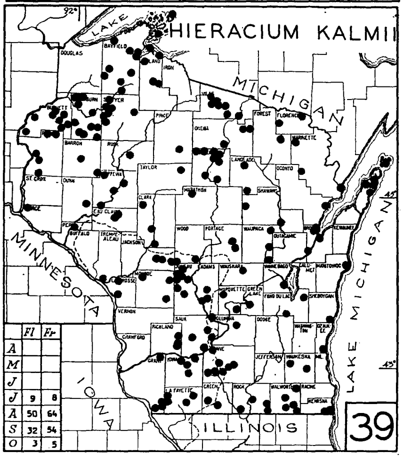
Hieracium canadense sensu older U.S. floras, not Michx.
Hieracium canadense var. *fasciculatum* (Pursh) Fern.
Hieracium Kalmii L. var. *fasciculatum* (Pursh) Lepage.
Hieracium Kalmii L. var. *subintegrum* (Lepage) Lepage.

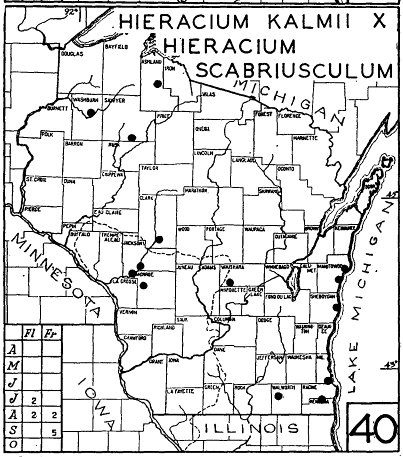
[Lepage, Ernest. *Hieracium canadense* Michx. et ses Alliées en Amérique du Nord. Naturaliste Canadien 87: 59–107. 1960]

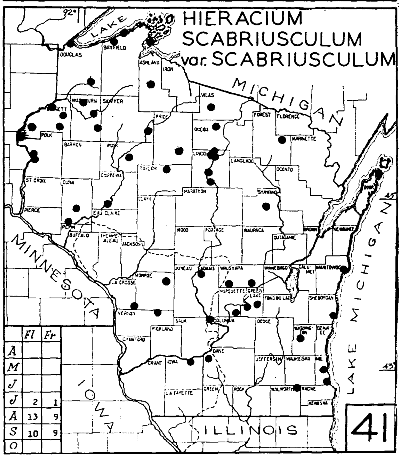
Slender to robust perennials 3–11 (–12) dm tall; *stem leafy, pilose at base, becoming less so toward the inflorescence.* Leaves elliptical

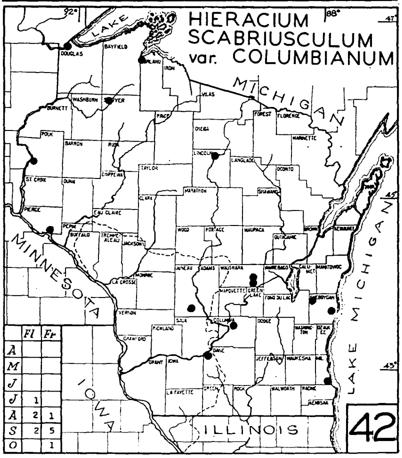

HIERACIUM FLORENTINUM
DATES INDICATE EARLIEST COLLECTIONS IN EACH COUNTY
Fl Fr
J 19 4
J 5 15
A 4 2
S 4 3
37


HIERACIUM CAESPITOSUM
DATES INDICATE EARLIEST COLLECTIONS IN EACH COUNTY
Fl Fr
J 6 1
J 2 1
A 1
38


HIERACIUM KALMII
Fl Fr
J 9 8
A 50 64
S 32 54
O 3 5
39


HIERACIUM KALMII X HIERACIUM SCABRIUSCULUM
Fl Fr
J 2
A 2 2
S 5
40


HIERACIUM SCABRIUSCULUM var. SCABRIUSCULUM
Fl Fr
J 2 1
A 13 9
S 10 9
41


HIERACIUM SCABRIUSCULUM var. COLUMBIANUM
Fl Fr
J 1
A 2 1
S 2 5
O 1
42

to lanceolate or lance-ovate, 3–11(–13) cm long, 8–25(–27) mm wide, entire to distantly toothed, prominently so in robust plants, sessile, *the bases rounded to cuneate,* the lower pilose beneath, subpilose to glabrous above. Inflorescence paniculate, few to many headed (then much branched); heads yellow, *the involucre spreading-campanulate, (6–)8–13 mm high,* the green to dark olive *bracts 0.7–1.5(–1.8) mm wide, glabrous to slightly glandular.* Achenes 1.9–2.9 mm long, the pappus yellow-brown.

Common throughout Wisconsin, especially in the Bracken-grassland north of the "Tension Zone" (Curtis 1959), mostly on *sandy slightly acid soil* (cf. Deam 1940), with Jack Pine, oaks and pines, and aspen, on sandy lakeshores and rivers, weedy on sandy roadsides, railroad tracks, in pastures, gravel pits, quarries, and sandy fields. Flowering from mid-July through late September (mid-October); fruiting from late July through October.

H. Kalmii is very similar to the sub-arctic *H. canadense* Michx., which occurs throughout E. Canada and from Maine to Lake Superior (Isle Royale; Keweenaw P. I.) and Cook Co., Minn. The two species differ in the upper leaves, triangular with cordate to truncate bases in *H. canadense,* lanceolate with rounded to cuneate bases in *H. Kalmii.* The involucre is glandular in *H. canadense,* glandular to glabrous in *H. Kalmii.* The distinctive style color, reported as yellow in *H. canadense* and brown in *H. Kalmii,* can not be ascertained from dried material.

In Wisconsin, Lepage (l.c.) recognized two varieties in addition to typical *H. Kalmii:* Var. SUBINTEGRUM (Lepage) Lepage, with three specimens, we believe to be quite untenable even as a form, representing simply plants with more entire leaves. One sheet so named, however [Ashland Co.: Rocky SE. shores of Outer Island, Lake Superior, *Cottam & Vogl 633* (WIS)], is most unusual in its nearly linear leaves, smooth as in *H. Kalmii,* but with large heads strongly resembling those of *H. scabriusculum.* Var. FASCICULATUM (Pursh) Lepage has been applied to robust extremes, with larger leaves, longer, more irregular teeth, and more branched, larger inflorescences bearing 30 to 40 heads. Since there are all possible intermediates between this and the typical variety, it hardly deserves recognition. *H. Kalmii* hybridizes with *H. scabriusculum* (see p. 317).

6. HIERACIUM SCABRIUSCULUM Schwein. Maps 41, 42.
Hieracium umbellatum of authors, not L.

Slender, scabrous (rarely pilose), leafy perennials 5–11 dm tall. Leaves ovate, obovate, or lanceolate, with acute tips, rounded sessile bases, 2–10 cm long, 0.7–2 cm wide, the involute, more or less *toothed margins and surfaces conspicuously scabrous.* Inflorescence *umbellate-paniculate, the peduncles appressed pubescent, scabrous; involucre 8–12 mm high, the bracts (1.1–)1.3–2.6 mm wide,* green, most often glabrous or with few gland-tipped hairs. Achenes 2.5–3.2 mm long; pappus yellow-white.

Hieracium scabriusculum closely resembles *H. Kalmii* (with which it hybridizes; cf. p. 317), but can be distinguished by very scabrous leaves, especially the lower, and generally wider bracts. Though width of the median involucral bracts is of taxonomic importance, immature heads may be subtended by phyllaries more narrow than indicated in the key.

KEY TO VARIETIES (After Lepage)

a. Stem and leaves all without long hairs --6a. var. *SCABRIUSCULUM.*

aa. Stem and leaves on lower part of plant pilose --6b. var. *COLUMBIANUM.*

6a. HIERACIUM SCABRIUSCULUM Schwein. var. SCABRIUSCULUM Map 41.

Stem and leaves not pilose, or only very slightly so.

Scattered throughout Wisconsin, common along roadsides, on sandy lake shores, in dry sand, on open wooded slopes and in vacant city lots (Douglas Co.: Superior). Flowering and fruiting from late July through September.

6b. HIERACIUM SCABRIUSCULUM Schwein. var. COLUMBIANUM (Rydb.) Lepage Map 42.

Lower stem and leaves white pilose. A weak taxon of uncertain validity, sporadic in Wisconsin, in sandy fields or on gravelly lake shores, roadsides, and rocky woods. Flowering from late July through September, and fruiting from late August to early October.

7. HIERACIUM SCABRUM Michx. Rough Hawkweed. Maps 43, 44.

Coarse, stiffly-pilose glandular perennials (2–)3–9 dm tall. *Leaves spatulate to obovate,* (3–)3.5–13 cm long, 1.4–4.5 cm wide, *rusty-pilose to glabrous, entire* or rarely minutely and distantly denticulate, the lower petioled, the upper sessile. Inflorescence paniculate, the *branches thickish, densely glandular with appressed brown pubescence,* the rather small heads yellow; *involucre 5–8 mm high,* dark green, glandular (cf. Rhodora 16:182–183. 1914).

Key to Varieties

a. Hairs of lower internodes, petioles and lower midribs 2–3 mm long ---------------------------------7a. var. *SCABRUM.*

aa. Hairs of lower internodes 0.2–0.5 mm long; leaf surfaces usually glabrous to very slightly pilose --------7b. var. *TONSUM.*

7a. Hieracium scabrum Michx. var. scabrum — Map 43.

Coarse, the stem generally stiffly pilose-glandular, the usually scattered leaves rusty-pilose.

Relatively common throughout Wisconsin, especially in the southern dry-mesic forest (Curtis 1959) and in the Northern Hardwoods region, mostly in dry sandy soil, Jack Pine or Red Pine woods, oak woods and oak openings, rarely in more mesic woods, lake shores, stream banks, sandy prairies, and sunny hillsides, pastures, fields, and railroads, both on sandstone and limestone. Flowering from the third week of July to late September; fruiting into early October.

7b. Hieracium scabrum Michx. var. tonsum Fern. & St. John — Map 44.

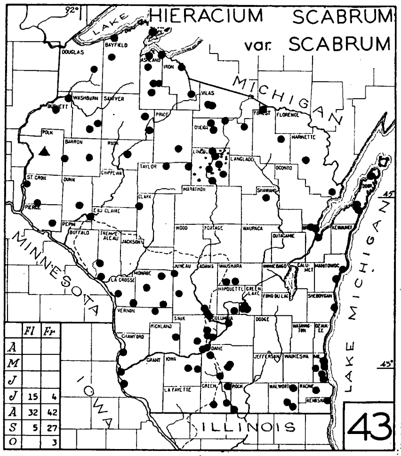
Rather delicate with sub-scapose to scapose sub-glabrous stems, the leaves usually glabrous and often more clustered at the base than in var. *scabrum.*

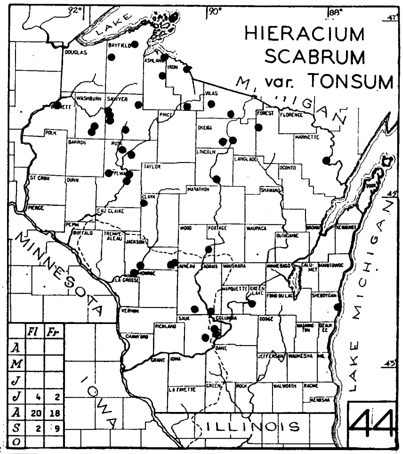
Scattered through Wisconsin with habitats similar to those of var. *scabrum,* but more abundant in the Northern Hardwood region, in Black Oak, Sugar Maple, *Acer-Populus,* and spruce-fir-hemlock-*Thuja* woods, sandy plains, lake shores, and pastures. Flowering from late July to early September; fruiting to late September.

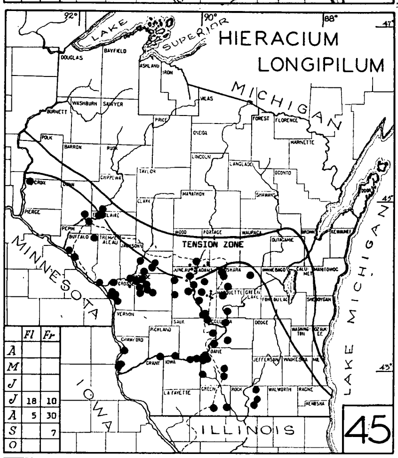
The two varieties may occur together in Iron, Vilas and Washburn Counties (all collected by Fassett), the latter collection intermediate between the varieties.

8. Hieracium longipilum Torr. Long-Beard Hawkweed; Prairie Hawkweed. — Map 45.

Strict perennials 4–14 dm tall, *densely covered with stiff more or less ascending rusty-red to white hairs 7–20 mm long.* Leaves crowded near base of stem, spatulate to oblanceolate, 5–18 cm long, 1–3.3 cm wide, ascending, entire, abundantly pilose, the lowest petioled, the upper sessile. *Inflorescence an elongate to compact panicle,* the branches appressed-glandular pubescent; heads yellow; involucre cylindrical to spreading, 6–9 mm high. Achenes 2.5–3.2 mm long, slightly tapered at summit.


HIERACIUM SCABRUM
var. SCABRUM
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A
M
J
J 15 4
A 32 42
S 5 27
O 3
43


HIERACIUM
SCABRUM
var. TONSUM
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A
M
J
J 4 2
A 20 18
S 2 9
O
44


HIERACIUM
LONGIPILUM
SUPERIOR
MICHIGAN
TENSION ZONE
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
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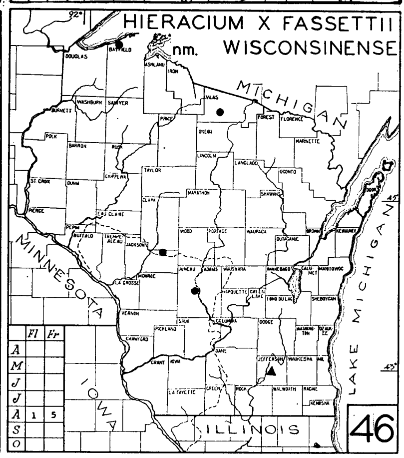
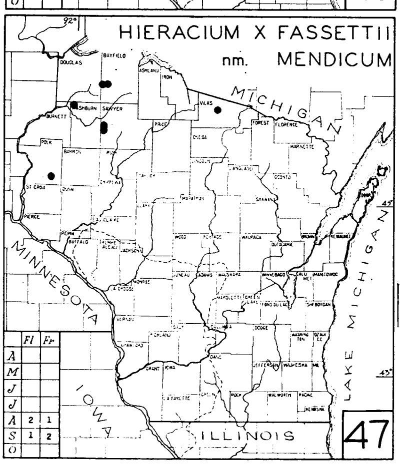
J
J 18 10
A 5 30
S 7
O
45


HIERACIUM X FASSETTII
nm. WISCONSINENSE
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A
M
J
J
A 1 5
S
O
46


HIERACIUM X FASSETTII
nm. MENDICUM
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A
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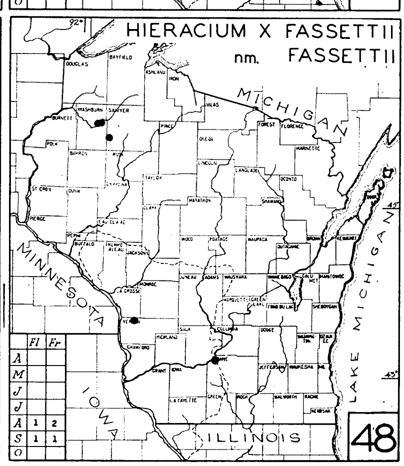
A 2 1
S 1 2
O
47


HIERACIUM X FASSETTII
nm. FASSETTII
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A
M
J
J
A 1 2
S 1 1
O
48

SW. Wisconsin, most prevalent in, and characteristic of sandy prairies, especially along the Chippewa, Wisconsin, and Trempeleau Rivers and on railroad rights-of-ways, occasionally on steep dry prairies, in Jack Pine woods, abandoned fields, and rarely as a roadside weed. Flowering from early July through mid-August; fruiting from late July through late September.

NATURAL HYBRIDS IN HIERACIUM.

I. HIERACIUM AURANTIACUM L. X H. FLORENTINUM All.

Closely resembling the parents except for the ligules which are yellow with red tips.

A single collection: Taylor Co.: roadside 3 miles north of Rib Lake, June 29, 1947 [fl] *Anderson* 319 (WIS).

II. HIERACIUM KALMII L. X H. SCABRIUSCULUM Schwein.
Map 40.

This hybrid, proposed by Lepage (1960), can be distinguished by the sparsely scabrous leaves and the intermediate width of the involucral bracts. Rare in Wisconsin, in secondary Red Maple woods, dunes, outwash sand prairies, and wooded hills.

III. HIERACIUM SCABRIUSCULUM Schwein. X H. SCABRUM Michx.

Leaves subdentate, scabrous or pilose on margins, the peduncles scabrous and red-pilose, the characters intermediate between the parents.

Two collections: Ashland Co.: La Point, Lake Superior, *Lapham s.n.* (WIS). Washburn Co.: Jack Pine woods, Gilmore Lake, Minong, *Fassett 15151* (WIS).

IV. HIERACIUM KALMII L. X H. SCABRUM Michx.

Hieracium X *Fassettii* Lepage

Included here is a diversity of forms which have properties of both parents, i.e. they may look like *H. Kalmii* but have hairy peduncles, leaf margins and stem bases (as *H. scabrum*); or they may look like *H. scabrum* but lack glandular hairs and have larger heads (as *H. Kalmii*). Three NOTOMORPHS, groupings representing supposedly stable, apomictic segregates or back-crosses, based on type and quantity of gland-tipped hairs have been separated by Lepage (1960) who has annotate our specimens and who cites all collections.

a. nm. FASSETTII Lepage (1960:94) Map 48.

Like *H. Kalmii,* but stems red-pilose below, less so above, the lower leaves red hairy above and beneath, the upper glabrous, the margins ciliate. Heads more than 5, the peduncles and involucres dark glandular-pilose (as in *H. scabrum*). Scattered and rare in Wisconsin on sandy banks and in Jack Pine Woods.

b. nm. WISCONSINENSE Lepage (1960:97) Map 46.

Like *H. Kalmii*, but stems more or less villous-hispid, lower leaves pilose beneath, the upper ones glabrous, the peduncles with minute colorless or light brown stipitate glands. Heads few, the involucres sparsely glandular. Only in Wisconsin, scattered and rare in Red Pine woods, on clay bluffs and along creeks. [Type: Summit of clay bluff along Lake Superior, Port Wing, Bayfield Co., *Fassett 14924* (WIS)]

c. nm. MENDICUM Lepage (1960:99) Map 47.

Stem totally glabrous to hirsute-vilous at the base. Leaves sub-entire glabrous. Peduncles elongate, glabrous or puberulent, eglandular. Heads many, small. ". . . distinguished from nm. *wisconsinense* by the absence of the tiny glands on the peduncles and the absence of the rigid, red hairs at the top of the stem; the hairs of the involucre are occasionally glandular, also more robust." (Lepage 1961). Rare in NE. Wisconsin on sandy lake shores and banks. [Type: Sandy bank, Sand Lake, 10 mi. S. of Hayward, Sawyer Co., *Fassett & Gilbert 15155* (WIS)]

HIERACIUM GRONOVII L., the Hairy Hawkweed, a perennial resembling *H. scabrum* with fewer leaves on lower stem and thinner, less glandular peduncles, has been collected once in Wisconsin (Sauk Co.: Bluffs, Devil's Lake, Aug. 11, 1897 [fr] *Umbach s.n.* (F)) This record is no doubt based on error, for the abundant botanizing in that area during the last 50 years has never yielded another *H. Gronovii*. The closest reported stations are in Cook County, Illinois (Jones & Fuller 1955). One may assume a label mix-up with interchange of material from northern Indiana, Umbach's main collecting grounds, where the species is common.

HIERACIUM (ALBIFLORUM Hook.?)

Young, sterile plant; stem with dense, long golden-brown pilose hairs; leaves spatulate with same pilosity on lower midrib and margins, less so on upper and lower surfaces. Douglas Co.: Sandy, low quite dry ravine at Nebagamon, July 12, 1917, *Goessl 7656* (MIL). This specimen very closely resembles certain collections of the western *H. albiflorum* Hook. (e.g. *Sandburg 5619*, Kootenai, Idaho, July, 1892 (WIS)).

53. CREPIS L. HAWK'S BEARD

[Babcock, E. The Genus *Crepis*. U. of Calif. Press, 1947.]

Annuals (ours) with well developed basal rosettes or leafy glabrous to hispidulous branching stems. Involucral bracts in two series, the outer becoming thickened at base. Corollas yellow. Achenes fusiform, beaked or the beak lacking. Introduced weeds.

KEY TO SPECIES

A. Achene not beaked; plants glabrous to hispidulous, at least above, not setose.

B. Ligules yellow; inner surface of inner series of bracts microscopically appressed-puberulent; common, NW. Wisconsin ______________________________1. *C. TECTORUM*.

BB. Ligules yellow, minutely tipped with red; inner surface of inner series of bracts glabrous; rare. _2. *C. CAPILLARIS.*

AA. Achene slenderly beaked; stem and involucre strongly setose with stiff yellow bristles; rare. ______________3. *C. SETOSA.*

1. CREPIS TECTORUM L. Hawk's Beard. Map 49.

Annual or biennial 2–5 (–9) dm tall, branching above. Lower stem glabrous, pilose to hispid-tomentose on peduncles. Basal and lower cauline leaves 6–16 cm long, 1–3 cm wide, short-petioled, pinnatifid or dentate to entire, sparsely pilose on upper surface. Upper cauline leaves sessile, linear. Corymbs open, much-branched, with several to many (–80) small heads, these when in flower ca. 25–30 mm in diam.; outermost bracts very short, the inner in a single series, 5.5–8.8 mm high, glandular-pubescent and minutely arachnoid on outer surface, with *minute (20x) silky appressed hairs on the inner.* Achenes narrowed toward summit, but not beaked, scabrous on the ribs. Pappus of numerous glistening white bristles. 2n=8 (Babcock 1947).

Native of Eurasia, locally abundant in NW. Wisconsin (esp. in area of "Glacial Lake Barrens"; cf. p. 267) on roadsides, in sand or gravel in Jack Pine woods, lake shores, river banks, cultivated or abandoned fields, low pastures, bogs, dumps and deer yards. Flowering from early June through early October; fruiting from mid-June to mid-October.

Crepis tectorum can be confused with species of *Hieracium,* especially *H. florentinum,* but has many cauline leaves, the lower lobed to dentate, while *H. florentinum* has all leaves entire and usually only 2 or 3 on the scape.

2. CREPIS CAPILLARIS (L.) Wallr.

Our plants small (ca. 15 cm tall), resembling *C. tectorum,* but ligules minutely *tipped with red, and inner surface of inner series of bracts glabrous;* generally more pubescent than *C. tectorum, in* more robust specimens the peduncles noticeably enlarged (fistulose). 2n=6 (Babcock 1947).

Native of Central Europe, naturalized along the U.S. West Coast, a rare adventive in Wisconsin, collected twice: Dane Co.: Madison, University Farms, July 11, 1916, [y.fr] *Denniston s.n.,* (WIS). Fond du Lac Co.: Single plant, yard at 722 Woodside Ave., Ripon; "probably an impurity in grass seed sown June, 1950." Oct. 3, 1951 [f l] *Cors. s.n.* (WIS). A specimen from Illinois was also thought to be introduced as an impurity in grass seed (cf. Jones and Fuller 1955: 486).

3. CREPIS SETOSA Hall f.

Branched annual, ca. 5 dm tall, with long slender taproot. Leaves, stems, and involucres hispid with stiff yellow hairs. Achenes beaked, light brown. Pappus copious, of numerous white bristles. 2n=8 (Babcock 1947).

Native of SE. Europe, occasionally introduced but not persistent in the United States, rare in Wisconsin, collected once in Fond du Lac Co.:" lawn weed, impurity in grass seed sown June, 1950; two plants of this species bloomed in July and August, 1951," *Cors s.n.* (WIS). Note citation of previous species.

54. TARAXACUM Zinn. DANDELION

Deep-rooted perennials with pinnatifid leaves in basal rosettes and showy, solitary, yellow heads on hollow scapes. Involucre biseriate, the outer row reflexed or erect, the inner erect. Achenes tuberculate above, cylindrical to fusiform, topped with a small pyramidal projection subtending the elongate slender beak. Pappus copious, of white to tawny bristles. Naturalized from the temperate Old World.

KEY TO SPECIES

A. Mature achenes reddish to deep brown or purplish; leaves generally deeply lobed or cut to midrib ---1. *T. ERYTHROSPERMUM.*

AA. Mature achenes tan to olivaceous, not red; leaves various, deeply lobed to entire ------------------2. *T. OFFICINALE.*

1. TARAXACUM ERYTHROSPERMUM Andrz. Red-Seeded Dandelion Map 50.

Taraxacum laevigatum of many authors, not of (Willd.) DC.

Weedy scapose perennials 5–20(–30) cm tall, with deep straight taproots. *Leaves* lanceolate to oblanceolate, *deeply runcinate-pinnatifid,* 4–21 cm long, 1–3 cm wide, sessile to short-petioled. Inner series of bracts 10–15 mm long, at times with a small apical projection (corniculate), *not reflexed, the outer series shorter, erect to reflexed. Achenes red to reddish-brown or purplish,* the body 3–3.7 mm long, the beak 7–11 mm long. 2n=24 (Poddubnaja & Dionowa 1937, ex Darlington 1955).

Naturalized from Europe, rather common as a weed in Wisconsin. Flowering from late April through May and from late August to September; fruiting from May through mid-October. One may assume that this species is more common in Wisconsin than Map 50 indicates.

2. TARAXACUM OFFICINALE Weber Common Dandelion. Map 51.

Very common weedy scapose perenials 1–4(–6) dm tall. *Leaves* in a basal rosette, lanceolae to oblanceolate, *variously sinuately lobed (usually not to the midrib)* to entire, 11–35 cm long, 2–3 cm wide, *tapering to slightly winged petioles.* Inner series of bracts erect, 1–17 mm long, *the outer series shorter, strongly reflexed in fruit. Achenes tan to olivaceous,* the body 2.5–3.1 mm long, the beak 7–11 mm long. Sexual micro-species: diploid 2n=16. Apomicts: triploid 2n=24; tetraploid 2n=32; pentaploid 2n=40; hexaploid 2n=48 (Gustafson ex Löve & Löve 1947).

Naturalized from Europe, a ubiquitous weed throughout Wisconsin. Flowering mainly from April to June, occasionally in September; fruiting from May through September (–November).

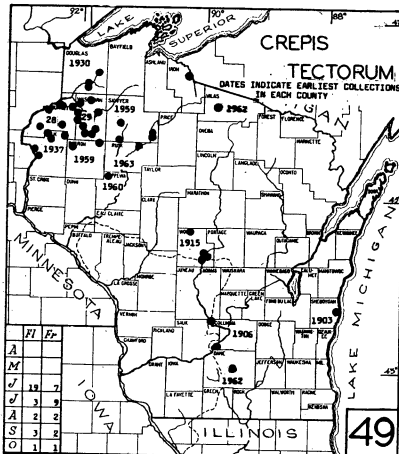
Taraxacum officinale, has been divided, especially in N. Europe, into innumerable apomictic micro-species, based on shapes of involucral bracts, shape of leaves, extent of lobing, etc., all characters difficult to determine objectively. It is best, therefore, to consider all Wisconsin *Taxaxaca* with tannish to olivaceous achenes the highly polymorphic *T. officinale.* Fernald (1950) and Sherff (1920) use the corniculate bracts of *T. erythrospermum* to distinguish it from *T. officinale.* Since Wisconsin plants show this rarely it has not been used as a key character. Fernald considered the extent of leaf lobing to be important, leaves of *T. erythrospermum* being shorter and generally more deeply lobed than those of *T. officinale.*

55. SONCHUS L. Sow Thistle

Annual or perennial leafy weeds, mostly glabrous, sometimes glandular above. Leaves alternate, sessile, lobed or unlobed, with spinulose-dentate margins. Heads yellow, many flowered, the involucral bracts imbricated in 2–3 series. Achenes laterally compressed, beakless. Pappus bristles abundant, glistening white. An Old World genus, all our species introduced weeds.

Key to Species

A. Perennials with underground horizontal rootstocks; heads large, the involucre 12–20 mm high; leaf bases auriculate, more or less clasping the stem, the rounded auricles small and inconspicuous; achenes 5-nerved; terminal leaf lobe elongate-triangular to oblong.


CREPIS TECTORUM
DATES INDICATE EARLIEST COLLECTIONS IN EACH COUNTY
LAKE SUPERIOR
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
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M
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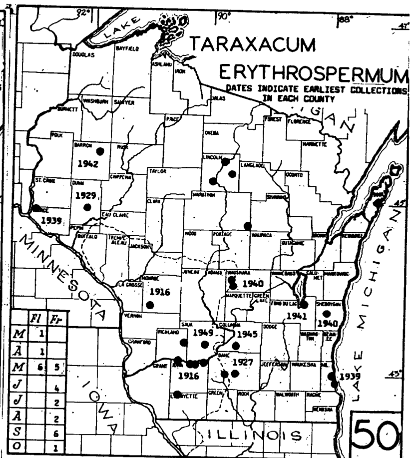
J 3 9
A 2 2
S 3 2
O 1 1
49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DATES INDICATE EARLIEST COLLECTIONS IN EACH COUNTY
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
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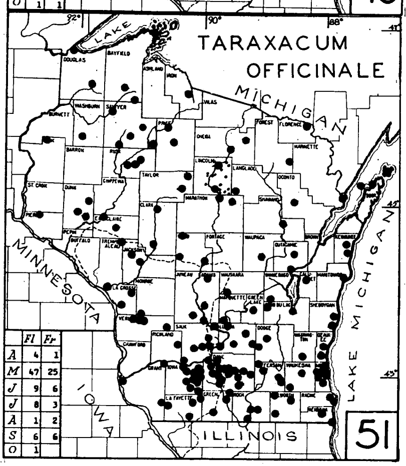
M 6 5
J 4
J 2
A 2
S 6
O 1
50


TARAXACUM OFFICINALE
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
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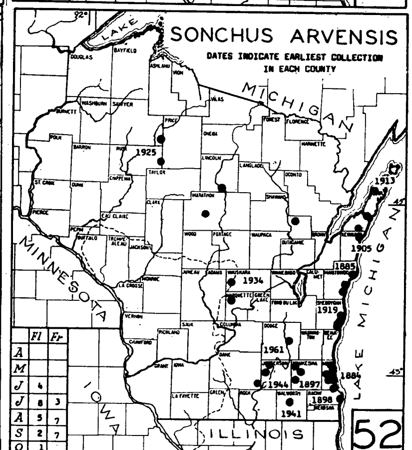
M 47 25
J 9 6
J 8 3
A 1 2
S 6 6
O 1
51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DATES INDICATE EARLIEST COLLECTION IN EACH COUNTY
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
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M
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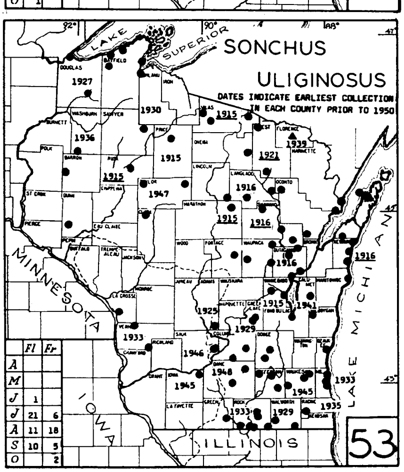
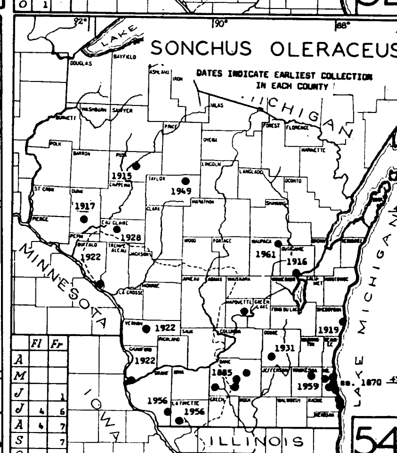
A 5 7
S 2 7
O 1
52


SONCHUS ULIGINOSUS
DATES INDICATE EARLIEST COLLECTION IN EACH COUNTY PRIOR TO 1950
LAKE SUPERIOR
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A
M
J 1
J 21 6
A 11 18
S 10 5
O 2
53


SONCHUS OLERACEUS
DATES INDICATE EARLIEST COLLECTION IN EACH COUNTY
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A
M
J 1
J 4 6
A 4 7
S 7
O 1 3
54

B. Peduncles and involucre glandular ------1. *S. ARVENSIS.*

BB. Peduncles and involucre glabrous ----2. *S. ULIGINOSUS.*

AA. Annuals with elongate taproots; heads smaller, mostly 9–12 (–14) mm high; leaf bases auriculate-clasping, the acute or rounded auricles large and conspicuous; achenes 3- to 5-nerved; terminal leaf lobe triangular.

C. Auriculate leaf bases acute, the leaf margins sparsely prickly; achenes striate with 5 weak nerves; terminal leaf lobe sharply equilaterally triangular, cut nearly to midrib ------------------------------------3. *S. OLERACEUS.*

CC. Auriculate leaf bases rounded, the leaf margins abundantly spinulose-dentate; achenes 3-nerved; leaves mostly unlobed, or if lobed, terminal leaf lobe broadly or irregularly triangular, the leaf cut about halfway to midrib ---4. *S. ASPER.*

1. SONCHUS ARVENSIS L. Field Sow Thistle. Map 52.

Perennials from long horizontal underground rootstocks, 5–13 dm tall, leafy mostly on lower half of glabrous stem. *Leaves* glabrous, oblanceolate, the upper lanceolate, *generally deeply lobed or sometimes entire, the margins spinulose-dentate, the small basal lobes rounded, short-auriculate.* Inflorescence an open corymbiform panicle, *the few to many heads on glandular peduncles. Involucral bracts* dark to pale green, (10–)14–18(–23) mm high, *glandular.* Achenes dark brown, 5-nerved, rugulose-papillose, 0.8–1.1 mm wide, 2.3–3.1 mm long. 2n=54 (Mulligan 1957, ex Löve & Löve 1961); 2n=64 (Darlington 1955).

Native of Europe and Western Asia, in Wisconsin infrequent on roadsides, river banks, beaches and abandoned low pastures, first collected in 1884. Flowering from (mid-) late June through September; fruiting from July through September.

2. SONCHUS ULIGINOSUS Bieb. Smooth Sow Thistle. Map 53.
Sonchus arvensis L. var. *glabrescens* Guenth., Grab. & Wimm.

Very similar to *S. arvensis* but 6–13(–25) dm tall, from long horizontal underground rootstocks, the few to many heads on *glabrous peduncles, the involucral bracts glabrous, 11–16 mm high, with wide scarious white margins.* Achenes 2.0–3.1 mm long, 0.9–1.4 mm wide. 2n=36 (Löve & Löve 1961).

Common in E. and N. Wisconsin as a weed in railroad yards and on roadsides, *generally in moister habitats than S. arvensis,* such as lake shores, river banks, marshes, low wet fields and pastures, as well as in Oak-Hickory and Oak-Basswood woods, roadsides in sandy aspen stands and near houses in Northern Wisconsin; first collected in 1915. Flowering from early July to September; fruiting from July to early October.

3. SONCHUS OLERACEUS L. Common Sow Thistle; Milk Thistle. Map 54.

Slender to robust annuals 5–13 dm tall, from taproots, glabrous (rarely glandular) above. *Leaves oblanceolate with soft spiny teeth and large acute clasping basal auricles, the lower generally more or less deeply lyrate-lobed, the terminal lobe sharply broad-triangular, cut nearly to midrib,* the upper lanceolate, often unlobed. Inflorescence corymbiform-paniculate; heads solitary or several, on glabrous or rarely glandular peduncles, the involucre glabrous, 8–12 mm high. *Achenes* transversely rugose with usually *5 ribs or nerves,* including the two marginal (10X), light brown, 2.3–3.3 mm long. $2n=32$ (Cooper & Mahoney 1935, probably from Wisconsin material).

Native of Europe, W. Asia and N. Africa, naturalized generally south of the "Tension Zone" in disturbed open weedy areas such as gardens, gravelly roadsides, railroad ballast and beaches. Flowering sporadically from (late June-) July to October; fruiting from June into November.

Most distinguishing field characters of *Sonchus oleraceus* are lyrate-lobed thin leaves resembling those of *Lactuca floridana,* and large, very acute, clasping leaf auricles.

Sonchus oleraceus has long been considered closely related to *S. asper,* Bentham and Hooker treating *S. asper* as its variety. Barber (1941) listed four characters to distinguish *S. oleraceus* from *S. asper:* 1) looser growth habit, 2) less spinose leaf margins, 3) sagittate spreading leaf bases, and 4) transverse achene ribs, and often more deeply lobed leaves. Their rare hybrids are sterile because the 9 chromosomes of *S. asper* and the 16 of *S. oleraceus* do not properly pair at meiosis. The *S. oleraceus* characters are all highly developed in *S. tenerrimus,* an annual of Southern Europe. Stebbins, *et al.* (1953) suggest that *S. oleraceus* ($2n = 32$) is an amphidiploid of *S. asper* ($2n = 18$) and *S. tenerrimus* ($2n = 14$).

4. SONCHUS ASPER (L.) Hill Spiny Sow Thistle. Map 55.

Annuals from long taproots, 3–10 dm tall. *Lower leaves lanceolate to spatulate-oblanceolate, mostly unlobed* [forma INERMIS (Bisch.) G. Beck] to sometimes shallowly runcinate-lobed *(the lobes usually cut less than halfway to the midrib, the terminal lobe* *broadly and irregularly triangular), the margins strongly spinescent-dentate, the large rounded spiny bases auriculate-clasping.* Inflorescences umbellate; heads solitary or crowded on glabrous or glandular peduncles [forma GLANDULOSIS Beckh.], the involucres 10–15 mm high, glabrous, gray-green, the innermost bracts often with white scarious margins. *Achenes 2–3 mm long, 3-nerved* (10x), *otherwise smooth.* 2n=18 (Barber, 1941).

A native of Europe, N. Africa and W. Asia, in Wisconsin not infrequent in roadsides, moist sand, damp woods, cedar swamps, bogs, railroad yards and embankments, lawns, and pastures. Flowering and fruiting from July to October.

56. LACTUCA L. WILD LETTUCE

Leafy-stemmed annuals, biennials or short-lived perennials with paniculate inflorescences. Involucre urn-shaped to cylindrical, the bracts in two or more unequal series. Achenes laterally compressed, beaked or unbeaked, with pappus attached to the enlarged tip. Heads usually numerous, the few flowers yellow, blue, or rarely white. Latin name for Lettuce, from *Lac*—milk, alluding to the milky juice.

KEY TO SPECIES

A. Mature achenes with distinct filiform beak; leaves variously lobed or entire, the bases sagittate-clasping, or leaves petioled; corollas yellow, blue or purple.

B. Achenes with short white bristles near summit; lower leaves lobed, the upper entire, with leaf margins, midribs and often lower stems spinulose; common weed -- 1. *L. SERRIOLA.*

BB. Achenes lacking bristles near summit; leaves lobed to entire, neither margins, midrib nor lower stem spinulose (except in *L. ludoviciana).*

C. Mature achenes 1.5–3 mm, the beak 0.5–2 mm long; pappus 9–11 mm long; involucre 13–20 mm high; leaves thickish, mostly entire or the lower runcinate; corollas blue or purple; introduced perennial, rare -- 4. *L. PULCHELLA.*

CC. Mature achenes 2.5–4 mm, the beak 1–3 mm long; pappus 4–9 mm long; involucre 6–19 mm high; leaves lobed to dentate or rarely entire with sagittate bases.

D. Achenes 2.5–3.4 mm long, the beak 1–2 mm long; pappus 4–6 mm long; involucre 6–12 mm high; leaves petioled, lobed or the upper unlobed, the margins dentate to entire; corollas yellow; very common ____________________2. *L. CANADENSIS.*

DD. Achenes 3.4–4 mm long, the beak 2.5–3 mm long; pappus 7–9 mm long; involucre (10–) 14–19 mm high; leaves lobed to dentate, pronouncedly glaucous and rather thick-textured, spinulose on margin and midrib beneath; corollas blue or yellow; prairies __ ________________________3. *L. LUDOVICIANA.*

AA. Mature achenes with short stout beak or beak lacking; leaves deeply lobed, rarely sessile, the bases not sagittate-clasping; corolla blue to whitish; tall woodland species.

E. Pappus white; leaves lyrately lobed, petioled; flowers blue; S. Wisconsin ______________________5. *L. FLORIDANA.*

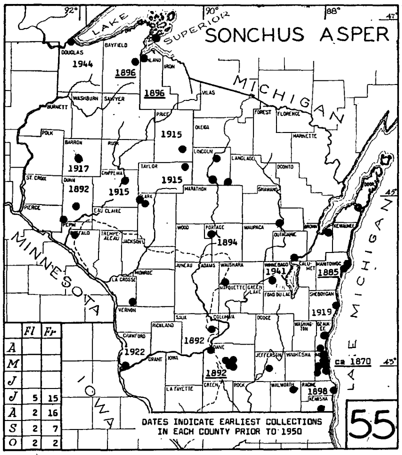
EE. Pappus brown or tawny, never white; leaves sessile, the lower lobed, the upper entire; flowers very pale bluish to ivory or whitish, inconspicuous; common throughout ____ __________________________________6. *L. BIENNIS.*

1. LACTUCA SERRIOLA L. Prickly Lettuce; Compass Plant. Map 56.
Lactuca scariola L.

Slender to robust glaucous annuals or biennials 4–11 dm tall, the *lower stem occasionally with prickly hairs.* Lower leaves lobed, broadly sagittate-clasping at base, *the margins and midrib beneath spinulose-ciliate,* the upper minutely serrulate, 5–16 cm long, 2–10 cm wide. Inflorescence an open panicle; heads narrowly cylindrical, the corollas pale yellow; involucre 9–14 mm high, the narrow bracts spreading in fruit. *Achenes 5–7-ribbed, bristly near summit,* 2.5–4 mm long, with a beak 3–4.5 mm long. $2n=18$ (Thompson, ex Darlington 1955).

Native of Eurasia to the Himalayas, in S. Wisconsin a prevalent weed on roadsides, vacant lots, side walks, railroads (especially in r.r. yards), disturbed prairies, woods, Lake Michigan dunes, and (Curtis 1959), "one of the unusual features of the bracken-grassland community." Flowering from mid-July through September; fruiting from late July to October.

This species, easily distinguished by its prickliness, has a tendency, when growing in the open, for the stem leaves to be held vertically in a north–south plane, hence "Compass Plant." *Lactuca serriola* is the wild ancestor of cultivated lettuce, *L. sativa* (cf. Whitaker et al. 1939, 1941), and its great variability in Wisconsin may well be due to introgression from the cultivar.


SONCHUS ASPER
LAKE SUPERIOR
MICHIGAN
MINNESOTA
IOWA
LAKE MICHIGAN
1944
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1896
1915
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1915
1915
1894
1941
1885
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1922
1892
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1898
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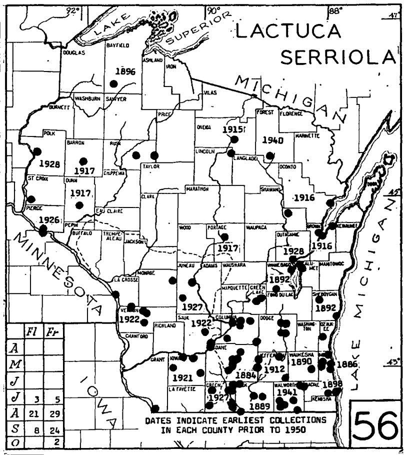
S 2 7
O 2 2
DATES INDICATE EARLIEST COLLECTIONS IN EACH COUNTY PRIOR TO 1950
55


LACTUCA SERRIOLA
LAKE SUPERIOR
MICHIGAN
MINNESOTA
IOWA
LAKE MICHIGAN
1896
1915
1940
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1917
1917
1916
1926
1917
1916
1928
1892
1927
1892
1922
1922
1921
1884
1912
1890
1886
1927
1889
1941
1898
Fl Fr
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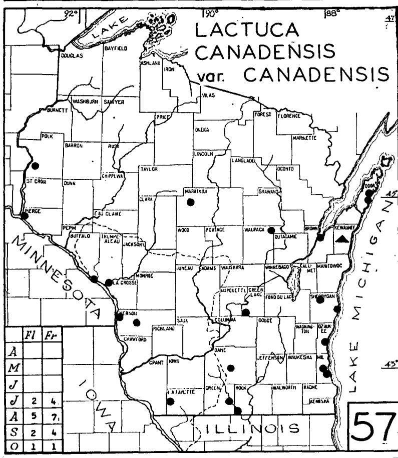
S 8 24
O 2
DATES INDICATE EARLIEST COLLECTIONS IN EACH COUNTY PRIOR TO 1950
56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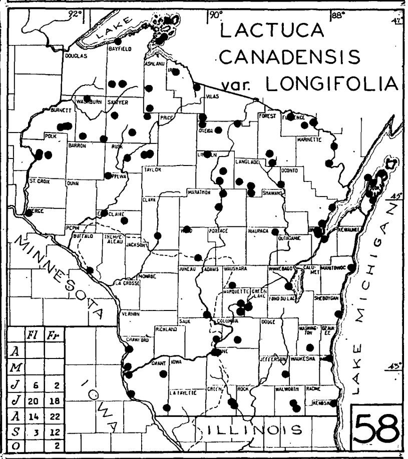
S 2 4
O 1 1
57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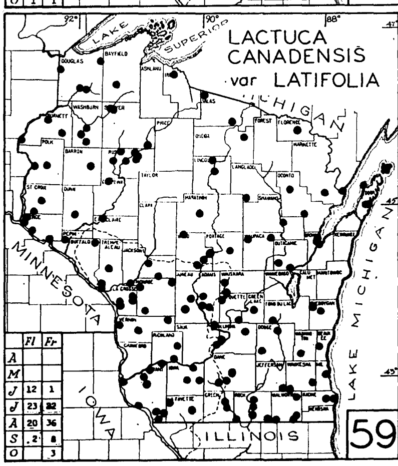
A 14 22
S 3 12
O 2
58


LACTUCA CANADENSIS var LATIFOLIA
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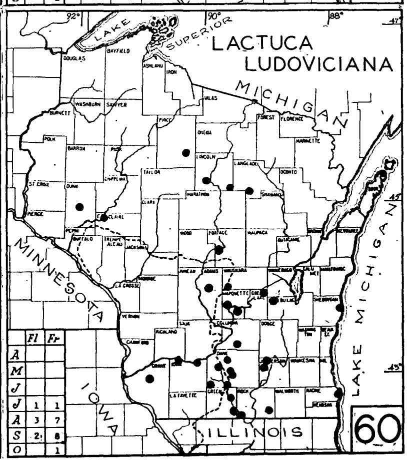
A 20 36
S 2 8
O 3
59


LACTUCA LUDOVICIANA
LAKE SUPERIOR
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A
M
J
J 1 1
A 3 7
S 2 8
O 1
60

2. LACTUCA CANADENSIS L. Wild Lettuce, Wild Opium.
Maps 57–59.

Glabrous leafy biennials 8–16 dm tall. Leaves 6–40 cm long, the lower oblanceolate, petioled and lobed, the upper usually lanceolate, entire, sessile-sagittate. *Inflorescences variable* from open pyramidal panicles to dense spike-like racemes; *corollas pale yellow; mature involucre narrow,* 6–13 mm high, *the bracts often green with purple margins. Mature achenes with 1 median rib, 2.5–3.5 mm long, the beak 1–3 mm long,* frequently drying green. Pappus 4–6 mm long, glistening white. 2n=34 (Whitaker & Jagger 1939).

Throughout Wisconsin in a great variety of habitats, prevalent in wet to wet-mesic prairies (Curtis 1959), on roadsides, sandy fields, limestone bluffs, and in disturbed maple-hemlock, aspen and river bottom woods, shaded ravines and marshes. Flowering from late June through September; fruiting from July through September.

Divisible, strictly on the basis of leaf lobing and toothing, into the following rather weak varieties (after Fernald 1950).

KEY TO VARIETIES

a. Most leaves lobed.
  b. Lower most leaves with lobes entire, 3–7(–10) mm wide ---------------------------------2b. var. *LONGIFOLIA.*
  bb. Lowermost leaves with lobes dentate, (6–)14–25(–40) mm wide, the upper leaves usually lobed --2c. var. *LATIFOLIA.*
aa. All but the lowermost leaves not lobed, the margins entire ---------------------------------------2a. var. *CANADENSIS.*

2a. LACTUCA CANADENSIS L. var. CANADENSIS Map 57.

Lactuca integrifolia (Bigel.) Gray *sensu* Wiegand (1920) and Am. authors.

All leaves entire or rarely the lowest coarsely incised. Mostly in E. Wisconsin.

2b. LACTUCA CANADENSIS L. var. LONGIFOLIA (Michx.) Farw.
Map 58.

Lactuca canadensis L. var. *typica sensu* Wiegand (1920), not L.

Principal *leaves lobed, the lobes entire, rarely 1 cm wide,* the upper leaves lanceolate and entire. Throughout Wisconsin, though more common in the north.

2c. LACTUCA CANADENSIS L. var. LATIFOLIA Ktze. Map 59.

Principal *leaves lobed, the lobes dentate, and wider than in var. longifolia,* the upper ones lobed or entire. Throughout Wisconsin.

Two northern sheets of *Lactuca canadensis* [Marinette Co.: *Schuette s.n.* (F). Douglas Co.: Brule Barrens, *Thomson 5186* (WIS)] closely resemble *L. ludoviciana* in the large spreading inflorescences and large heads, but are more like *L. canadensis* var. *latifolia* in the coarsely lobed, not spinulose-dentate leaves.

3. LACTUCA LUDOVICIANA (Nutt.) Ridd. Prairie Lettuce. Map 60.

Robust biennials or short-lived perennials 4–12 dm tall. Leaves 6–17(–28) cm long, 2–6(–9) cm wide, crowded, sessile-sagittate, *thickish, conspicuously glaucous, the lower with midrib spinulose beneath, deeply lobed, the lobes acute to obtuse, sharply dentate,* the teeth and lobes more or less falcate, the upper mostly unlobed, dentate. Inflorescences paniculate-racemose; corollas yellow or blue (Gleason, 1952; Wisconsin plants mainly in fruit, their color mostly not established); *involucre cylindrical to ovate (12–)14–20 mm high. Achenes with one lateral rib, 3.4–4 mm long, the beak 2.5–3 mm long, very similar to those of Lactuca canadensis, but larger.* Pappus snowy white. 2n=34 (Stebbins *et al.* 1953, ex Darlington 1955).

Scattered or locally common through S. and central Wisconsin, most abundant in dry-mesic upland prairies (Curtis, 1959), mesic deep-soil and in sandy prairies, often on railroads or roadsides, in N. Wisconsin introduced on roadsides, railroads, coal yards, and sandy fields. Flowering from July through mid-September; fruiting from late July to October.[15]

Vegetatively resembling *L. serriola* and *L. canadensis,* but differing by the wider, very glaucous leaves, with the larger teeth lacking the many smaller secondary teeth of *L. serriola,* and the wider, more robust, abrupt inflorescences with much larger heads.

4. LACTUCA PULCHELLA (Pursh.) DC. Map 61.

Slender leafy glabrous perennials with deep taproots, 3–6 dm tall. *Leaves sessile, thickish,* 5–10(–13) cm long, 1–2(–3) cm wide, *the lower quite entire to deeply runcinate-pinnatifid,* the lobes entire or nearly so, the upper lanceolate, entire. Inflorescences open panicu-

[15] It is possible that this species is seasonally isolated from *L. canadensis.* Field observations by the second author, on July 31, 1962, in Central Wisconsin (Marquette Co.), showed that *L. ludoviciana,* which there is not uncommon on sandy roadsides and open oak woods and often grows with L. *canadensis,* blooms earlier, with almost all inflorescences past flowering, while most plants of *L. canadensis* were just at beginning of anthesis.

late-racemose, the *few large heads on scaly-bracted peduncles; corollas bright blue to blue-violet. Involucre* cylindrical, *13–20 mm high.* Achenes thickish, 1.5–3 mm long, with short firm beak 0.5–2 mm long; pappus white.

Native of the grasslands of the Western United States, in Wisconsin occasional and sporadic along railroad rights-of-way or railroad yards. Flowering from early July to late August; fruiting from mid-August.

5. LACTUCA FLORIDANA (L.) Gaertn. Blue Lettuce. Map 62.
Lactuc villosa Jacq.

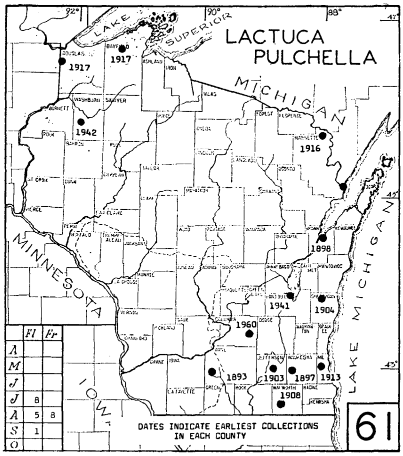
Slender biennials 1–2 m tall, similar to *L. biennis. Leaves thin, deeply lyrate-lobed,* 7–28 cm long, 3–12 cm wide, *the margins dentate, the midrib often pilose beneath. Inflorescences spreading paniculate-racemose; corollas light blue,* often with purplish tinge; involucre cylindrical to spreading, 6–10 mm high. Mature achenes *brown or mottled,* 3–4 mm long, the *beak very short or lacking. Pappus white (never brownish),* 5–7 mm long.

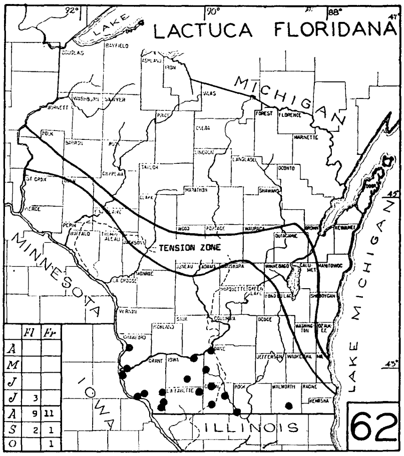
Rather common in SW. Wisconsin in rich mesic oak woods, river bottoms, forests, on roadsides, and cultivated areas. Flowering from late July through early (late) September; fruiting from August into October.

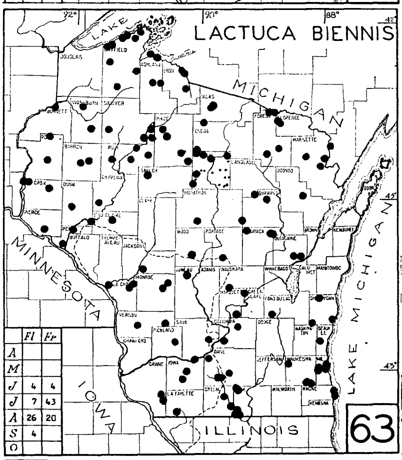
6. LACTUCA BIENNIS L. Woodland Lettuce. Map 63.
Lactuca spicata (Lam.) Hitchc., *sensu* Am. authors, not Lam.

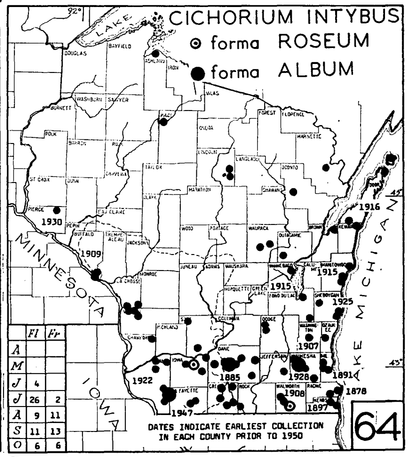
Slender to very robust leafy biennials 1–3 m or more tall. *Lower leaves often lyrately lobed, the falcate lobes often alternate,* (7–) 9–18(–51) cm long, 3–10(–16) cm wide, the upper lanceolate, entire. Panicles elongate, *the corollas very pale blue to translucent ivory or whitish, the limb often very small and corollas therefore very inconspicuous,* the open head ca. 8–10 mm diam.; involucre cylindrical to campanulate, 8–12 mm high. *Achenes* thickish, ca 4 mm long, the beak lacking. *Pappus tawny or brown, sometimes reddish, never white,* 4–5(–9) mm long. 2n=34 (Thompson, ex Darlington 1955).

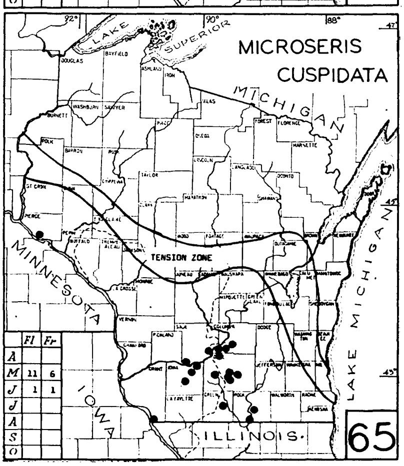
A woodland species, most common in the southern dry mesic oak forest and low flood plain forests, in the north not uncommon in maple-basswood and low maple-elm-ash forests, tamarack-spruce-white cedar-hemlock-hardwoods, *Rubus* thickets, on wooded shores of lakes, streams and rivers, and roadsides, there to over 5 m tall! Flowering from mid-June to mid-September; fruiting from late July to late September.

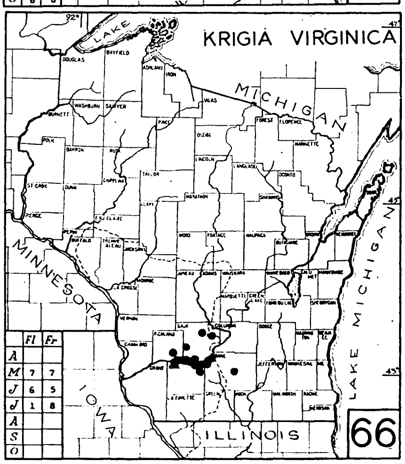

LACTUCA PULCHELLA
1917
1917
1942
1916
1898
1941
1904
1960
1893
1903
1897
1913
1908
DATES INDICATE EARLIEST COLLECTIONS IN EACH COUNTY
61


LACTUCA FLORIDANA
TENSION ZONE
62


LACTUCA BIENNIS
63


CICHORIUM INTYBUS
forma ROSEUM
forma ALBUM
DATES INDICATE EARLIEST COLLECTION IN EACH COUNTY PRIOR TO 1950
64


MICROSERIS CUSPIDATA
TENSION ZONE
65


KRIGIA VIRGINICA
66

57. CICHORIUM L. CHICORY

1. CICHORIUM INTYBUS L. Chicory; Blue Sailors. Map 64.

Branched, glabrous to densely pilose, robust perennial, to 1 m tall, the deep taproot used as an adulterant or substitute for coffee. Leaves alternate, variously lobed. *Heads* 3–4 cm diam., *showy, bright blue* [white in forma ALBIFLORUM Neum.; pink in forma ROSEUM Neum.], *in sessile clusters of 2–3 in the axils of upper leaves or terminal on erect, hollow, glandular peduncles, each with 1–2 sessile heads.* Involucre biseriate, the outer series glandular. *Pappus of numerous minute chaffy scales.* 2n=18 (Stebbins, ex Darlington 1955).

Native to the Mediterranean Region, abundant in S. and E. Wisconsin along roadsides and in disturbed areas in cities. Flowering from (mid-) late June through October; fruiting from late July through October.

58. MICROSERIS D. Don

1. MICROSERIS CUSPIDATA (Pursh) Schultz Bip. Map 65.
Agoseris cuspidata (Pursh) Steud.

Scapose perennials with deep taproots. *Scape glabrous below, abundantly pilose above,* 1–5 dm tall. *Leaves basal, grass-like to linear-elliptic,* 11–27 cm long, 4–11(–22) mm wide, the margins woolly-pubescent. Heads solitary, large, 3–5 cm in diam.; corollas yellow. x=9 (Darlington 1955).

Native of the western Great Plains, in S. Wisconsin rather rare and sporadic, mainly on sandy, or dry rocky calcareous prairies and bluffs, gravelly hillsides, and along railroads, in Pierce County (Hager City) on the Mississippi River sand terraces with *Anemone patens* and *A. caroliniana* [*Wadmond s.n.* (WIS)]. Flowering throughout May (–June); fruiting from mid-May to June.

Microseris cuspidata can be distinguished from *Tragopogon* by the scapose habit, beakless achenes, and woolly leaf margins.

59. KRIGIA Schreb. DWARF DANDELION.

[Shinners, Lloyd H. Revision of the genus *Krigia* Schreber. Wrightia 1: 187–206. 1947.]

Scapose annuals or perennials. Leaves basal, variously lobed to entire, glabrous or glandular. Heads solitary to clustered, the corollas yellow to yellow-orange. Involucral bracts biseriate. Achenes cylindrical to conical, truncate. Pappus double, the outer series of minute scales, the inner of few to numerous scabrous bristles.

KEY TO SPECIES

A. Plants annual; achene conical; pappus of 5 outer scales alternating with 5 inner scabrous hairs; scape leafless; rare, S. Wisconsin ______________________________1. *K. VIRGINICA.*

AA. Plants perennial; achene cylindrical; pappus of more numerous scales and scabrous hairs; scape bearing 1–2 reduced sessile leaves; peduncles glabrous or glandular; common throughout ______________________________________2. *K. BIFLORA.*

1. KRIGIA VIRGINICA (L.) Willd. Dwarf Dandelion. Map 66.

Very slender scapose annual (5–)9–29 cm tall, from long taproot. Stem glandular at base and at base of involucre, sparsely so in mid-portion. Leaves numerous, basal, oblong to spatulate, often with remote acute teeth, glandular over both surfaces or at least on the margins, often black-punctate. Heads solitary, when flowering 18–20 mm in diam. (fresh). Involucral bracts of fruiting plant trans-Incent, often with red or purple center line. *Pappus of 5 outer white or brownish 1 mm long scales alternating with 5 inner scabrous 4–6 mm long bristles.*

Locally abundant in S.-central Wisconsin, in sandy soil along roads, railroads and Jack Pine barrens along the Wisconsin River in Dane, Sauk, Iowa and Richland counties, the range closely paralleling that of *Opuntia compressa* var. *macrorhiza* (Ugent, 1962), at Arena, Iowa Co., on sand dunes and flats with *Diodia teres* var. *setifera* (only Wisc. station), *Polygonella articulata, Polanisia dodecandra, Hudsonia tomentosa, Hypericum gentianoides, Cycloloma atriplicifolia. Cyperus schweinitzii, Cenchrus pauciflorus,* etc., the Madison record presumably an introduction in the University of Wisconsin Arboretum [1947, *Greene s.n.* (WIS)].

2. KRIGIA BIFLORA (Walt.) Blake Dwarf Dandelion. Maps 67, 68.

Slender perennials 2–6 dm tall, the stem scape-like; leaves mostly basal, *except for 1–2 mostly reduced, sessile-clasping bracts subtending inflorescence branches,* spatulate-lanceolate with winged petioles, glabrous (rarely pilose), entire, repand to variously lobed. Heads few, orange-yellow, 2–3 cm in diam. when in flower, on elongate peduncles arising singly or several in the axil of 1–3 short leafy bracts. *Pappus double, the outer series of numerous tawny minute scales, the inner of scabrous bristles.* 2n=10 (cf. p. 336).

KEY TO SUBSPECIES

a. Inflorescence branches and involucre completely glabrous; leaves nearly always entire ....2a. ssp. *BIFLORA*.
aa. Inflorescence branches and at times the involucre sparsely to densely glandular; leaves entire to often deeply lobed ....2b. ssp. *GLANDULIFERA*.

2a. KRIGIA BILFORA (Walt.) Blake, ssp. BIFLORA. Map 67.

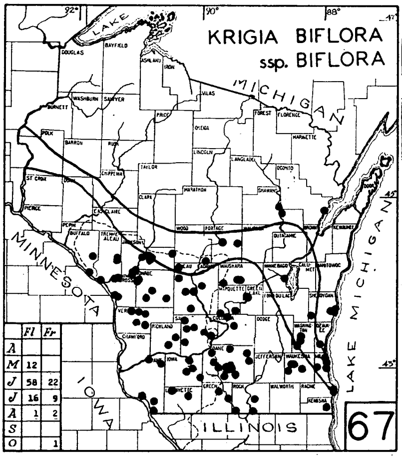
Common in Wisconsin in the southern "forest-prairie province", in open oak-hickory, maple-basswood, and Jack Pine-Jack Oak woods, sandy prairies, roadsides, railroads, and thickets. Flowering from late May to mid-July (-August); fruiting from June through July (-October).

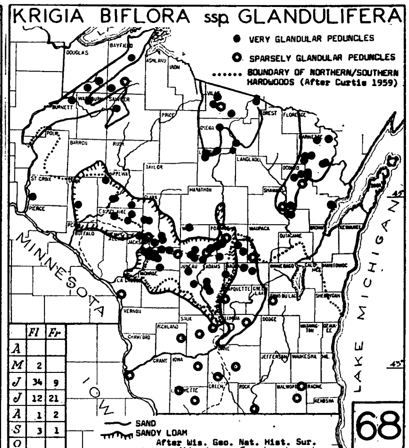
2b. KRIGIA BIFLORA (Walt.) Blake, ssp. **GLANDULIFERA** (Fern.) Iltis, *stat. nov.* Map 68.
Krigia biflora (Walt.) Blake, forma *glandulifera* Fern. Rhodora 37:337. 1935

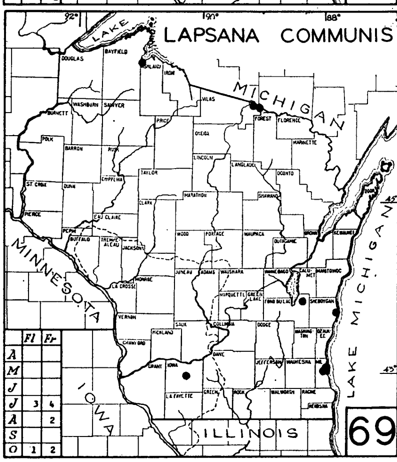
Relatively common in sandy areas north of, or within the "Tension Zone", on roadsides, lake shores, or in oak or Jack Pine woods, on sandy hillsides and open fields, less common in aspen woods, sedge meadows and alder-White Cedar swamps. Flowering from (late May-) early June to mid-July (-September), the peak about 10 days later than in ssp. *biflora*, this perhaps related to its more northerly range; fruiting from June sporadically through August (-October).

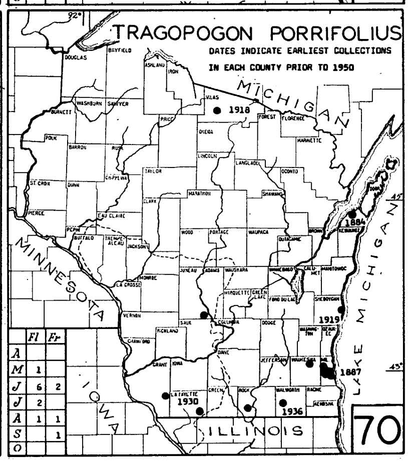
In a recent revision of the genus, Shinners (1947b) considered the glandularity of the peduncles to be of no taxonomic or geographic significance and relegates Fernald's form to synonomy. A glance at the great similarity of the glandular to the non-glandular plants makes this view understandable. Yet there are several reasons to think that the two forms have had separate histories, and that it would be better to recognize them as geographic subspecies.

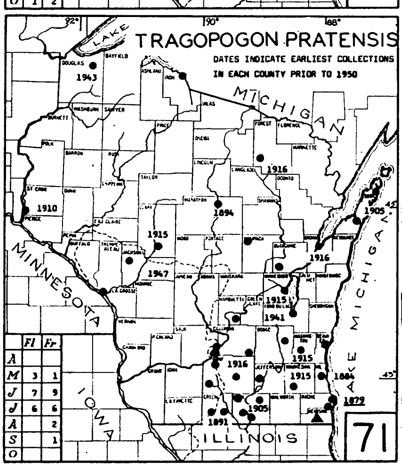
Morphologically, the only differences are those outlined in the key. The glandularity varies from plants densely glandular on involucral bracts, peduncles and even scapes, to plants that have just a few hairs at the very base of the head, or none at all. Linked with glandularity is a strong tendency for deep lobing of the leaf, a tendency noted by Fernald (1935: 337–8). While all but a very few plants of ssp. *biflora* have entire (unlobed) leaves, as do many plants of ssp. *glandulifera,* deeply lobed leaves are a common tendency of the latter taxon only. It is likely that detailed measure-

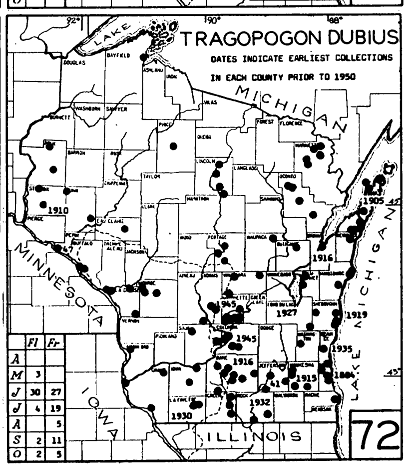

KRIGIA BIFLORA
ssp. BIFLORA
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
67


KRIGIA BIFLORA ssp. GLANDULIFERA
VERY GLANDULAR PEDUNCLES
SPARSELY GLANDULAR PEDUNCLES
BOUNDARY OF NORTHERN/SOUTHERN HARDWOODS (After Curtis 1959)
SAND
SANDY LOAM
After Wis. Geo. Nat. Hist. Sur.
68


LAPSANA COMMUNIS
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
69


TRAGOPOGON PORRIFOLIUS
DATES INDICATE EARLIEST COLLECTIONS
IN EACH COUNTY PRIOR TO 1950
70


TRAGOPOGON PRATENSIS
DATES INDICATE EARLIEST COLLECTIONS
IN EACH COUNTY PRIOR TO 1950
71


TRAGOPOGON DUBIUS
DATES INDICATE EARLIEST COLLECTIONS
IN EACH COUNTY PRIOR TO 1950
72

ments will in the future add other characters to these distinctions. Chromosome number of ssp. *glandulifera* is 2n=10, counted recently on Wisconsin specimens (Vilas Co.) by Dr. S. Kawano at the Univ. of Wis. Herbarium. The number for ssp. *biflora* is unknown.

Though the total range of either subspecies is not known to us, their distribution in Wisconsin in relation to the above characters is significant (cf. maps 67, 68). Good ssp. *biflora,* with no glandular hairs whatsoever, is restricted to rocky woods and sand areas *south* or within the floristic "Tension Zone" (cf. Desmarais 1952: 377–8; Curtis 1959; and others), i.e. to south of the Northern Hardwood region. On the other hand, heavily glandular plants are restricted to sandy areas within and *north* of the "Tension Zone", in effect, to areas within the Northern Hardwoods. From within the Wisconsin area of good ssp. *biflora* there are a number of specimens that have only 5 mm of peduncle beneath the head that is glandular, or sometimes less, with only 2 or 3 hairs! These are mostly restricted to south of the "Tension Zone" (Map 68, stars), and, since in every other way they are ssp. *biflora* plants, it seems reasonable to suppose that their weakly expressed glandularity represent introgression from ssp. *glandulifera.* In Wisconsin, *Krigia biflora* often acts as a pioneer. This attribute, together with wind-borne fruits, would facilitate establishment, migration, and hybridization.

While throughout most of Wisconsin the mass ranges of the subspecies do not overlap, in the "Tension Zone" in Central Wisconsin both may grow within the same population. In eight mass collections from Jackson County, Fassett (ms., ca. 1948) calculated percentages of glandular plants in a given population, finding that five stations were 100% glandular, one was 98%, one was 95% and one, in eastern Jackson County, 57% glandular. This last station also had plants with both slightly glandular and glabrous peduncles on the same plant.

While ssp. *biflora* is widespread in the eastern U.S., we have only few records of glandular plants in the University of Wisconsin Herbarium south of the region of the Northern Hardwoods. One sheet from Peoria, Illinois (a wooded valley), and a few from eastern Kentucky and the Southern Appalachians have hairy peduncles. Intermediates, like those of southern Wisconsin, are not rare in Iowa or Minnesota. These observations essentially agree with those Fernald (1935) who also reports the Colorado and New Mexico plants to be glandular, as does Scoggan (1957) for those from Manitoba. All in all, it suggests that these subspecies were once segregated along the lines of the Northern Hardwoods or perhaps Rocky Mountains area (ssp. *glandulifera)* vs. Southern Deciduous Forest area (ssp. *biflora),* but have in recent times begun to reintegrate. In Wisconsin, near the western limit of the Northern Hardwoods, where the more northern (or western) ssp. *glandulifera* may have met the southern ssp. *biflora* only recently, the distinctions of morphology on a geographic basis are still quite clear.

60. LAPSANA L.

1. LAPSANA COMMUNIS L. Nipple Wort. Map 69.

Slender weedy annual 4–6 dm tall, branched above. *Stem pilose below, glandular-pilose above.* Lower leaves lyrately-lobed to ovate, long petioled, the upper sub-sessile to sessile, ovate to lanceolate, *the dentate margins pilose.* Inflorescence an open panicle. Heads few flowered, small, the corollas yellow; involucre glabrous, biseriate, *the inner series of 8 erect, keeled bracts 6–7 mm high, the outer ca 1/10 as long.* Achenes narrowed toward summit, but not beaked. *Pappus none.* 2x=14 (Löve & Löve 1961).

Naturalized from Europe, rare in Wisconsin in mesic or moist habitats, on refuse heaps, roadsides, fence lines, deciduous or coniferous woods, and street corners in Milwaukee. Flowering in July; fruiting in July and August.

61. LEONTODON L.

1. LEONTODON AUTUMNALIS L. Autumn Dandelion; Hawkbit.

Slender, simple or branched scapose perennial ca 5 dm tall. Leaves basal, oblanceolate, their lobes distant, linear, entire, glabrous to sparsely pilose. Heads *subtended by swollen, scaley-bracted sparsely pilose peduncles,* the corollas yellow. Involucre campanulate, ca 9 mm high, the bracts narrow, glandular-pubescent. Achenes columnar, faintly nerved, rugulose. Pappus uniseriate, the bristles plumose. Native of Eurasia, established on the E. U.S. coast but rarely inland, in Wisconsin collected once in Sheboygan, June, 1903 [fr] *Goessl s.n.* (WIS) (very possibly in the collector's garden!?).

62. TRAGOPOGON L. GOAT'S BEARD

[Ownbey, Marion. Natural Hybridization and Amphidiploidy in the Genus *Tragopogon.* Am. Jour. Bot. 37: 487–499. 1950]

Branched or unbranched glabrous perennials with a long straight taproot. Leaves alternate, grass- or ribbon-like, the sessile bases clasping. Heads large, the numerous flowers yellow or purple. Involucre uniseriate. Achenes cylindrical, long beaked. Pappus of numerous plumose bristles. Eurasian genus, with several species common weeds.

Key to Species

A. Ligules pale violet to deep purple; achenes abruptly tapering to beak longer than achene body; involucral bracts 7–11; cultivated and rarely escaped ------------1. *T. PORRIFOLIUS.*

AA. Ligules yellow; achenes gradually tapering to a beak longer or shorter than the achene body; common weeds.

- B. Bracts generally 8 or 9, margined with red or purple, about equal to the corollas; achene beak shorter than body; peduncle slender, not enlarged below the head; leaf tips recurved -------------------------2. *T. PRATENSIS.*
- BB. Bracts generally 11–13, not margined with red or purple; achene beak longer than body; peduncle strongly enlarged (inflated) below the head; leaf tips not recurved -------- ----------------------------------3. *T. DUBIUS.*

1. Tragopogon porrifolius L. Salsify; Oyster Plant. Map 70.

Glabrous perennial to 8 dm or more tall, with *pale violet to purple ligules shorter than the involucral bracts, the flowering heads borne on somewhat swollen hollow peduncles.* Leaves to 34 cm long, to 1 cm wide, narrow-lanceolate to linear. Involucre of (7–)*8–9(11) bracts,* 2.5–3 cm long, becoming longer in fruit. Achenes *tapering abruptly to a slender beak somewhat longer to twice the length of the achene body.* 2n=12 (Ownbey 1950).

Introduced from Europe, rarely found in Wisconsin on open roadsides and railroads as an escape, the plants often grown as root vegetables. Flowering from late May to early August; fruiting from August to September.

2. Tragopogon pratensis L. Lesser Goat's Beard. Map 71.

Perennial branching from midway on stem, 5–8 dm tall, with *yellow ligules about equaling the involucral bracts, the fruiting peduncles remaining thin and cylindrical.* Leaves 17–26 cm long, to 1.7 cm wide at the base, *the tips recurved.* Involucre 21–23 mm long in flower, extending to 32 mm in fruit, *the (7–)8–9(–11) bracts margined with red or purple.* Achenes gradually tapering to a thin beak shorter than achene body. Fruiting head abruptly and pronouncedly thickened. 2n=12 (Winge 1926, ex Ownbey 1950).

Native of Europe, mainly in southern and eastern Wisconsin as a weed along roadsides, vacant lots, on railroad prairies, hayfields, and with *Juniperus virginiana,* etc. on sandstone bluffs. Flowering from late May through mid-July; fruiting from June to mid-August.

3. TRAGOPOGON DUBIUS Scop. Greater Goat's Beard. Map 72.

Perennial branching from near base, 5–9 dm tall, with *yellow ligules all shorter than the involucral bracts, the peduncles enlarged and hollow* (in late plants or late shoots less so). Leaves to 30 cm long, 8–12 mm wide at the base. Involucre 25–35 mm long lengthening to as much as 67 mm in fruit, *the 13 bracts green throughout.* Achenes abundantly scabrous, gradually tapering to a thin beak equalling or slightly longer than the achene body. 2n=12 (Ownbey 1950).

Naturalized from Europe, mainly in S. and E. Wisconsin as a common weed of roadsides, sandy prairies, sandstone cliffs, railroad ballasts, abandoned fields, orchards, dry sandy oak woods, Sugar Maple-Basswood woods, and pastures. Flowering from late May to mid-July, sporadically through September and October; fruiting from late June through October.

Tragopogon dubius, quite similar to *T. pratensis,* may be distinguished, aside from key characters and generally longer fruits, as follows (after Ownbey 1950):

	T. DUBIUS	T. PRATENSIS
LEAVES:	Tips straight	Tips recurved
BRACTS:	Long, narrow, not margined with red or purple, 13	Shorter, wider, red or purple margins, 8 or 9
BRANCHING:	From near base	From midway on stem
LIGULES:	Shorter than bracts	Equalling bracts
ACHENES:	Slender	Thicker

Ownbey (1950) reports natural hybrids and their amphidiploids in Washington State, where all three species are found sympatrically. Hybrids, then, may occur in southern Wisconsin, though none have been recognized to date.

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PRELIMINARY REPORTS ON THE FLORA OF WISCONSIN NO. 49. COMPOSITAE II—COMPOSITE FAMILY II

THE GENUS *Senecio*—THE RAGWORTS—IN WISCONSIN[1,2]

T. M. Barkley

Senecio is a world-wide genus of some one thousand or more species, exhibiting great morphological and ecological diversity. It varies from tropical trees to small arctic herbs, and includes widespread weedy species and narrow endemics. Many native temperate North American *Senecio* species are biologically complicated in that they readily intergrade with each other.

The distribution maps are based on specimens in the University of Wisconsin (WIS), Milwaukee Public Museum (MIL) and Northland College, Ashland (NC) herbaria, and on my revision (1962) of *Senecio aureus* and allied species, which includes *S. aureus, S. pseudaureus* var. *semicordatus, S. pauperculus, S. plattensis,* and *S. indecorus* of the Wisconsin flora. I am grateful to Hugh H. Iltis, University of Wisconsin, Emil P. Kruschke, Milwaukee Public Museum, and Eugene Hsi, Northland College for making the specimens of their respective institutions available to me. Mrs. Roberta Kirkpatrick, Ollie Weber, and Barbara Elder assisted in preparation of the manuscript.

Genus 26. SENECIO LINN. Groundsel, Ragwort, Butterweed

Annual, biennial or perennial herbs with alternate, toothed or divided to entire leaves and few to numerous cylindric or campanulate heads. Heads radiate or eradiate; rays yellow to whitish-yellow. Principal involucral bracts green, equal in size or nearly so, appearing in a single series, usually subtended by a few small calyculate bracts; receptacle naked. Disk florets perfect and fertile; style branches flattened and penicillate; ray florets pistillate and fertile. Pappus of fine, smooth or very lightly barbellate bristles. Achenes terete or nearly so at maturity, 5–10 nerved.

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KEY TO SPECIES

A. Leaves more or less equally distributed on the stem; annuals, or perhaps rarely biennials.

B. Rays conspicuous; leaves entire to weakly toothed; pubescence often copious. Rare native, N. Wisconsin ---------- ------------------------------------1. *S. congestus.*

BB. Rays inconspicuous or absent; leaves, or some of them, lobed to pinnatified; pubescence short and often scant, crisp. Introduced weeds.

C. Rays absent; calyculate bracts well developed with distinct black tips ----------------------2. *S. vulgaris.*

CC. Rays present, small; calyculate bracts usually without distinct black tips ------------------3. *S. sylvaticus.*

AA. Cauline leaves relatively few, progressively reduced upward, usually smaller and more toothed than the basal leaves; perennials or sometimes biennials with short, erect, or spreading underground parts.

D. Basal leaves cordate or abruptly contracted to the petiole.

E. Inflorescence a loose to congested corymbose cyme, rarely conspicuously subumbellate.

F. Basal leaves typically cordate, occasionally subcordate or truncate; caudex weakly spreading to suberect. Common and widespread ------ 4. *S. aureus.*

FF. Basal leaves truncate to abruptly contracted; caudex simple, very short, erect or suberect. Sandy lakeshore prairies, Kenosha and Racine Co.s, rare ---- -------------5. *S. pseudaureus* var. *semicordatus.*

EE. Inflorescence subumbellate; basal leaf blades usually abruptly contracted to the petiole. Apostle Islands, Lake Superior, rare ----------------------8. *S. indecorus.*

DD. Basal leaves rounded or obtuse to tapering at the base, rarely subtruncate. Common and widespread species.

G. Pubescence normally persistent, at least along the upper stem, among the heads in the inflorescence, and in and near the axils of the basal leaves; caudex usually short and simple, erect or suberect; lower cauline leaves usually well developed, pinnatifid --------6. *S. plattensis.*[3]

GG. Glabrous or nearly so at maturity, caudex weakly branching and often elongated; cauline leaves usually reduced ----------7. *S. pauperculus* var. *pauperculus.*[3]

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[3] Species 6 and 7 intergrade freely and intermediates are common (cf. text).

1. SENECIO CONGESTUS (R.Br.) DC. Marsh Fleabane Map 1.
   S. palustris (Linn.) Hook. 1834, not of Velloso, 1827.
   S. congestus var. *tonsus* Fern. (TYPE: La Chapelle, Wisconsin, July 16, 1897, *Cheney 7419* (GH, WIS)).

Annual (sometimes biennial?) herbs, 3–8 dm tall, densely lanate-tomentose with long, jointed hairs, especially on the upper stem and among the heads in the inflorescence, or occasionally rather sparsely tomentose (var. TONSUS Fern.); stems thick and soft, unbranched, arising singly from a cluster of fibrous roots. Leaves linear-spatulate to narrowly oblanceolate, the lowermost to 12 cm long, progressively shorter up the stem; margins shallowly pinnatifid to merely undulate or subentire. Inflorescence congested to occasionally rather open; heads frequently numerous, to 50 or more; involucral bracts narrow, 4–7 mm long (calyculate bracts absent); rays light yellow, the ligule 5–6 mm long (dry); pappus long and abundant, conspicuous in mature plants.

NW. Wisconsin and Door Co., in swamps, edge of streams, etc., rather rare. Flowering from late May through July. A distinctive, circumpolar species, occuring in North America as far south as Iowa.

2. SENECIO VULGARIS Linn. Common Groundsel Map 2.

Annual weed to 3(–4) dm tall, lightly crisp-pubescent, glabrate and smooth in age; stem leafy throughout, unbranched to strongly branched, from a more or less distinct taproot. Leaves fleshy, 1–8 cm long, the margins undulate to pinnatilobate, the lobes often denticulate; lower leaves petiolate, becoming progressively more sessile and clasping upward. Heads strictly discoid, cylindrical; principal involucral bracts 4–7 mm long, about 21 in number; *calyculate bracts much shorter than the principal involucral bracts, conhpicuously black-tipped.*

SE. and extreme N. Wisconsin, in waste ground, roadsides, gardens, etc., a native of the Old World, now established throughout much of the temperate zone. Flowering from mid-May to early in July, and from the second week in September to mid-November.

3. SENECIO SYLVATICUS Linn. Wood Groundsel Map 1.

Annual weed to 8 dm tall, moderately crisp-pubescent to subglabrous; stems leafy througout, usually unbranched, arising singly from a taproot. Leaves more or less distinctly pinnatifid, the segments often denticulate. Heads cylindrical; involucral bracts 5–7 mm long, about 13 in number; *calyculate bracts* usually present but *very small, narrow, and inconspicuous, usually lacking distinct black tips;* rays present, small, the ligule often less than 1 mm long.

A native of the Old World, now widely established as a weed, in North America most abundant in the northeastern U.S., adjacent Canada, and along the Pacific Coast, known from Wisconsin by a single collection, viz. *Fassett 9558*, talus, gabbro knob, Hurley, Iron County (S25 T46N R2E), Aug. 21, 1929 (WIS).

Senecio sylvaticus is readily distinguished from the similar *S. vulgaris* by the presence of small rays, as well as a pronounced oily scent, which is lacking in fresh material of *S. vulgaris*.

4. SENECIO AUREUS Linn. Golden Ragwort Map 3.
S. gracilis Pursh
S. aureus var. *gracilis* (Pursh) Hook.

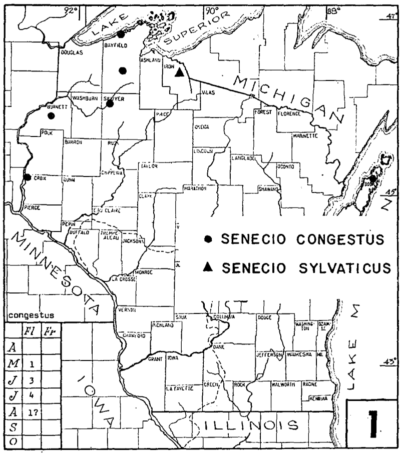
Perennial herbs 2–6 dm tall, glabrous or occasionally lightly tomentose in and near the axils of the basal leaves and among the heads in the inflorescence; stems single or loosely clustered from a horizontal, more or less branched and rhizomatous caudex. Basal leaf-blades rotund-ovate, cordate or sometimes subcordate, crenate to serrate-dentate, 1–6+ cm long, 1–6+ cm wide; petiole commonly 2–4 times as long as blade; cauline leaves reduced upward. Inflorescence a loose to congested corymbose cyme of 6–20 heads, the ligule 5–15 mm long, or ray florets absent in occasional individuals.

Throughout Wisconsin, frequent in rich woods, pastures, bogs, and other damp or wet areas. Flowering from mid-May in the southern part of the state to the second week in July in the north. Common and widespread, with many races and local variants, ranging from Newfoundland to Florida and west to the limit of the deciduous forest.

In SE. Wisconsin, especially in Dane, Jefferson, Kenosha, and Racine counties, occasional individuals bear a marked, somewhat intangible resemblance to *Senecio pseudaureus* var. *semicordatus*. In these individuals (hollow circles, Map 4) the basal leaf blade is rather abruptly contracted to the petiole, the petiole is relatively long and slender, and the underground portions tend to be reduced to a short caudex.

A slender, small-leaved phase, *S. aureus* var. *gracilis* or *S. gracilis*, uncommon in Wisconsin, though rather frequent in the Middle Atlantic States, is not sufficiently well defined morphologically or geographically to warrant taxonomic recognition.

5. SENECIO PSEUDAUREUS Rydb. var. SEMICORDATUS (Mack. & Bush) T. M. Barkley Western Golden Ragwort Map 4.
S. semicordatus Mack. & Bush
S. aureus var. *semicordatus* (Mack. & Bush) Greenm.


● SENECIO CONGESTUS
▲ SENECIO SYLVATICUS
congestus
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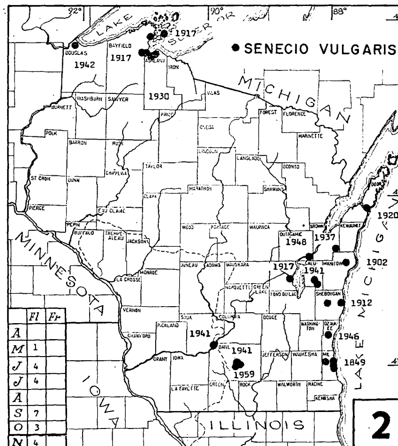
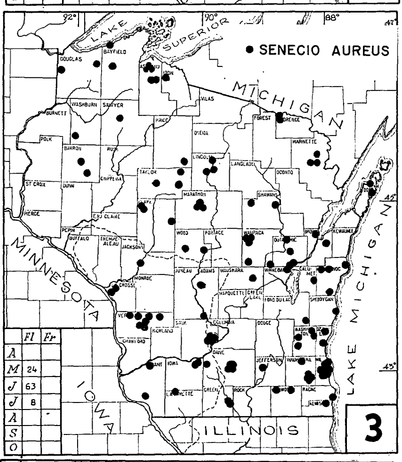
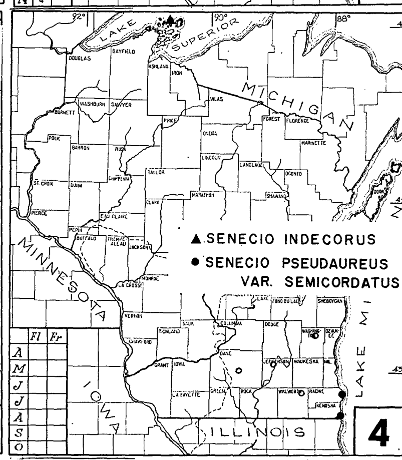
A
M 1
J 3
J 4
A 17
S
O
1


● SENECIO VULGARIS
Fl Fr
A
M 1
J 4
J 4
A
S 7
O 3
N 4
2


● SENECIO AUREUS
Fl Fr
A
M 24
J 63
J 8
A
S
O
3


▲ SENECIO INDECORUS
● SENECIO PSEUDAUREUS VAR. SEMICORDATUS
Fl Fr
A
M
J
J
A
S
O
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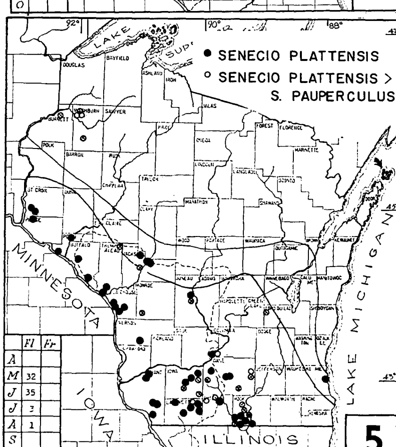
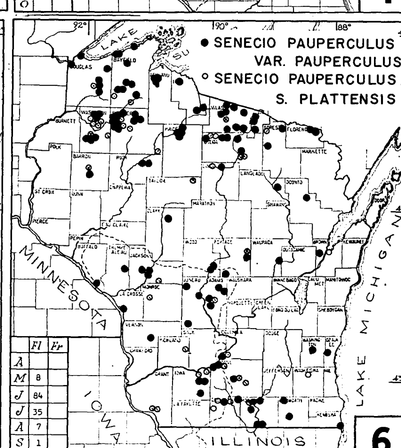

● SENECIO PLATTENSIS
○ SENECIO PLATTENSIS > S. PAUPERCULUS
Fl Fr
A
M 32
J 35
J 3
A 1
S
O
5


● SENECIO PAUPERCULUS VAR. PAUPERCULUS
○ SENECIO PAUPERCULUS > S. PLATTENSIS
Fl Fr
A
M 8
J 84
J 35
A 7
S 1
6

Thin, slender, perennial herbs, seldom over 5 dm tall, glabrous or only slightly tomentose; stems single or rarely loosely clustered from a stout, short, erect to weakly spreading caudex. Basal leaves with margins often crenate to shallowly dentate, the blades 2–4 cm long and 1–2 cm wide or sometimes smaller, abruptly contracted to a thin petiole. Inflorescence a loose to subcongested corymbose cyme, often somewhat subumbellate; heads 6–12; principal involucral bracts 4–6 mm long; ray florets with ligules 5–7 mm long (dry).

Senecio pseudaureus var. *semicordatus* occurs from Manitoba and Minnesota, south through the Missouri River Valley to Kansas and Missouri. Its occurence in Wisconsin is doubtful, and its inclusion in this treatment rests on a few specimens from two localities on the shore of Lake Michigan: Racine Co.: Barnes Prairie at Mygatts Corner.[4] Kenosha Co.: 4 m S. of Kenosha, May 31, 1939, *A. M. Fuller C–424* (F, MIL). These differ from typical *S. pseudaureus* var. *semicordatus* of the northern prairies in their somewhat smaller leaves, shorter petioles of basal leaves, more conspicuously sharp but shallow dentation on the lower cauline leaves and more pronouncedly subumbellate inflorescences. Plants with strong morphological tendencies toward *S. pseudaureus* var. *semicordatus* occur, especially in southern Wisconsin, in certain populations of otherwise typical *S. aureus,* (cf. *S. aureus;* hollow circles, Map 4).

7. SENECIO PLATTENSIS Nutt. Prairie Ragwort Map 5, 7; fig. 1

Herbaceous perennial, 2–5+ dm tall, more or less persistently floccose-tomentose, especially underneath the leaves, in the leaf axils, and among the heads of the inflorescence, sometimes subglabrate in age; stems single or occasionally loosely clustered from a short erect caudex, this occasionally stolon-producing. Basal leaf blades subelliptic to oblanceolate, crenate to serrate-dentate or occasionally subentire, 1–6+ cm long and 0.5–3+ cm wide, the petiole about as long to twice as long as the blade. Cauline leaves progressively reduced up the stem, the lower and middle often nearly as large as the basal leaves and sub-lyrate to deeply pinnatisect, the uppermost irregularly dissected to subentire. Inflorescence a rather congested to open corymbose cyme of 6–20 heads; principal involucral bracts 5–7 mm long; ray florets with ligules 5–10 mm long. Achenes hirtellous, especially along the angles, or occasionally glabrous.

North American prairies and plains; in Wisconsin in prairies and prairie-like habitats in the south and west and in Door County. Flowering from mid-May to the third week in June (rarely later).

[4] Collection and herbarium data for this collection have been misplaced.

Senecio plattensis and *S. pauperculus* are distinct species, each with its own range and morphological characteristics (cf. Map 7). In the upper Mississippi Valley, from Minnesota and Wisconsin south to Missouri, where their ranges overlap, the two species intergrade morphologically. The extent of the intergradation varies from locality to locality, with most intergradant specimens not precisely midway between *S. plattensis* and *S. pauperculus,* but usually rather strongly resembling one of the two taxa, with some slight morphological tendencies toward the other. With sufficient comparative material, most of the intermediate specimens are readily referable to one taxon or the other.

HYBRIDS OF S. PLATTENSIS AND S. PAUPERCULUS

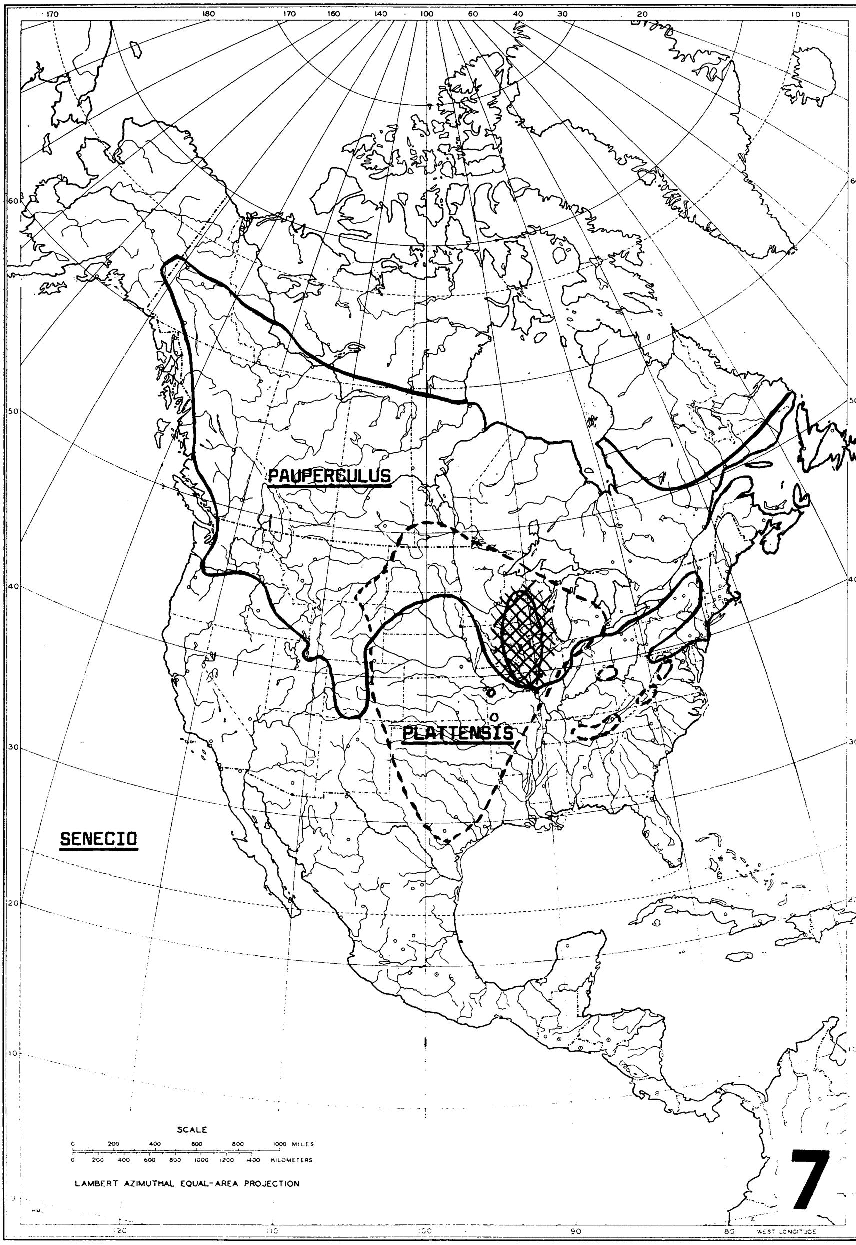
Senecio plattensis is most frequent in western Wisconsin, from St. Croix county to Rock county south of the Tension Zone and within the region of prairies (Curtis, 1959). However, intermediates tending toward *S. pauperculus* may be found nearly throughout Wisconsin (hollow circles on Maps 5 and 6). These flower at nearly the same time as the typical *S. plattensis* and/or *S. pauperculus* of the region (see Fig. 1). The species are somewhat seasonally isolated in Wisconsin, though at the present time the intermediates effectively bridge the gap between them.[5]

7. SENECIO PAUPERCULUS Michx., var. PAUPERCULUS Northern Ragwort Map 6, 7; fig. 1.

S. balsamitae Muhl. ex Willd.
S. pauperculus var. *balsamitae* (Muhl.) Fernald
S. aureus var. *balsamitae* (Muhl.) T. & G.

Herbaceous short-lived perennial, 2–6+ dm tall, glabrous to sometimes lightly tomentose in and near the leaf axils and in the inflorescence; occasionally lightly tomentose throughout; stems single or frequently loosely clustered from a simple to weakly spreading caudex. Basal leaf-blades lanceolate or oblanceolate to subelliptic, crenate-dentate to subentire, 1–6+ cm long and 0.5–2+ cm wide, the petiole as long to sometimes twice as long as the blade. Cauline leaves reduced up the stem, becoming sessile; margins variously dissected to subentire. Inflorescence a loose to sometimes congested corymbose cyme of 2–10+ heads; principal involucral bracts

[5] Note by H. H. Iltis: *S. pauperculus,* as Barkley (1962) so well points out, is evidently a Cordilleran element which migrated eastward post-glacially. The ease with which it apparently hybridized with *S. plattensis* is therefore doubly significant, and is direct, genetic proof that the migration is indeed post-glacial, since a long period of contact would have resulted in mutual merging.



MAP. 7. Geographic ranges of *Senecio pauperculus* and *S. plattensis*. Cross-hatched area in the region of geographic overlap represents area of conspicuous morphological intergradation.

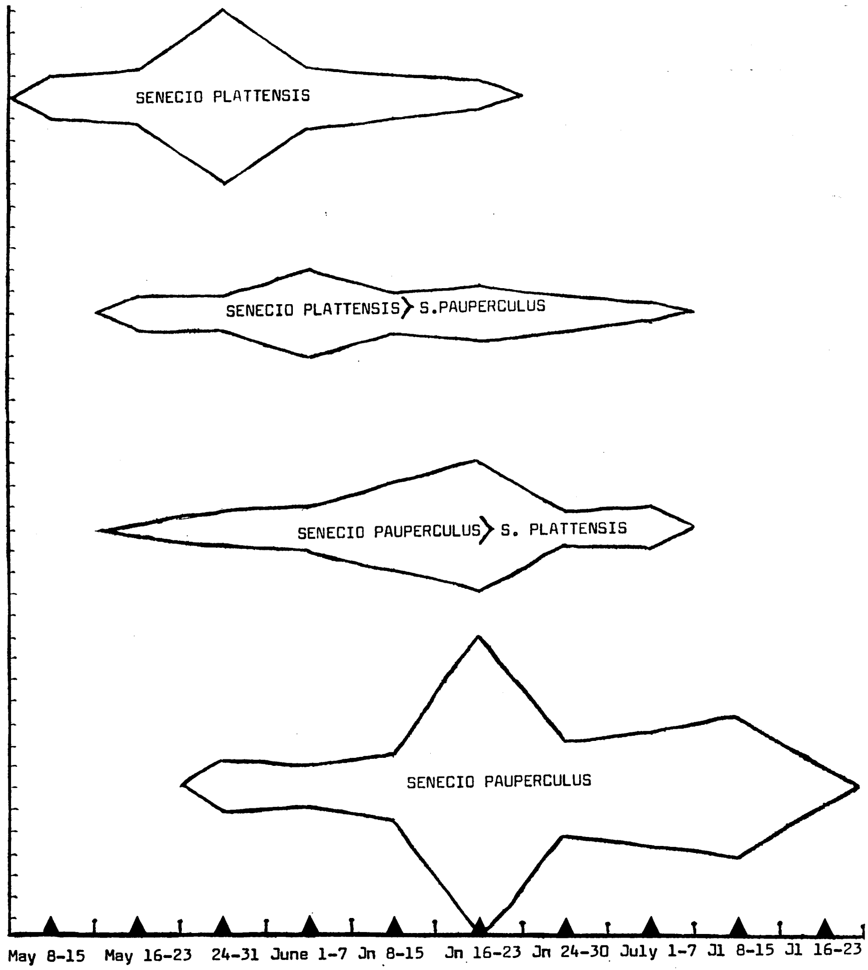


FIG. 1. Flowering dates of *Senecio plattensis* and *S. pauperculus* in Wisconsin. One vertical division (left hand margin) on each weekly coordinant (triangles at base) represents two collections. Only collections with accurate and complete label data were used. The seasonal isolation of the two parental species may be partially due to differences in latitude, *S. plattensis* being southern, *S. pauperculus* mainly northern (cf. maps 5 and 6).

3.5–8 mm long; ray florets with ligules 5–10 mm long, or rarely absent. Achenes glabrous, rarely hispidulous along the angles.

Throughout Wisconsin in meadows, bogs, streambanks, and open woods. Flowering from late May in southern Wisconsin to mid-July or exceptionally later in the north.

A widespread, northern and western species encompassing many morphological phases and intergrading with related species in areas of range overlap. The more or less typical representatives of *Senecio pauperculus* are most frequent north of the Tension Zone, in the northern third of Wisconsin. Southward and especially in the southwest half of Wisconsin, *S. pauperculus* intergrades with *S. plattensis* (cf. *S. plattensis*). These intergradants (hollow circles on Map 6) flower nearly at the same time as typical *S. pauperculus* of the region (Fig. 1).

8. SENECIO INDECORUS Greene Northern Squaw-weed Map 4.

Herbaceous perennial 2–5 dm tall; glabrous or essentially so; stems single from a short caudex. Basal leaf blades ovate to obovate, abruptly contracted at the base, 1–2 cm long, 1–2 cm wide; cauline leaves reduced upward, often lyrate or subpinnatifid. Inflorescence distinctly subumbellate, the peduncles 1–1.5 cm long; heads about 6–20; involucral bracts 5–7 mm long; rays normally absent, but present in all Wisconsin material.[6]

Streambanks and open areas in boreal North America, known from Wisconsin by only two collections, both from North Twin Island in the Apostle Islands of Lake Superior. Ashland Co. [*Lane 2192,* June 21, 1955 (WIS); *Lane 2458,* July 13, 1955 (NC)]. *Senecio indecorus* occurs also along the northern edge of Lake Superior and on the Keweenaw Peninsula of Michigan.

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[6] Throughout its range, most individuals in any population are eradiate, with a few radiate individuals, however, usually present. Whether *S. indecorus* behaves abnormally in Wisconsin, or whether collectors merely happened to select radiate individuals, has not been determined.

PRELIMINARY REPORTS ON THE FLORA OF WISCONSIN, No. 50. COMPOSITAE III—COMPOSITE FAMILY III

THE GENUS *Solidago*—GOLDENROD

Peter J. Salamun

The distribution of the species and varieties of the genus *Solidago* in Wisconsin, habitat information and dates of flowering and fruiting were compiled from specimens in the herbaria of the University of Wisconsin (WIS), University of Wisconsin—Milwaukee (UWM), Milwaukee Public Museum (MIL), and the University of Minnesota (MIN). Other sources of information are cited in the text. Each dot, circle or cross on the maps indicates a specific location where a specimen was collected. The numbers within the squares in the lower lefthand corner of each map represent the number of specimens noted that were flowering or fruiting in the respective months. Specimens in vegetative condition, in bud or with immature fruit are not included. These indicate approximately when a species or variety is apt to flower or fruit in Wisconsin.

The nomenclature, phylogenetic sequence, and descriptive features generally follow the *New Britton and Brown Illustrated Flora* (Cronquist, in Gleason, 1952) and *Gray's Manual of Botany*, Ed. 8 (Fernald, 1950). Where the names differ in these references, those in the first are usually given priority and those of the latter are listed underneath in italics. More recent treatments of certain taxa are discussed in the text.

Grateful acknowledgement is made to the curators. Dr. Hugh H. Iltis, University of Wisconsin, Professor Alvin L. Throne, University of Wisconsin–Milwaukee, Mr. Albert Fuller, Milwaukee Public Museum, and Dr. Gerald B. Ownbey, University of Minnesota, for the loan of their Wisconsin specimens; to Dr. Lorin I. Nevling, Associate Curator, Gray Herbarium of Harvard University and Dr. Bassett Maguire, Curator, New York Botanical Garden, for the loan of supplementary specimens; to Drs. Arthur Cronquist, Jean R. Beaudry, and Lloyd H. Shinners for helpful comments concerning certain taxa; and to Dr. Hugh H. Iltis for his suggestions in the preparation of this report as well as his critical reading of the manuscript.

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31. SOLIDAGO L. GOLDENROD

Perennial herbs with rhizomes or caudices and fibrous roots, the erect wandlike stems, single or clustered, bearing simple, alternate, entire or variously toothed leaves, and few to many small campanulate to subcylindric, racemed, corymbed or clustered heads. Heads small, radiate (in our species); both ray and disk flowers yellow (except in *S. bicolor* and a few albino forms). Rays pistillate and fertile. Disk flowers perfect and fertile; anthers entire at base; style branches somewhat flattened, and with lanceolate hairy appendages. Achenes many ribbed, nearly terete, glabrous or hairy; pappus of many equal, usually white, capillary bristles. Receptacles small, flat or slightly convex, not chaffy. Involucral bracts more or less imbricate in everal series, appressed, somewhat chartaceous at the base, sometimes with herbaceous green tips.

A genus of approximately 100 species, most in North America with a few in South America, Azores and Eurasia, reaching its greatest complexity in eastern United States where taxonomically it is one of the most difficult genera. The genus may be subdivided into two sections, *Virgaurea* Endl. and *Euthamia* Nutt., with species 1 to 19 included in the first, and 20 to 21 in the second section.

KEY TO WISCONSIN SPECIES OF *SOLIDAGO*

[Adapted chiefly from Cronquist, A. C., in Gleason, 1952 (Vol. 3:414–416) and Fernald, 1950 (1381–1389).]

A. Heads in clusters or short racemes in the axils of upper leaves or on elongate branches forming racemose, thyrsoid or spreading panicles.
  B. Inflorescence a series of clusters or short racemes in the axils of upper cauline leaves or, if a terminal panicle or thyrse, with erect summit, the *heads spirally arranged on the branches, thus not secund.*
    C. Inflorescence a series of axillary clusters or short racemes, all but the uppermost of which are exceeded by their subtending leaves.
      D. Cauline leaves lanceolate, acuminate, tapering to a sessile or obscurely short-petiolate base; stem glabrous, glaucous, terete; rare, in Southeasternmost Wisconsin ____________________1. *S. caesia.*
      DD. Cauline leaves ovate to elliptic, abruptly acuminate at the tip, abruptly narrowed to a short winged petiole; stem glabrous or slightly pubescent above, somewhat angled; widespread ___2. *S. flexicaulis.*

CC. Inflorescence a terminal panicle or thyrse, or if of axillary clusters or racemes only the lowermost exceeded by the subtending leaves.

E. Lower cauline leaves, including petioles, seldom more than 7 times as long as wide, if longer, then without sheathing petioles; plants chiefly of upland areas.

F. Involucres mostly 3–5 mm (sometimes 6 mm) high; pedicels mostly less than 5 mm long.

G. Stems pubescent from base through inflorescence; leaves pubescent above and below -------------------------------3. *S. hispida.*

GG. Stems glabrous except for occasional sparse puberulence in the inflorescence and uppermost stem; leaves glabrous except for hispidulous margins and sometimes sparse pubescence beneath.

H. Achenes short-hairy; basal and lower cauline leaves broadly spatulate to obovate; mostly on cliffs, in the Driftless Area of southwestern Wisconsin ------------------------------4. *S. sciaphila.*

HH. Achenes glabrous; basal and lower cauline leaves ovate to oblong-lanceolate; widespread --------------5. *S. speciosa.*

FF. Involucres mostly 5–9 mm high; many pedicels 5–15 mm long; very local, Door County ------------------------------------6. *S. spathulata.*

EE. Lower cauline leaves, including petioles, mostly 7–15 times as long as wide, petioles with sheathing bases; plants of marshes and bogs --7. *S. uliginosa.*

BB. Inflorescence a terminal panicle with nodding summit and with at least the lower branches more or less recurved; *heads secund* (one sided), viz., *borne on the upper side of the branches.*

I. Leaves triple-nerved, i.e., the two obvious lateral nerves prolonged parallel with the midrib.

J. Stems more or less pubescent or scabrous, at least in the upper portion below the inflorescence.

K. Cauline leaves obovate, oblanceolate to linear, entire or sparingly serrate, obscurely 3-nerved; basal leaves present at flowering time; very widespread -------------------------8. *S. nemoralis.*

KK. Cauline leaves mostly lanceolate to ovate, evidently 3-nerved; basal leaves wanting or deciduous at flowering time.

L. Cauline leaves canescent on both surfaces, mostly ovate to elliptic, acute to roundish at the tips; very rare, adventive ---9. *S. mollis.*

LL. Cauline leaves glabrous to puberulent beneath, glabrous or scabrous above, mostly narrowly lance-elliptic, acuminate at the tips; widespread species.

M. Involucres 2–3 mm high 10. *S. canadensis.*

MM. Involucres 3–6 mm high.

N. Leaves glabrous or scabrous above, pubescent on the veins beneath; stem pilose chiefly above the middle ------------------------10. *S. canadensis.*

NN. Leaves scabrous above, densely pubescent beneath; stem grayish with close puberulence throughout, except sometime near the base ---11. *S. altissima.*

JJ. Stems glabrous below the inflorescence.

O. Basal and lower cauline leaves the largest, persistent at flowering time; cauline leaves progressively reduced upwards.

P. Basal and lower cauline leaves mostly 2–7.5 cm wide, scarcely 3-nerved, glabrous except for ciliate margins, sometimes sparingly hirsute on one or both surfaces; achenes short-hairy; throughout Wisconsin --12. *S. juncea.*

PP. Basal and lower cauline leaves mostly 0.5–2 cm wide, more or less strongly 3-nerved, glabrous except for ciliate margins; achenes glabrous or sparsely-hairy; prairies south of Tension Zone ----------13. *S. missouriensis.*

OO. Basal and lower cauline leaves mostly smaller than the middle ones, deciduous and lacking at flowering time; cauline leaves reduced only slightly upwards.

Q. Branchlets of panicle and pedicels glabrous; prairies south of Tension Zone ---------------------------------13. *S. missouriensis.*

QQ. Branchlets of panicle and pedicels more or less pilose; throughout Wisconsin -----------------------------------14. *S. gigantea.*

II. Leaves pinnately veined, the lateral veins not conspicuously prolonged parallel with the midrib.
R. Stems glabrous or only slightly pubescent in the upper portion below the inflorescence.
S. Upper surface of leaves strongly scabrous; upper portions of stems strongly angled --15. *S. patula*
SS. Upper surface of leaves only slightly pubescent or glabrous; stems terete.
T. Basal and lower cauline leaves with long-tapering bases, glabrous or sometimes short hirsute on both surfaces; inflorescence more or less compact.
U. Plant with stout branched caudex and fibrous roots; basal and lower cauline leaves mostly 2–7.5 cm wide; achenes short-hairy; throughout Wisconsin ------------------------------12. *S. juncea.*
UU. Plant with creeping rhizome; basal and lower cauline leaves mostly 0.5–2 cm wide; achenes glabrous or sparsely-hairy, prairies south of Tension Zone ---------------------------------13. *S. missouriensis.*
TT. Basal and lower cauline leaves elliptic or elliptic-ovate and abruptly tapering to the petiole, loosely hirsute on midrib and main veins beneath; inflorescence an open panicle with a few long, slender and strongly divergent or arched ascending branches --16. *S. ulmifolia.*
RR. Stems pubescent or scabrous their entire length; very widespread ------------------8. *S. nemoralis.*
AA. Heads in flat corymbiform inflorescences.
V. Basal and lower cauline leaves with either petioles or sheathing bases, middle and upper cauline ones progressively reduced and less petiolate or sessile; involucral bracts obtuse or broadly rounded, more or less longitudinally striate.
W. Cauline leaves elliptic, broadly lanceolate to broadly ovate, densely pubescent above and below; stems densely pubescent; plants of mesic-dry habitats, common, mostly south of Tension Zone ----17. *S. rigida.*
WW. Cauline leaves narrowly elliptic to linear-lanceolate, glabrous except for scabrous margins; stems glabrous or slightly puberulent below the inflorescence; plants of marshes, swamps, wet prairies and moist calcareous meadows.

X. Basal and lower cauline leaves narrowly elliptic, flat, obtuse or rounded at the tip, often serrate above the middle, not triple nerved; southeastern Wisconsin and Door County ______18. *S. ohioensis.*

XX. Basal and lower cauline leaves linear-lanceolate, often longitudinally folded, acute, entire, tending to be triple-nerved; southeastern Wisconsin ____19. *S. Riddellii.*

VV. Leaves uniform, only slightly reduced upwards, linear to narrowly lanceolate or narrowly oblong, tapering abruptly to a short base or sessile, the basal ones soon deciduous; involucral bracts acute, not striate.

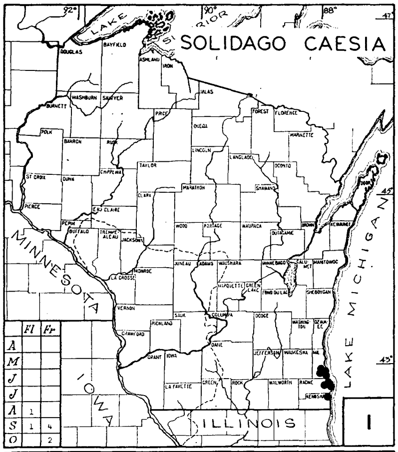
Y. Leaves 1-nerved or sometimes faintly 3-nerved, but without any additional nerves, 2–5 mm (rarely 6 mm) wide and 4–9 cm long, with conspicuous, dark and viscid punctation; heads slenderly cylindric (becoming slenderly turbinate on pressing), tending to be evidently pedicellate; involucres 4.5–6.5 mm high; not common; south of the Tension Zone ____20. *S. gymnospermoides.*

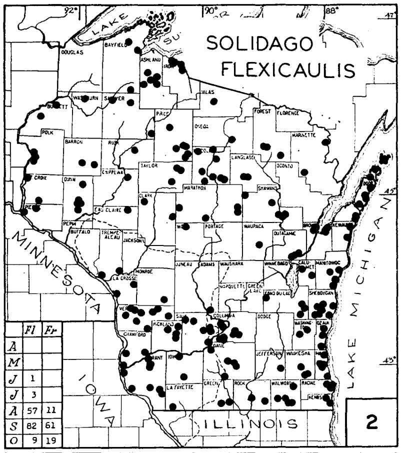
YY. Leaves evidently 3-nerved, the larger ones ordinarily with 1 or 2 additional pairs of fainter lateral nerves, 2–12 mm wide and 4–13 cm long, with less conspicuous punctation; heads slenderly campanulate to turbinate, chiefly sessile or subsessile in small glomerules; throughout Wisconsin __________21. *S. graminifolia.*

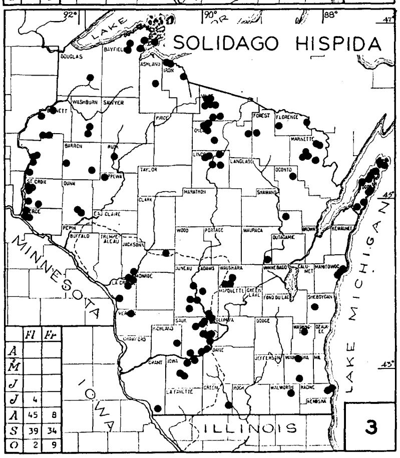
1. SOLIDAGO CAESIA L. Wreath or Blue-stemmed Goldenrod. Map 1.

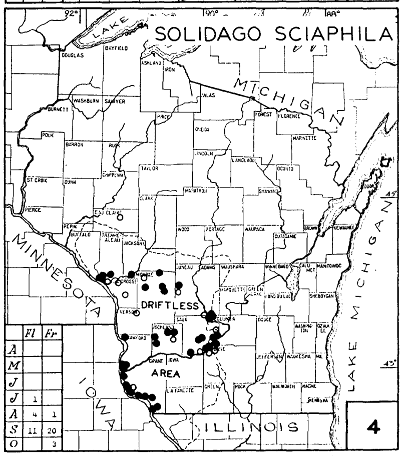
A slender glabrous plant 3-10 dm tall from a stout caudex or short rhizome; stem greenish or purplish, terete, glaucous, mostly simple or sometimes branching; *leaves narrowly lanceolate to lance-elliptic,* 4–12 cm long and 1–3.5 cm wide, serrate, pinnately veined, narrowed to a sessile or very short-petiolate base, acuminate at apex, glabrous or only slightly pubescent above and along the midrib beneath; basal and lowermost cauline ones deciduous at flowering time; *inflorescence a series of axillary clusters, all but the uppermost exceeded by subtending leaves;* involucre glabrous, 3–5 mm high, the bracts obtuse or rounded; rays 3–5; achenes hairy.

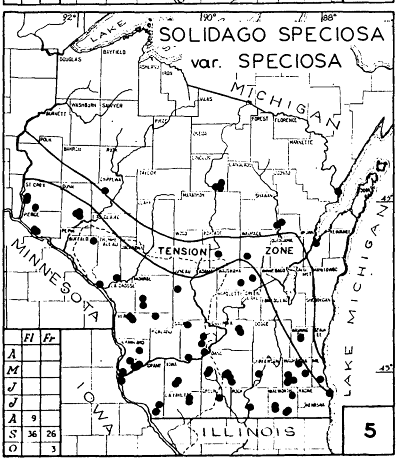
An Eastern Deciduous Forest species, restricted in Wisconsin to Milwaukee, Racine and Kenosha counties, where it reaches its western limit. Locally abundant in Milwaukee County, in Grant Park, near South Milwaukee, at the edge of a Sugar Maple-Beech woods above the ravine; and at the edge of and along a path in

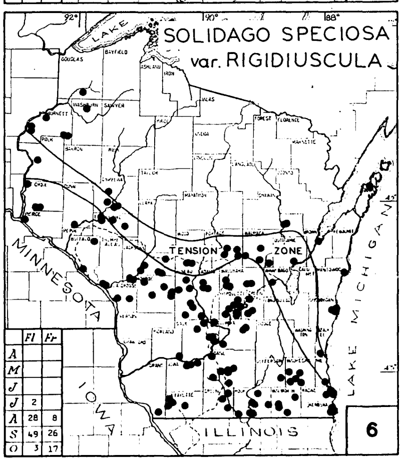

SOLIDAGO CAESIA
Fl Fr
A 1
S 1 4
O 2
LAKE SUPERIOR
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
1


SOLIDAGO FLEXICAULIS
Fl Fr
J 1
J 3
A 57 11
S 82 61
O 9 19
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
2


SOLIDAGO HISPIDA
Fl Fr
J 4
A 45 8
S 39 34
O 2 9
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
3


SOLIDAGO SCIAPHILA
MICHIGAN
DRIFTLESS AREA
Fl Fr
J 1
A 4 1
S 11 20
O 3
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
4


SOLIDAGO SPECIOSA var. SPECIOSA
MICHIGAN
TENSION ZONE
Fl Fr
A 9
S 36 26
O 3
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
5


SOLIDAGO SPECIOSA var. RIGIDIUSCULA
TENSION ZONE
Fl Fr
J 2
A 28 8
S 49 26
O 3 17
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
6

a Sugar Maple-Beech woods (Cudahy Woods) at the junction of W. College Ave. and S. Howell Ave. Flowering from late August to late September; fruiting into October.

2. SOLIDAGO FLEXICAULIS L. Flexuous-stemmed or Zigzag Goldenrod. Map 2.

Plant 2–10 dm high; stem mostly simple, slender, flexuous (zigzag), erect, striate-angled, and glabrous below the inflorescence; *leaves ovate to elliptic, 7–15 cm long, 3–10 cm wide, abruptly narrowed to a short winged petiole, acuminate at the tip, sharply serrate to nearly dentate,* hirsute beneath at least on the midrib and main veins, glabrous or sparsely pubescent above, the basal and lower cauline slightly smaller than the middle ones and usually deciduous by flowering time; upper cauline and bracteal leaves narrower and less toothed or entire, subtending the *clusters of heads;* involucre 4–6 mm high, bracts obtuse; rays 3–4; achenes short-hairy.

Throughout Wisconsin rather common in dry to mesic Oak, Sugar Maple, Basswood, Beech and Aspen woods, sometimes in mixed conifer-hardwood forests, and rare in low woods and edges of bogs. Collections are sparse in the central sand area and in the counties bordering Lake Superior. Flowering from (late July) early August to mid-September (early October); fruiting from late August to mid-October.

3. SOLIDAGO HISPIDA Muhl. var. HISPIDA. Hairy Goldenrod Map 3.

Plant with a stout branched caudex, 1–10 dm tall; stem erect, *hirsute throughout; leaves broadly oblanceolate to narrowly obovate,* 3–20 cm long, 1–5 cm wide at or near the base of plant, acute to nearly rounded at the tip, crenate or serrate, petioled, more or less pubescent, progressively reduced upward and becoming lance-elliptic to oblong, sessile or nearly so, and obscurely toothed to entire; *inflorescence a narrow, erect, terminal panicle,* the heads not secund; involucre 4–6 mm high; bracts obtuse or rounded, the tips slightly greenish; rays 7–14, deep yellow; achenes glabrous when mature.[1]

[1] A very similar eastern species, *Solidago bicolor* L., has been listed as occurring in Wisconsin (Fernald, 1950; Gleason, 1952). The following Wisconsin specimens were annotated by Cronquist as *S. bicolor:* Polk Co.: St. Croix Falls, September, 1851, *E. P. Sheldon* (MIN); Osceola, September, 1852, *E. P. Sheldon* (MIN). Door Co.: Ellison Bay, August 11, 1918, *Milton T. Greenman* (MIN). Milwaukee Co.: Milwaukee, *E. J. Hasse* (NY). This species differs from *S. hispida* chiefly in having whitish or cream-colored rays. Because the rays of *S. hispida* tend to fade and those of *S. bicolor* become yellowish after some years in the herbarium, it is difficult to distinguish the two species. According to Cronquist (personal communication) another difference is the color of the involucre, that of *S. bicolor* being distinctly paler and, doubtless it was on this basis the above specimens were identified. There have been no recent collections of *S. bicolor* in Wisconsin and, during four years of field work, I was not able to find this species in this area.

Locally abundant on dry to moist sandy or rocky soils in open White Pine-Red Pine or mixed conifer-hardwood woods, chiefly in the northern part of the state, extending southward to Iowa and Kenosha counties on sand or gravelly wooded hillsides, sandstone cliffs, outcrops and slopes. In the Driftless Area it frequently occurs in areas adjacent to *S. sciaphila.* In these localities *S. hispida* usually occupies the more mesic wooded sandy areas while *S. sciaphila* prefers the more open cliff (drier?) sites. Flowering from (late July) early August to October, and fruiting from August to October.

Var. *arnoglossa* Fern., distinguished by its smaller size and scanty pubescence, has been listed from northern Michigan by Fernald (1950) and Gleason (1952), and northeast Minnesota by Fernald (1950) and Rosendahl and Cronquist (1945). To date only var. *hispida* has been collected in Wisconsin.

4. SOIIDAGO SCIAPHILA Steele Cliff Goldenrod Map 4.

Plant about 4–10 dm tall, with a caudex, *glabrous throughout except for sparse pubescence in the inflorescence;* basal and lower cauline leaves broadly oblanceolate to elliptic-ovate, 3–15 (–22) cm long and 1–5 (–8) cm wide, *crenate to serrate,* acute, tapering to the petioles, the upper cauline progressively reduced, becoming oblanceolate to elliptic, sessile or nearly so, and obscurely serrate to entire; inflorescence a narrow terminal panicle; involucre about 4–6 mm high, bracts obtuse, entire; rays 5–8; *achenes with short stiff hairs,* clearly visible with a hand lens even when immature.

This species, one of Wisconsin's few endemics (?), is apparently confined almost entirely to the Wisconsin Driftless Area where it occurs in open or lightly wooded sandstone and limestone cliffs, outcroppings and slopes, and rarely in open Black Oak or Jack Pine woods at the base of cliffs. Fernald (1950) extended the general range of this species to include western Ontario, Michigan and Minnesota, perhaps due to possible confusion of this species with glabrous northern variants of *S. hispida.* Flowering from (late July) mid-August to late September; fruiting from late August through mid-October.

Some individual specimens were observed with sparse pubescence in the upper portions of the stems below the inflorescences, and some of these also are sparsely pubescent on the undersides of the leaves. These individuals are plotted as open circles on Map 4. Since *S. hispida,* a similar but more pubescent species often occurs nearby on the more wooded slopes, these plants may possibly represent hybrids between *S. sciaphila* and *S. hispida.*

5. SOLIDAGO SPECIOSA Nutt. Showy Goldenrod. Maps 5, 6, 7.

A slender to stocky or sometimes stout plant with a thick caudex, 3–12 dm tall, glabrous or slightly scabrous (except slightly pubescent in the inflorescence); *leaves firm,* obovate to lanceolate or broadly elliptic, decreasing in size upwards and sessile or nearly so, the lower 6–13 (–20) cm long, 1.5–6 (–7) cm wide, abruptly short petiolate, *entire or slightly toothed,* the lateral veins not prominent; *inflorescence a terminal narrowly pyramidal to thyrsiform panicle,* the heads not secund, the branches stiffly ascending or sometimes slightly spreading; involucre 3–6 mm high; bracts obtuse or rounded, yellowish; rays 6–8; *achenes glabrous.*

KEY TO VARIETIES

A. Tall robust plants, 6–12 dm high; middle and lower cauline leaves 2–5 cm wide; basal leaves 4–6 (–7) cm wide ------------------------------------ 5a. *S. speciosa* var. *speciosa.*

AA. Plants 3–8 dm high; middle and lower cauline leaves 1–3 cm wide (mostly less than 2 cm wide); basal leaves 1.5–3.5 cm wide.

B. Cauline leaves numerous, usually 18–40; inflorescence dense with ascending branches -- 5b. *S. speciosa* var. *rigidiuscula.*

BB. Cauline leaves relatively few, 3–20; inflorescence tending to become somewhat open paniculate --------------------------------------- 5c. *S. speciosa* var. *jejunifolia.*

5a. SOLIDAGO SPECIOSA Nutt. var. SPECIOSA. Map 5.

Chiefly in western and southwestern Wisconsin south of the Tension Zone, in remnant mesic prairies (Curtis, 1955), open sandy fields, roadsides, open sandstone bluffs, steep roadbanks, neglected cemeteries, and sometimes in open Black Oak or Jack Pine woods, spreading northward and eastward along sandy roadsides and railroad rights-of-way. Flowering mid-August through September; fruiting from early September to mid-October.

According to Cronquist (Gleason, 1952), this variety occupies that portion of the species-range which was originally forested, while the next, var. *rigidiuscula,* is mostly in the Great Plains area and slightly eastward. In Wisconsin the ranges of both varieties extend only slightly beyond the prairie areas.

5b. SOLIDAGO SPECIOSA Nutt. var. RIGIDIUSCULA Rydb. Map 6.
Solidago speciosa Nutt. var. *angustata* T. & G.

Locally common south of the Tension Zone in prairie remnants and on sandy soils along roadsides, in open fields, ridges, outcroppings, river terraces and open Black Oak and Jack Pine woods, more common than var. *speciosa* and, with a similar range in the state, but occurring farther eastward, chiefly along sandy roadsides, railroad rights-of-way, and on sandy beaches and dunes along the shores of Lake Michigan. Flowering (late July) early August to early October; fruiting from mid-August to late October.

5c. SOLIDAGO SPECIOSA Nutt. var. JEJUNIFOLIA (Steele) Cron.
Map 7.

Solidago jejunifolia Steele.
Solidago castrensis Steele, Contr. U. S. Natl. Herb. 16:223. 1913.

[Type: Juneau County, Camp Douglas, Sept. 9, 1890, *E. A. Mearns 96* (US No. 670444).]

There are a number of specimens in the University of Wisconsin Herbarium which fit the description of this variety. These appear to be mostly depauperate slender plants (cf. Cronquist, 1947, pp. 77–78).

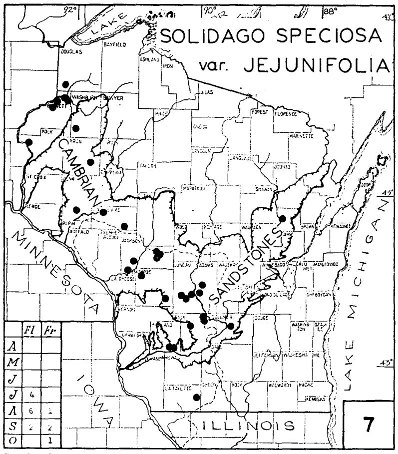
Northwestern and central Wisconsin following the area of outcropping Cambrian sandstone, in sandy soils along roadsides, river terraces, in Bur Oak and Black Oak openings, and in open Jack Pine stands. Flowering from (mid-) late July to late August (early September); fruiting from late August into October.

6. SOLIDAGO SPATHULATA DC. var. GILLMANI (Gray) Cron. Gillman's Goldenrod. Map 8.

Solidago racemosa Greene var. *Gillmani* (Gray) Fern.

Plants 1–9 dm tall from a short branched caudex, essentially glabrous except for slight pubescence in the inflorescence and sometimes along the stem; *basal and lower cauline leaves narrowly oblanceolate to narrowly obovate,* 3–20 cm long and 0.4–4 cm wide, serrate or crenate serrate to subentire, acute, ciliate margined, cauline leaves progressively reduced upward; inflorescence a terminal raceme, the heads not secund, on *pedicels 5–15 mm long;* involucre 3–9 mm high, somewhat glutinous, the bracts obtuse to acute; rays 7–9; achenes short-hairy.

This variety is an eastern representative of the wide-ranging (eastern U. S., southern Canada to the Pacific northwest) *S. spath-*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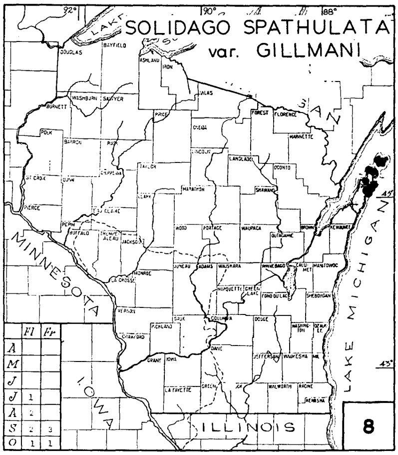
SANDSTONES
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
7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var. GILLMANI
MINNESOTA
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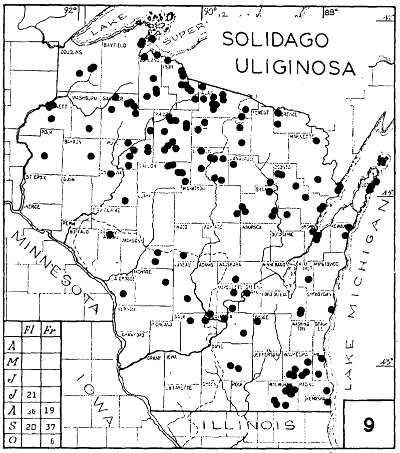
LAKE MICHIGAN
8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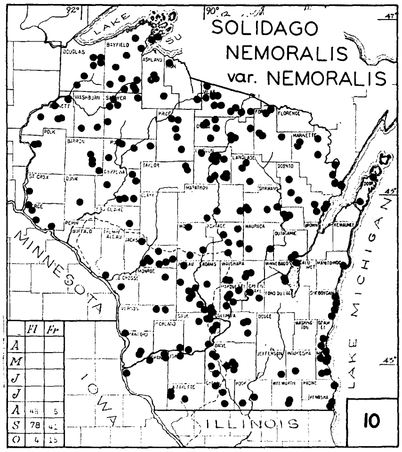
LAKE MICHIGAN
9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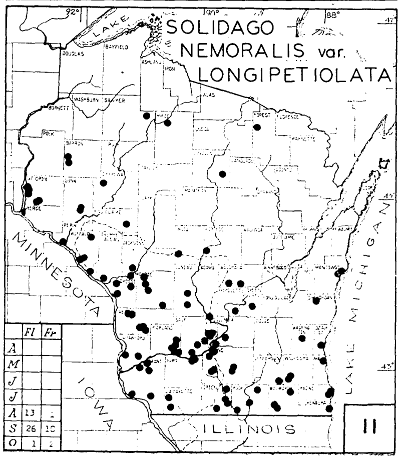
var. NEMORALIS
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
10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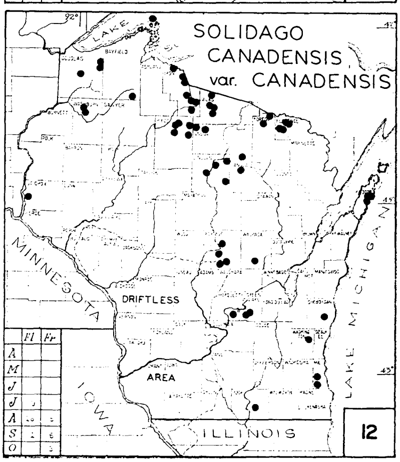
NEMORALIS var.
LONGIPETIOLATA
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
11


SOLIDAGO
CANADENSIS
var. CANADENSIS
DRIFTLESS
AREA
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
12

ulata. In Wisconsin it is infrequent on open sand dunes, ridges and sandy beaches along Lake Michigan. All our specimens are from Door County, there associated with such strand species as *Calamovilfa longifolia, Artemisia caudata, Elymus canadensis, Calamagrostis inexpansa, Potentilla anserina, Rudbeckia hirta, Agropyron psammophilum (A. dasystachyum* sensu Fassett) and *Salix* sp. Since this plant also has been collected in the Indiana Dunes area, its present limited distribution in the state may be due to the widespread and often needless habitat destruction along the Lake Michigan shore. Flowering (late July) early August to October; fruiting mid-September into October.

This plant represents one of an aggregate of entities which have been variously described as *S. racemosa* Greene, *S. Gillmani* Steele and *S. Randii* Porter. In a recent work, Cronquist (Gleason, 1952) considers all these varieties of *S. spathulata*, a treatment followed here.[2]

7. SOLIDAGO ULIGINOSA Nutt. var. ULIGINOSA. Swamp Goldenrod. Map 9.

An essentially glabrous plant, except sometimes puberulent in the inflorescence, from a rather long caudex; stem 0.4–15 dm tall; basal and lower cauline leaves persistent, varying from narrowly oblanceolate to ovate lanceolate or elliptic, from nearly entire to serrate, tips acute, *tapering to long petioles with more or less sheathing bases,* blade and petiole 6–30 cm long and 1–6 cm wide; upper leaves progressively reduced and becoming entire and sessile; inflorescence terminal, thyrsiform, the short branches varying from straight to slightly recurved, the heads from non-secund to slightly secund; involucre 3–6 mm high, the inner bracts rounded to obtuse, the outer ones often acute; rays 1–8; *achenes glabrous or nearly so.*

A variable species, but only var. *uliginosa* appears to occur in our area.

Fairly abundant in northern Wisconsin in moist sandy roadsides, ditches, wet to mesic sedge meadows, fens, edges of bogs and open marshy areas, less frequently at the edges of conifer-hardwood forests and Sugar Maple woods, southward in central and eastern Wisconsin, chiefly in black muck soils of marshy areas, edges of bogs and moist lake banks. A number of plants were observed in the low prairie area of southeastern Kenosha County in

[2] *Solidago spathulata* var. *racemosa* (Greene) Cron. (*S. racemosa* Greene) and *Solidago spathulata* var. *Randii* (Porter) Cron. (*S. Randii* (Porter) Britt.) are also listed as occurring in Wisconsin by both Gleason (1952) and Fernald (1950), presumably based on the few Wisconsin specimens in the Gray and New York Botanical Garden Herbaria. These specimens all appear to be var. *Gillmani.*

association with *S. Riddellii, S. ohioensis* and *Aster ptarmicoides.* Flowering (late July) early August to September; fruiting from mid-August to mid-October.

Solidago Purshii Porter, as described by Fernald (1950), but not listed by Cronquist (Gleason, 1952), has similar morphological features and a range that includes Wisconsin. The chief morphological differences between these entities is that *S. uliginosa* tends to have secund heads while those of *S. Purshii* are non-secund. Recently, Beaudry and Chabot (1959) further distinguished between these plants on the basis of chromosome numbers. *S. uliginosa* is a tetraploid ($2n = 36$), while *S. Purshii* is diploid ($2n = 18$). The Wisconsin specimens, including those in the Gray Herbarium, appear to have the tendency for secund heads and, therefore, all are considered as *S. uliginosa.*

8. SOLIDAGO NEMORALIS Ait. Field Goldenrod; Old-field Goldenrod. Maps 10, 11.

Small plants from a caudex; stems 1–12 dm tall, *densely pubescent* with loosely spreading hairs; *leaves oblanceolate to spatulate-ovate or sometimes lance-linear,* the basal and lower cauline ones 5–25 cm long and 0.5–2.5 cm wide, long-petioled, crenate, crenate-serrate to entire, densely pubescent, often with axillary tufts; inflorescence a terminal panicle, sometimes elongate, narrow and only *nodding at the tip,* sometimes with spreading recurved branches and heads secund; involucre 3–6 mm high, the bracts acute to obtuse; rays 5–9; achenes more or less pubescent.

KEY TO VARIETIES

A. Involucre 3–4 mm high; achenes with short ascending or spreading hairs; lower cauline leaves mostly 3–6 times as long as wide; basal leaves broadly oblanceolate to spatulate-obovate ------------------ 8a. *S. nemoralis* var. *nemoralis.*

AA. Involucre 4–6 mm high; achenes silky with relatively long appressed pubescence; lower cauline leaves 7–10 times as long as wide; basal leaves mostly narrowly oblanceolate to lance-linear ---------------- 8b. *S. nemoralis* var. *longipetiolata.*

8a. SOLIDAGO NEMORALIS Ait. var. NEMORALIS. Map 10.

Common throughout Wisconsin, on dry, sandy, clayey and sterile soils in open fields, pastures, along roadbanks, on prairies, railroad embankments, edges of oak woods, and in Jack Pine and Black Oak barrens. Flowering from early August to early October; fruiting late August to mid-October.

8b. SOLIDAGO NEMORALIS Ait. var. LONGIPETIOLATA (Mack. & Bush) Palmer and Stey. Map 11.

Solidago nemoralis Ait. var. *decemflora* (DC.) Fern.

Habitats are similar to those of var. *nemoralis,* though more common in southwestern Wisconsin. Flowering from mid-August through late September (October); fruiting from early September into October.

Beaudry and Chabot (1959) have determined that var. *nemoralis* is a diploid ($2n = 18$) and var. *longipetiolata* is a tetraploid ($2n = 36$). On this evidence as well as the differences in morphology and geographic distribution, those workers recommend that the latter variety be given specific status as *S. decemflora* DC.

There are no references in the literature to hybridization between these two varieties. A population analysis of a limited number of Wisconsin specimens is shown in Fig. 1. Most of the individuals of each variety can be distinguished by the height of the involucre and the type of achene pubescence. The relationship of length and width of the lower leaves is quite variable and is a less reliable taxonomic character. A few individuals appear to be intermediate with long involucres and short, appressed pubescence or sericeus achenes and short involucres, and suggest that some intergradation occurs between these two entities. It is also possible to interpret these results as indicating that some genetic barrier exists and that specific status for each variety might be considered. Since the morphological differences are not great, chiefly quantitative in degree of achene pubescence and size of involucre, it seems best for the present to retain both entities as varieties.

9. SOLIDAGO MOLLIS Bartl.

A rigidly erect plant, canescent throughout; stems 1–6 dm tall, solitary or loosely clustered, from a creeping rhizome, sometimes glabrate near the base; cauline leaves elliptic or oval to obovate, sessile or nearly so, triple-nerved, lower ones 3–10 cm long and 8–40 mm wide, gradually reduced upwards; basal leaves wanting; inflorescence terminal, dense, paniculate or compactly thyrsoid, the lower branches more or less recurved, and heads secund; involucre 3.5–6.5 mm high, with rounded to acute yellowish chartaceous bracts; rays 6–9; achenes with short hairs.

A western species accidentally introduced into Wisconsin but probably not established, the only record consisting of the following flowerless specimen: Washington Co.: Soo Line R. R., se of Slinger (center of N ¼ Sec. 28, T1ON, R19E), July 6, 1940, *Shinners 2135* (WIS). It is reported to flower in late July to September, and fruits from August to October.

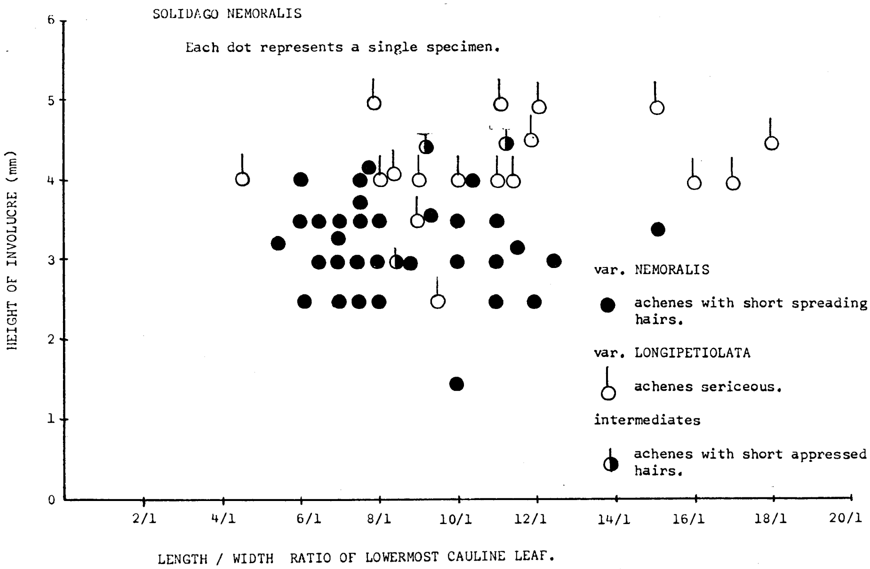


FIGURE 1.

10. SOLIDAGO CANADENSIS L. Canada Goldenrod. Maps 12, 13, 14

Plant with creeping rhizome and with solitary or clustered stems, 3–15 dm tall, pubescent at least above the middle; *leaves lanceolate to lance-elliptic, long acuminate, tapering to a sessile base,* the larger 5–13 cm long and 0.5–1.8 cm wide, *mostly sharply serrate* and only slightly reduced upward, *triple-nerved,* glabrous to scabrous above, *puberulent at least on the midrib and main veins beneath* or over the entire surface, the basal and lower cauline leaves reduced or soon deciduous. Inflorescence a terminal broad pyramidal panicle with conspicuous recurved branches, and secund heads; involucre 2–5 mm high, the bracts thin and slender, acute or acuminate, yellowish, without conspicuous green tips; rays mostly 10–17; achenes short-hairy. An extremely variable and widely distributed species.

KEY TO VARIETIES

A. Involucres 2–3 mm high; widespread species.

B. Leaves glabrous or merely scabrous above, slightly pilose along the midrib and main veins beneath; stems more or less puberulent above the middle, glabrous below ____________________________10a. *S. canadensis* var. *canadensis.*

BB. Leaves scabrous puberulent above, densely puberulent beneath; stems densely puberulent throughout, or glabrate only near the base--10b. *S. canadensis* var. *gilvocanescens.*

AA. Involucres 3–5 mm high; northern Wisconsin ------------------------------------10c. *S. canadensis* var. *salebrosa.*

10a. SOLIDAGO CANADENSIS L. var. CANADENSIS. Map 12.

Occasional along roadsides, open fields, slopes, edges of marshes and swamps, along fencerows, and edges of and in open woods, chiefly in northern and eastern Wisconsin. Not as common as the next variety. Flowering (late July) early August to early September; fruiting August to October.

10b. S. CANADENSIS L. var. GILVOCANESCENS Rydb.[3] Map 13.

The common phase of the species, occurring abundantly in open fields, prairies, sandy beaches, along railroad rights-of-way, roadsides, slopes, dry to moist ditches, edges of bogs, marshes and woods, and occasionally in open deciduous woods and in Jack Pine and Black Oak Barrens. Flowering (mid-) late July to mid- (late) September; fruiting late August into October.

10c. SOLIDAGO CANADENSIS L. var. SALEBROSA (Piper) M. E. Jones.[3] Map 14.

Solidago lepida DC. var. *fallax* Fern.
Solidago lepida DC. var. *elongata* (Nutt.) Fern.

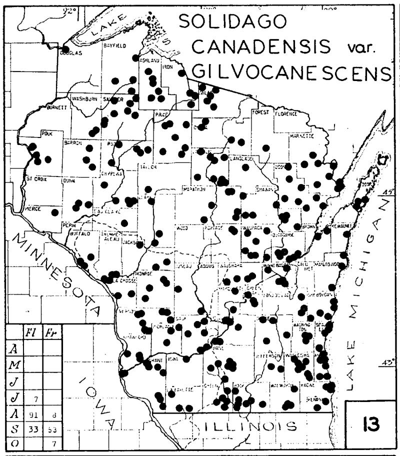
A boreal plant which has been collected in only a few northern counties. It prefers open habitats along roadsides, sandy shores, moist to dry fields and edges of deciduous and coniferous woods. Flowering (late July) August to mid-September; fruiting late August to October.

The taxonomic status of this plant is not clearly established as evidenced by the different designations of Cronquist (1952) and Fernald (1950). The first worker described this plant as *S. elongata* Nutt. but in the appendix of the same reference reduced it to the varietal status under *S. canadensis*. Fernald considered it as *S. lepida* DC. and divided it into four varieties, two of which apparently occur in Wisconsin. In the latter treatment, the specimens collected in the state seem to fit more closely the description of var. *elongata* (Nutt.) Fern. than var. *fallax* Fern. The nomenclatorial version of Cronquist (1952) is used only because this reference is being followed in this report.

11. SOLIDAGO ALTISSIMA L. Tall Goldenrod. Map 15.

Solidago canadensis L. var. *scabra* (Muhl.) T. & G.

A tall robust plant with long rhizomes; stems 8–20 dm high, *grayish with spreading puberulence,* at least above the middle;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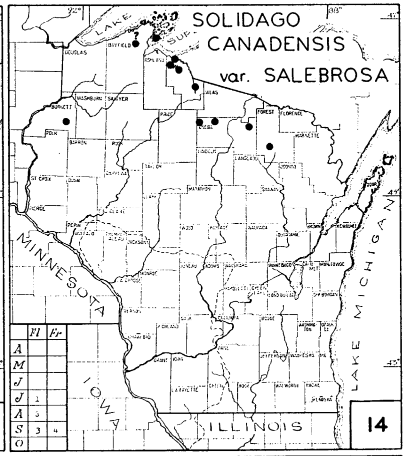
GILVOCANESCENS
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
13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var. SALEBROSA
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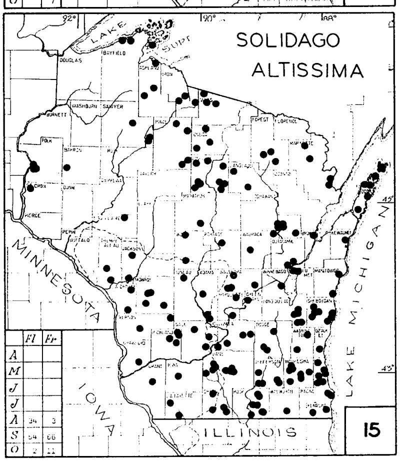
ILLINOIS
LAKE MICHIGAN
14


SOLIDAGO
ALTISSIMA
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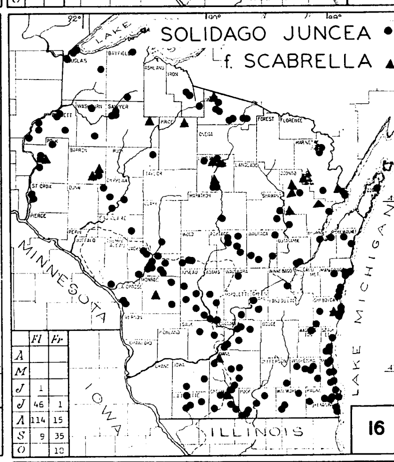
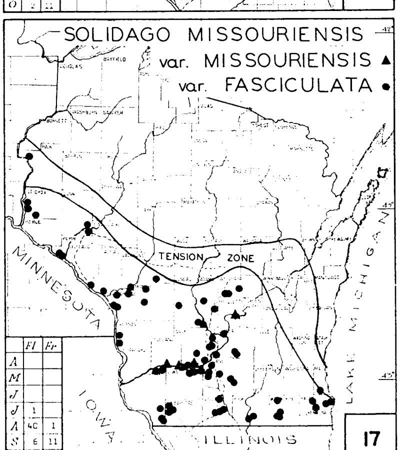
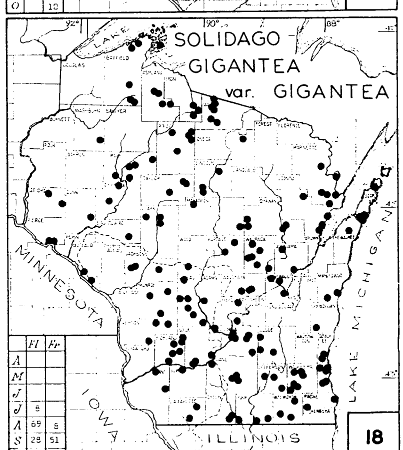
IOWA
ILLINOIS
LAKE MICHIGAN
15


SOLIDAGO JUNCEA •
f. SCABRELLA ▲
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
16


SOLIDAGO MISSOURIENSIS
var. MISSOURIENSIS ▲
var. FASCICULATA •
TENSION ZONE
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
17


SOLIDAGO
GIGANTEA
var. GIGANTEA
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
18

leaves lanceolate to lance-elliptic, acuminate at apex, tapering to a sessile base, middle ones 5–15 cm long and 0.7–2.2 cm wide, *triple-nerved, cinerous with spreading puberulence beneath, scabrous above;* lower cauline and basal leaves soon deciduous, the upper gradually reduced upwards, few toothed to nearly entire; inflorescence a terminal pyramidal panicle with many recurved branches and secund heads; involucre 3–5 mm high; bracts yellowish, inner ones sharply acute to broadly rounded, outer ones acute; rays 9–15; achenes short-hairy.

Widespread throughout, but more common in southern Wisconsin, most frequently in open moist to dry fallow fields, prairies, dry open roadsides, steep sloping banks, railroad embankments, brushy roadsides, fencerows, open sandy areas, and along edges or, rarely, in open deciduous woods and Jack Pine-Black Oak Barrens. Flowering (early) mid-August to late September (early October); fruiting late August through October (early November).

This species is similar in general appearance to *S. canadensis* var. *gilvocanescens,* which blooms about two or more weeks earlier, and extremes of either are often difficult to distinguish in our area. Cronquist[3] (1952) considers this plant as *S. canadensis* var. *scabra* (Muhl.) T. & G. On the basis of quantitative measurements the two entities usually can be separated. In *S. altissima,* the involucres are 3–5 mm high, and the middle cauline leaves are sparsely pubescent (scabrous) on the upper surface and more or less densely puberulent or pilose beneath. The involucre in *S. canadensis* var. *gilvocanescens* is usually 2–3 mm high and the upper and lower surfaces of the cauline leaves are more or less uniformly puberulent. Recently, Beaudry and Chabot (1957) determined that *S. canadensis,* and presumably *S. canadensis* var. *gilvocanescens,* is diploid ($2n = 18$), while *S. altissima* is hexaploid ($2n = 54$). They also noted that *S. altissima* blooms about a month later, at least in Quebec, than *S. canadensis.* Similar differences in flowering dates occur in Wisconsin (see flowering data on Maps 12, 13 and 15). On this evidence it seems more desirable to consider this plant as a distinct species.

12. SOLIDAGO JUNCEA Ait. Early Goldenrod. Map 16.

An essentially glabrous plant, except for scabrous or ciliate leaf margins and sometimes sparingly hirtellous on lower surfaces of leaves and branches of the panicle; stems solitary or few, from a caudex, 3–12 dm tall; *basal leaves on caudex, oblanceolate to narrowly oval, acuminate, tapering to the long petiole,* serrate, *persistent,* 10–15 cm long and 1.5–8 cm wide, *not conspicuously 3-nerved;*

[3] See Cronquist (Gleason, 1952, 3:546).

cauline leaves remote, decreasing in size upwards, becoming lance-elliptic, less toothed and sessile; *inflorescence a pyramidal or somewhat rhomboidal panicle* with recurved branches and secund heads; involucre glabrous, 3–5 mm high; bracts acute or obtuse, firm, pale green or straw-colored; rays 7–12; achenes pubescent.

Plants with more or less hirsute upper and lower leaf surfaces and panicle branches have been designated as forma *scabrella* (T. & G.) Fern. Specimens of this form are indicated by triangles on Map 16.

Common throughout Wisconsin, especially abundant in sandy or loamy open fallow fields, along railroad embankments and weedy fencerows, less common in mesic to wet-mesic prairies and fields, along brushy roadsides, on steep roadbanks, and rarely at the edges of open deciduous woods. The sparsity of plants in the north central and west central counties is probably due to limited collecting. The paucity of plants in the southwestern counties, however, was confirmed on the several trips into this region. The agricultural practice of clearing fencerows, the absence of fallow fields, as well as the frequent clearing by cutting and burning along roadsides and railroad rights-of-way may be contributing factors to this rarity. Flowering late June to early (mid-) September; fruiting from late July into October.

13. SOLIDAGO MISSOURIENSIS Nutt. Missouri Goldenrod Map 17.

A glabrous plant 3–10 dm high from a creeping rhizome; *leaves oblanceolate, mostly triple-nerved, rather firm, sharply acute to acuminate, tapering to a sessile or inconspicuous petiole,* glabrous except for scabrous margins, the lower 0.3–2 cm wide, serrate, only slightly reduced upwards and becoming lance-elliptic to linear and entire; inflorescence a pyramidal panicle; *branches glabrous,* more or less recurved, the heads secund; involucre glabrous, 3–5 mm high; bracts firm, blunt or acute; rays 7–12; achenes sparsely pubescent.

KEY TO VARIETIES

A. Plants 1–8 dm tall; panicles 2–12 cm broad, with ascending branches bearing scarcely or only slightly recurving one-sided racemes; achenes strigose-pilose or hirsute 1.3–2.2 mm long; basal leaves often present at flowering time ________________________________ 13a. *S. missouriensis* var. *missouriensis.*

AA. Plants mostly taller, up to 1 m high; panicles up to 20 cm wide, usually with arched recurving branches; achenes glabrous or short-hispid, 1–1.3 mm long. Basal leaves usually wanting at flowering time. ____ 13b. *S. missouriensis* var. *fasciculata.*

13a. SOLIDAGO MISSOURIENSIS Nutt. var. MISSOURIENSIS.
Map 17, triangles.

The western phase of the species, collected in few south central and southwestern counties, in dry sandy prairies, along open sandy roadsides and on sandy river terraces. This variety is less common than the next and appears to prefer drier habitats. Flowering August to September; fruiting from September to October.

13b. SOLIDAGO MISSOURIENSIS Nutt. var. FASCICULATA Holz.
Map 17, dots.

The widespread variety in our area, occurring chiefly in the southwestern half of the state. It is present, but not abundantly, in dry to mesic prairies on gentle slopes, river terraces, along roadsides and along railroad rights-of-way, sometimes in sandy prairies, on or adjacent to blow-out dunes, and on steep hillsides. This variety as well as var. *missouriensis* appears to be restricted to the prairie areas of Wisconsin south of the Tension Zone. Flowering from (late July) early August into September; fruiting from mid-August into October.

14. SOLIDAGO GIGANTEA Ait. Late Goldenrod Maps 18, 19, 20.

A tall plant from a creeping rhizome; stems stout, often 5–25 dm tall, *glabrous below the inflorescence, sometimes glaucous;* leaves numerous, *lanceolate to narrowly lance-linear, acuminate, tapering to a sessile or nearly so base,* more or less sharply serrate chiefly above the middle, *triple-nerved and relatively uniform in shape throughout* and only slightly reduced in size upward, the lower ones soon deciduous; larger leaves 6–18 cm long and 1.5–3.5 cm wide, *glabrous or scabrous above, glabrous or sparsely pubescent on the main veins beneath;* inflorescence a terminal pyramidal panicle with recurved pilose branches and heads secund; involucre 2.5–4 mm high; bracts blunt to acute, slightly green-tipped; rays 10–17; achenes short-hairy.

KEY TO VARIETIES

A. Cauline leaves 1–2.5 cm wide, the middle ones mostly more than five times as long as wide, serrate; lower panicle branches 3–15 cm long, commonly less than 10 cm long.
B. Leaves with midrib and main veins pilose beneath ---- -------------------------14a. *S. gigantea* var. *gigantea.*
BB. Leaves glabrous beneath ---14b. *S. gigantea* var. *serotina.*
AA. Cauline leaves 2–4 cm wide, the middle mostly less than five times as long as wide, coarsely serrate; lower panicle branches 5–25 cm long, commonly more than 10 cm long ----------- --------------------------14c. *S. gigantea* var. *Pitcheri.*

14a. SOLIDAGO GIGANTEA Ait. var. GIGANTEA. Map 18.

Common throughout Wisconsin in open moist fallow fields, fens, marshes, roadside ditches, along banks of lakes and streams, at the edges of bogs and moist sandy beaches, less common in dry to mesic prairies, open fields, along railroad embankments and brushy roadsides, in the latter habitats it is often associated with *S. canadensis* and *S. altissima*. Individuals with sparse pubescence in the upper portions of the stems, just below the inflorescences, may represent hybrids with these species. Flowering late July to September, and fruiting August to October.

14b. SOLIDAGO GIGANTEA Ait. var. SEROTINA (Kuntze) Cron. Map 19.

Solidago gigantea Ait. var. *leiophylla* Fern.

Similar habitats, distribution, and flowering and fruiting dates as var. *gigantea*.

Beaudry and Chabot (1959) noted that two cytodemes exist within both varieties of *S. gigantea*, one diploid (2n = 18) and the other a tetraploid (2n = 36), but made no recommendations concerning any special taxonomic treatment.

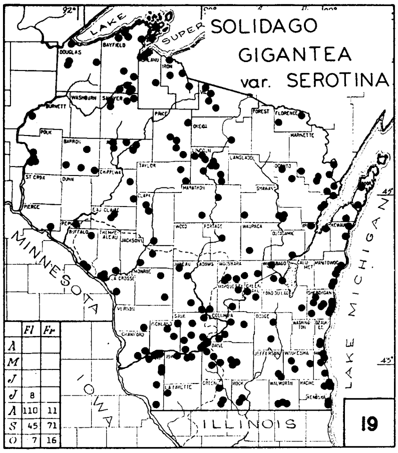
14c. SOLIDAGO GIGANTEA Ait. var. PITCHERI (Nutt.) Shinners. Map 20.

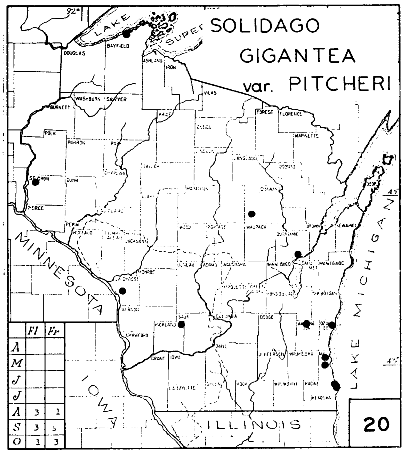
According to Shinners (1953) this variety is found in the low prairies of Iowa, Illinois, southern Wisconsin and Minnesota. The few specimens with broad leaves and broad panicles, which seem to fit the description of this taxon(see Map 20), do not appear to be restricted to the prairie areas of the state. Furthermore, it is possible that these plants may represent either robust plants of the two common varieties, or their tetraploid races.

Because of the limited number of specimens, no significant ecological or geographic trends can be determined for this variety in Wisconsin. Flowering and fruiting dates are probably similar to those of the other varieties.

15. SOLIDAGO PATULA Muhl. Roughleaved Goldenrod; Spreading Goldenrod. Map 21.

A smooth plant from a caudex, 5–20 dm high; stems glabrous below the inflorescence, more or less 4-angled; *leaves glabrous on lower surface, harshly scabrous on upper surface,* the basal and lower cauline leaves persistent, elliptic, elliptic-ovate or elliptic-obovate, acute to acuminate, serrate, 8–30 cm long and 4–10 cm wide, somewhat abruptly narrowed to a broad petiole; middle and upper cauline leaves much smaller, becoming sessile and somewhat


SOLIDAGO
GIGANTEA
var. SEROTINA
LAKE SUPERIOR
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
J 8
A 110 11
S 45 71
O 7 16
19


SOLIDAGO
GIGANTEA
var. PITCHERI
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
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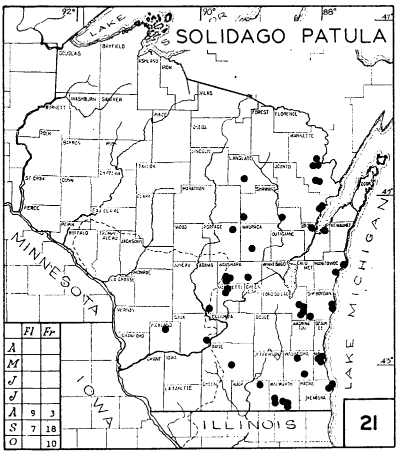
O 1 3
20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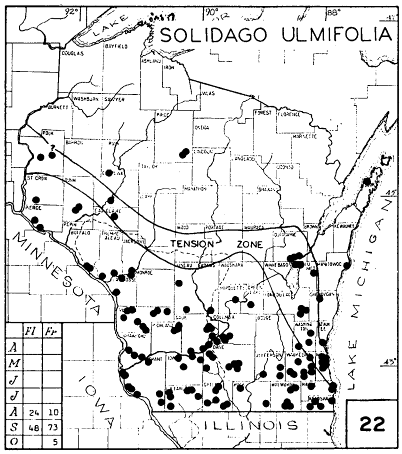
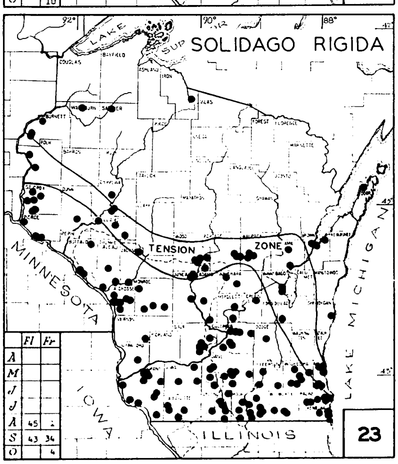
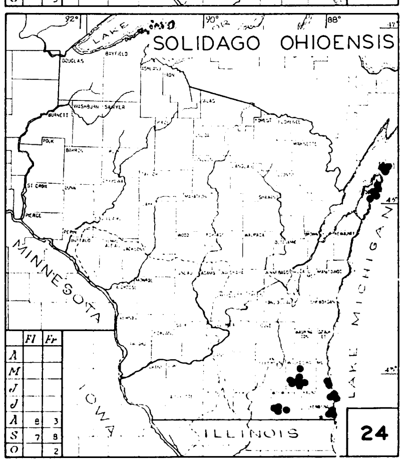
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A 9 3
S 7 18
O 10
21


SOLIDAGO ULMIFOLIA
TENSION ZONE
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A 24 10
S 48 73
O 5
22


SOLIDAGO RIGIDA
TENSION ZONE
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A 45 2
S 43 34
O 4
23


SOLIDAGO OHIOENSIS
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A 8 3
S 7 8
O 2
24

more lanceolate, more or less toothed; inflorescence a stiff terminal panicle, generally with *wide-spreading recurved branches,* but narrower and more elongate in smaller plants; heads secund; involucre about 3–4.5 mm high, the bracts greenish, acute to obtuse or rounded, ciliolate; rays 5–10; achenes sparsely pubescent.

An occasional plant in low conifer-deciduous woods, edges of bogs, on shrubby boggy stream and lake banks (Shrub-Carr community of Curtis, 1959), and in sedge meadows, rarer in low deciduous woods, roadside ditches, chiefly in eastern Wisconsin, but absent from Door County and northeastern counties, where it appears restricted to areas underlain by calcareous rocks. Flowering mid-August through September; fruiting late August to mid-October.

16. SOLIDAGO ULMIFOLIA Muhl. Elm-leaved Goldenrod. Map 22.

A slender stemmed plant from a caudex, 4–12 dm tall, glabrous or nearly so below the inflorescence, leaves thin, sharply and *coarsely serrate, elliptic to elliptic ovate,* larger ones 6–12 cm long and 1–5.5 cm wide, the lower usually deciduous by flowering time, acute or acuminate, abruptly narrowed to a short petiole or nearly sessile, glabrous to somewhat hirsute above, *loosely long-pilose beneath, especially on the veins;* inflorescence a terminal panicle with a *few long divergent or arched-recurving branches,* the heads secund; involucre 2.5–4.5 mm high, the bracts slender, acute to obtuse, yellowish; rays about 3–6; achenes minutely pubescent.

A species associated chiefly with the Mesic Southern Deciduous Forest Community (Curtis, 1959), most common at the edges of Sugar Maple-Basswood woods, Oak woods, and sometimes Birch-Aspen woods, frequently along brushy roadsides, wooded gravelly hills and sandy outcroppings, and occasionally on steep, dripping wet, sandstone cliffs and brushy rock outcrops in the Driftless Area. Flowering late July to early October; fruiting late August to October.

17. SOLIDAGO RIGIDA L. Rigid or Stiff Goldenrod. Map 23.

A coarse plant with a stout caudex; stem 3–15 dm tall; herbage grayish-pubescent; *leaves firm,* entire to slightly crenate, the basal and lower cauline persistent, elliptic-oblong, broadly lanceolate to broadly ovate, acute, 6–30 cm long and 2–10 cm wide, with equally long blades and petioles on the lower, the middle and upper cauline leaves reduced in size and sessile or nearly so; *inflorescence a large terminal corymb; heads large* with involucres 5–9 mm high; bracts firm, broadly rounded, glabrous or puberulent, conspicuously striate; rays 7–14; achenes 10–15 nerved, glabrous.

Widespread in dry to mesic prairies (Curtis, 1955), sandy roadsides, open sandy fields, south-facing slopes, and along fencerows throughout the southern half of the state, sometimes weedy in overgrazed pastures, spreading beyond the limits of the prairie areas into north and east Wisconsin, on sandy soils along roadsides, railroad rights-of-way and occasionally on sandy lake shores. Flowering from early August to late September; fruiting from early September into October.

18. SOLIDAGO OHIOENSIS Riddell. Ohio Goldenrod Map 24.

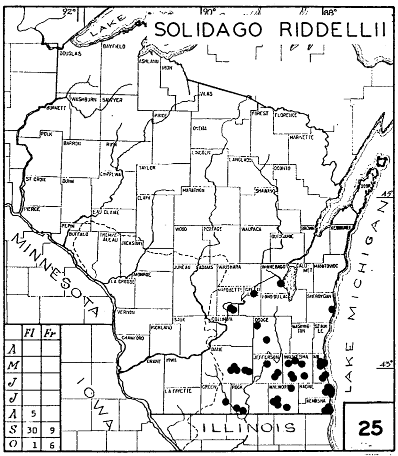
A slender glabrous plant from a branched caudex; stem 4–9 dm tall; *basal and lower cauline leaves persistent, long petioled, narrowly oblanceolate to spatulate,* the blade 7–22 cm long and 1–4 cm wide, *obtuse at tip,* entire or slightly toothed, the middle and upper cauline leaves few, progressively reduced upward and becoming short-petioled or sessile; inflorescence terminal, *corymbiform;* heads numerous; involucre 4–6 mm high; bracts obtuse or rounded, more or less striate; rays short, about 6–8; achenes glabrous, 3–5 angled.

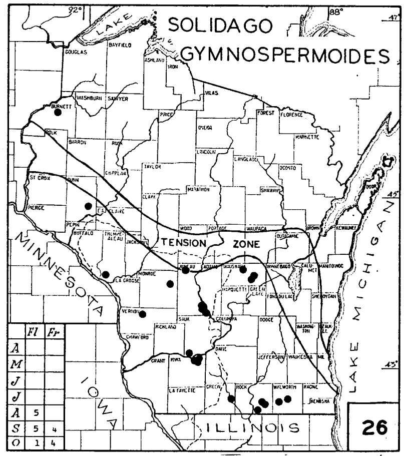
Rather rare in wet alkaline meadows, low prairies, especially those underlain by calcareous substrate, and fens (Curtis, 1959), in southeastern Wisconsin, and in moist to dry depressions between old beach ridges with such species as *Juniperus horizontalis, Calopogon pulchellus, Gentiana procera* and *Solidago spathulata* var. *Gillmani* in Door County; the absence of specimens in the intervening area may be the result of habitat destruction. Flowering from mid-August to late September; fruiting late August to October.

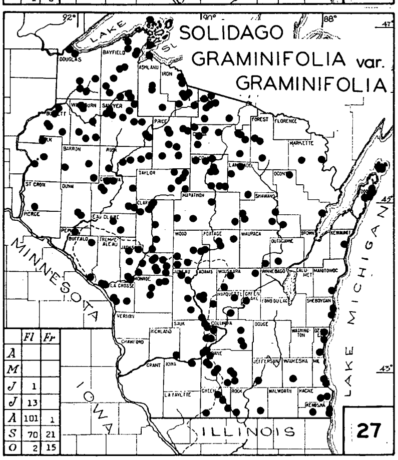
19. SOLIDAGO RIDDELLII Frank. Riddell's Goldenrod. Map 25.

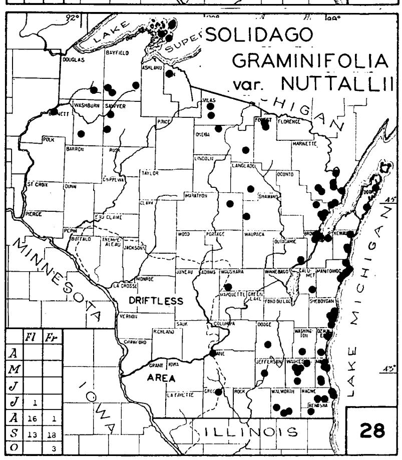
A glabrous plant from a caudex, sometimes with a creeping rhizome; stem stout, commonly 4–10 dm tall, with slight pubescence in the inflorescence; *middle and upper cauline leaves linear-lanceolate, often longitudinally folded, acute, sometimes with recurved tips, long tapering into a keeled, clasping or sheathing base,* lower and basal leaves tapering into a long keeled petiole, the lower ones 3–5 dm long, 1–2 cm wide; inflorescence terminal, corymbiform, the heads crowned; involucre 5–6 mm high; bracts glabrous, obtuse to rounded, more or less striate; rays small, 7–9; achenes glabrous or nearly so, 5–7 nerved.

Occasional in alkaline sedge meadows, wet prairies, edges of marshes, and rarely in moist roadside ditches, in the southeastern









quarter of the state. Flowering from early August to late September; fruiting September to October.

This species sometimes occurs with *S. ohioensis* and *Aster ptarmicoides* (Nees) T. & G. and hybridization among them has been suspected. Cronquist (Gleason, 1952, 3:460) mentions a report of a natural hybrid between *Aster ptarmicoides* and an unknown species of *Solidago*. He further suggests that the true affinities of this aster are with *Solidago* rather than with *Aster*.

Dr. Jean-Paul Bernard, in a personal communication, reported that in population samples of these species, including specimens from a wet prairie in Kenosha County, he observed certain intergrading characters. Among the Wisconsin plants he noted hybrids between *S. Riddellii* and *S. ohioensis,* and *S. Riddellii* and *Aster ptarmicoides.*[4]

20. SOLIDAGO GYMNOSPERMOIDES (Green) Fern. Map 26.

A glabrous plant, 3–10 dm tall, from a creeping rhizome; stem branched at or below the middle; leaves linear, attenuate, entire, with scabrous margins, mostly 4–9 cm long and 1.5–5 mm wide, *with dark and viscid punctation, lateral veins obscure to faintly 3-nerved,* the basal and lower cauline deciduous during flowering time, others not significantly reduced upwards; inflorescence a terminal corymb, open to compact, the heads sometimes sessile in small glomerules, but *more commonly somewhat pedunculate, slenderly cylindric;* involucre 4.5–6.5 mm high, narrow, viscid; bracts obtuse to acute; rays 10–14; achenes hairy.

A western species which reaches its eastward limit in western and central Wisconsin on dry sandy soils in open fields, along fencerows and at the edges of Jack Pine-Black Oak woods. Flowering August to September, and fruiting September to October.[5]

21. SOLIDAGO GRAMINIFOLIA (L.) Salisb. Grass-leaved Goldenrod. Maps 27, 28.

Plant from a branching rhizome; stems 3–12 dm tall, glabrous to hirtellous; leaves linear to linear-lanceolate or linear-elliptic, acuminate to nearly acute in some varieties, sessile, sparsely or moderately punctate, 4–13 cm long and 2–12 mm wide, the basal and lower cauline soon deciduous, others not much reduced upwards, *evidently 3–5 nerved,* glabrous or hirtellous beneath; inflorescence a terminal corymb; *heads sessile or nearly sessile in small glomerules, campanulate to broadly obconic;* involucre 2.5–5 mm high, more or less viscid; bracts obtuse or rounded; rays small, 15–25; achenes with short hairs.

KEY TO VARIETIES

A. Stem, branches and branchlets of the inflorescence essentially glabrous; leaves glabrous except for scabrous margins and occasionally scabrous along the main veins beneath ---------------------------- 21a. *S. graminifolia var. graminifolia.*

[4] Two plants which appear to be hybrids between *Solidago Riddellii* and *Aster ptarmicoides* were collected in a wet prairie area about two miles south of the city of Kenosha on September 22, 1963. One of these is deposited as a voucher specimen in the herbarium of the University of Wisconsin–Milwaukee (UWM) and the other has been transplanted to this campus for further study.

[5] *Solidago remota,* a plant of open sandy areas along the southern shores of Lake Michigan and Lake Erie, is listed by both Gleason (1952) and Fernald (1950) as extending to Wisconsin. However, no voucher specimens exist in any of the herbaria examined. Dr. Shinners, in a verbal communication, mentioned that a specimen had been collected in a sandy beach area along Lake Michigan in Kenosha County, but this specimen could not be located.

AA. Stems sometimes, branches and branchlets of the inflorescence evidently pubescent; leaves more or less pubescent ---------------------------------21b. *S. graminifolia* var. *Nuttallii.*

21a. SOLIDAGO GRAMINIFOLIA (L.) Salisb. var. GRAMINIFOLIA. Map 27.

Common throughout Wisconsin along open sandy or clayey roadsides, fencerows, in remnant mesic to moist prairies, moist to dry fallow fields, railroad rights-of-way and sedge meadows, occasionally in alkaline marshes, and edges of bogs, moist Maple-Basswood woods and Hemlock-Yellow Birch-Maple woods. Specimens are sparse in the area from Brown County to Walworth County and in the southwestern counties. Because considerable portions of these areas are underlain by dolomitic bedrock or glacial drift containing dolomite material, the lack of plants here may be correlated with soil alkalinity. Flowering (late July) early August into October; fruiting from late August into October.

21b. SOLIDAGO GRAMINIFOLIA (L.) Salisb. var. NUTTALLII (Greene) Fern. Map 28.

Generally distributed in eastern and northern Wisconsin in sandy open fields, along railroad rights-of-way, moist to dry open sandy roadsides, moist fencerows, mesic to moist prairie remnants, and sometimes at the edges of marshes, low woods and, rarely, bogs, in open deciduous woods or at the edges of Maple-Basswood, White Pine and Aspen woods. Flowering and fruiting as in var. *graminifolia* .

In addition to the varieties listed here, the following are excluded: Fernald (1950) lists a var. *media* (Greene) Harris, which is described as being glabrous except for scabrous lines; the leaves linear-lanceolate, long attenuate, with only two lateral nerves and with fewer flowered heads. Some narrow-leaved glabrous plants which fit this description were observed from central and southwestern Wisconsin. Rosendahl and Cronquist (1945) observed similar plants in Minnesota, and suggested they represent intergrades between *S. graminifolia* and *S. gymnospermoides.* Since these narrow-leaved plants were observed in the area of Wisconsin where the ranges of these two species overlap, this explanation has considerable merit.

Var. *major* (Michx.) Fern., the boreal phase of *S. graminifolia,* is distinguished by having broadly lanceolate leaves, mostly 7–10 times as long as wide, and with acute tips. Specimens of this variety have been collected in northern Michigan and northern Minnesota. Although no specimens have been collected in Wisconsin, they should be looked for in the northernmost counties.

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