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MADISON, WISCONSIN
1962

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TABLE OF CONTENTS

PRESIDENTIAL ADDRESS

NATURAL SCIENCES

SOCIAL SCIENCES

ARTS AND LETTERS

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PRESIDENTIAL ADDRESS

KNOWLEDGE AND THE LAW OF DIMINISHING RETURNS*

JOEL CARL WELTY
President, Wisconsin Academy of Sciences, Arts, and Letters, May 6, 1961 to May 5, 1962

About half a century ago, my youngest brother was given a birthday present of seventeen cents to do with as he pleased. In those days that was, for a child, a princely sum. My brother liked licorice candy, so he invested his complete fortune in licorice sticks, licorice straps, whips, and jawbreakers, with the predictable result that to this day he cannot abide the taste of licorice. Early in life he learned about the law of diminishing returns.

It is an interesting fact that in many affairs changes in quantity often bring about changes in quality or in essential nature. When a solid cone is intersected with a plane, the resulting figure may describe an ellipse. If the tilt of the plane is increased in one direction, the ellipse gradually shortens until it suddenly becomes a circle: a geometric figure with quite different mathematical properties. Increased in the opposite direction, the ellipse eventually turns into a parabola: again, a very different figure from an ellipse. Even in the esthetic enjoyment of simple pleasures, this same principle may be demonstrated. The Japanese have a poem which underscores this idea:

> The moon is at its loveliest tonight.
> I thank the clouds that o'er it flit
> And let me rest my neck a bit.

Consider, for example, the sizes and shapes of mammals. Elephants and mice are both warm-blooded animals, and one might think that a mouse is, so to speak, an elephant cut into 200,000 pieces, or an elephant, 200,000 mice huddled together. But their metabolism is geared to the amount of body surface each animal possesses, and proportionately the mouse has much more surface through which it loses body heat. You could never make an elephant-size animal out of a mouse simply by enlarging the mouse. Whereas an elephant burns oxygen at the rate of 67 cubic millimeters per gram of body weight per hour, a mouse burns 1,580 cubic millimeters per gram, or 24 times as much. If the tissues of the elephant metabolized as rapidly as those of the mouse, the elephant would literally cook itself to death in minutes. This all hinges

* Address of the retiring president, delivered at the 92nd annual meeting of the Academy, May 5, 1962.

on a simple geometric law: as one doubles the linear dimension of an object, its surface increases 4 times, but its mass, 8 times. As an animal increases in size, its metabolic needs change strikingly.

Body architecture is also subject to the laws of geometry. The strength of a supporting column such as the thigh-bone of a leg depends on its cross-section area. Since area does not increase as rapidly as mass as an animal grows larger, a big animal such as an elephant must have proportionately stronger, stockier legs than an antelope. Merely enlarging an antelope to the size of an elephant would not equip the animal with strong enough legs to hold the heavy body. A whale has so great a mass that there would not be space enough under the body to accommodate four legs large enough and strong enough to support it.

One more biological example. Turkey growers are interested in raising as much tender meat, on as little food, in as short a time as they can. Breeds of Turkeys that cooperate with these goals have been developed, among them the Broad-breasted Bronze Turkey. But here again the law of diminishing returns has caught up with "progress." Apparently, rapid, efficient meat production requires high blood pressure. As a result, these birds have developed blood pressures of 300 to 400 millimeters of mercury—high enough to rupture their aortas in epidemic proportions. Incidentally, Turkey growers have, for the time being, successfully countered this operation of the law of diminishing returns by lowering the birds' blood pressures through the use of tranquilizers! However, this example reveals that there may be dangers in the pursuit of a single objective to the neglect of a healthy, balanced concern for the good of the whole organism.

How does this law of diminishing returns apply to mankind? There is nothing on earth lovelier than a small, healthy, happy child, brimming with promise for the future, unless, perhaps, it is a pair of twins. Doubts begin to arise, however, when one has six or eight children, especially when several of them are of an age when one has to provide them with a college education. Doubt turns to alarm when the numbers of humans increase to the population densities found in Java, India, British Guiana, and many other countries.

Most people are familiar with the fact that all organisms, man included, can produce more offspring than are required to perpetuate the race. When living conditions are favorable and the death rate drops, population climbs. This is what modern medicine has done for British Guiana, where the population has doubled in the past seven years (1). Few people are aware of the fact, however, that population growth is by a form of geometric increase, or compound interest, which accelerates astonishingly in its later stages.

Demographers of the United Nations estimate that today the population of the world is increasing at the rate of two per cent per year, and that the rate is still rising (2). Two per cent is not an awesome figure, but given a little time to work it can produce fantastic results. Professor Hauser of the University of Chicago points out that an initial population of only 100 persons, multiplying at the rate of not two per cent, but only one per cent per year, and not over the full million year span of man's life on earth, but merely for the last 5000 years of recorded history, would by today have produced a population of one and one-half billion persons per square foot of land surface of the earth (3)!

Obviously such an increase has not occurred, and some of you may be inclined to shrug off any concern over such pure theory. What are the facts? Well, they are sobering enough. According to estimates from the United Nations, the world had a population of roughly one-quarter of a billion persons at the beginning of the Christian era. 1620 years later, when the Pilgrims landed at Plymouth Rock, that number had doubled to make one-half billion. About two centuries later, at the time of the Civil War, another half billion was added to make a total of one billion persons in the world. Since then, half-billion increases in population have occurred in successively shorter intervals of time. The sixth half billion, just added, required only eleven years. At the present rate of population growth, the next half billion will come in only six or seven years (4). Assuming a rate of population growth of two per cent, "In 150 years the number of people in the United States would approach the number currently inhabiting the whole world" (5). In 1915 Java's population was estimated to be five million persons; by 1957 it had reached 52 million.

It requires very little imagination to understand how the law of diminishing returns applies to human population increase. Our lovely little child already shows signs of becoming a hideous monster. Inevitably, there will be less food, housing, irreplaceable raw materials, and sheer space for living, as the population of the world snowballs toward self destruction. Back in the 1920's, if one wished to make a trip to Chicago to go shopping, he drove into the Loop, parked on State Street ouside of Marshall Field's, spent a leisurely hour shopping, came out, hopped in the car and drove home. Today the situation is somewhat different. One can't even park his car beside the interstate highway to admire the view or to get out and pick a daisy. In most parts of the world, the population has now reached a threshold where every increase brings some loss in human freedom, human rights, human dignity. Man must very soon choose between high mortality or low fertility. Either man's freedom to have as many children as he wants must be curtailed, or else the quality of human living will inevitably deteriorate.

Research studies by the New York City Youth Board (6) have shown that less than one per cent of the city's families produce 75 per cent of its juvenile delinquents. When there are already too many people in the world, how much longer can society afford the democratic luxury of unlimited freedom of procreation by all men? I realize that this is not a simple problem. But I am willing to hazard the prediction that if our population continues to grow at its present rate, or faster, for another century, democracy as we now know it will cease to exist.

There are other, less obvious, aspects of dense populations, through which the law of diminishing returns operates. Some years ago, Arthur Morgan of Antioch College made the observation that big communities offered evil men a greater opportunity to practice their skills as shysters, quacks, grafters, and gangsters than did small communities, because of the anonymity possible in large crowds. Pretending to be what one is not has survival value among strangers. In a small community, bluff and cheating are soon discovered, and countered if not corrected. It is in the populous cities that one finds also the anxiety-ridden man, rubbing elbows daily with thousands of strangers, in the "lonely crowd." Quite obviously, bigger communities are not necessarily better communities.

A subtler complication of population increase is already causing people to search their consciences. One of the basic tenets of Judeo-Christian ethics declares the worth and dignity of every man, regardless of his race, religion, economic station, or politics. We find this ethic hard enough to apply in low density populations like our own. Must it be sacrificed entirely when the day comes when the world is jammed with human beings barely able to find standing room?

To make the problem more concrete, shall we, the next time there is a famine in India, send surplus food and doctors to keep men alive, only to create a more acute famine the next time? To say that we should also send agricultural and economic experts to increase the production of food and goods only begs the question. In the race between the production of food and the reproduction of humans, unless some restraining factor is introduced, reproduction is guaranteed to win.

So far we have merely been setting the stage for our main concern. Our chief question is this: Does the law of diminishing returns apply to knowledge? This is an intriguing question, and worth some scrutiny. The Wisconsin Academy of Sciences, Arts, and Letters is firmly dedicated to the increase and diffusion of knowledge. This principle is one of the unchallenged absolutes of Western Civilization. It is one of the basic articles of faith of numberless universities, colleges, seminaries, and commencement speakers. "Fiat Lux." "Lux et Veritas." "Ye shall know the truth, and the truth shall make you free." "A little knowledge is a dangerous thing," said Alexander Pope. "Drink deep, or taste not the Pierian spring." Can one drink too much learning—to a point of intellectual inebriation? Is it conceivable that too *much* learning is a dangerous thing? Even to suggest that the unlimited increase of knowledge might be undesirable or unprofitable comes close to committing intellectual treason. However, if there ever was a time ripe for examining this question, it is now, for the production and accumulation of knowledge has accelerated phenomenally in recent decades.

We are all amply aware that the increase of knowledge has enriched man's life by giving him more power over his environment, and by making his life easier, safer, and more interesting. Technological science has made it possible for man to circle the globe, not only in 80 days but in 80 minutes, and it promises soon to broaden his horizons to include other planets. Agricultural knowledge enables us now to grow two blades of grass where one grew before. In 1900, man's life expectancy was 47 years; today, it is over 70 years. But there is no need to elaborate the virtues of growing knowledge before this assembly. We live in a remarkable age of intellectual, emotional, and material riches never before attained by the common man.

Can it be possible that knowledge, like human population, is in danger of snowballing into destruction? Is our store of knowledge a chest of jewels which may be transformed as it overflows into a Pandora's box of horrid problems? Already some problems have appeared, and others seem to be in prospect.

The massive quantity of modern knowledge has already created problems of storage and retrieval. Several recent writers have estimated that scientific knowledge is now doubling every 10 or 15 years—a rate of increase more than twice that of the world's population. The rate at which biological information has been increasing is revealed, for example, by the growth of the technical journal *Biological Abstracts*. Volume 1 of this periodical, published in 1926–27, had 976 pages and contained 10,900 abstracts. Volume 36 for 1961 contained 8,436 pages and 87,000 abstracts. Incidentally, the price of a single subscription to this journal is $170 a year! This single "volume" now requires about 16 inches of shelf space. Since first published, this journal has roughly doubled in size every 10 years. If this rate continues for only 100 years, by then each single annual volume will require 1400 feet of shelf space. And this is only one of several abstracting journals, not to mention the thousands of other journals from which the abstracts are made. The mere housekeeping problem of accommodating these books will be a librarian's nightmare. Certainly, before this unhappy day arrives, the law of diminishing returns will begin to operate.

Are we in danger of accumulating so much knowledge that, like the massive whale, grown too large for legs, our store of information will wallow uselessly on miles of library shelving, unable to be moved for man's good simply because of its enormous bulk? Like the Turkey growers, have we concentrated too much on one limited objective—the accumulation of knowledge—without winnowing it for its wholesome use to man?

At this point, someone might point out that 25 or 50 years from now, books will be discarded in favor of microfilm, microcards, information tape, or some other form of condensation. This will of course help the storage problem, but I doubt that books will become entirely passé. They are too thoroughly established in our daily habits and affections. Not only is microfilm hard on the eyes, but it does not lend itself to casual summer reading while one is comfortably stretched out in a hammock.

The sheer bulk of recorded knowledge not only creates a storage problem, but a serious problem of retrieval. In all the tremendous mass of literature, how does one find what he wants? Gerard Piel (7) tells of a paper on Boolean Algebra published by Lunts in 1950 in the *Journal of the Academy of Science* of the U.S.S.R. It concerned the design of computer circuits. Between 1950 and 1955, American computer scientists spent five fruitless years and an estimated $200,000 seeking the information they could have had free had they only read this one Russian paper!

In other words, scientific communications no longer communicate. Today, American scientific and technical writing costs $10 billion per year and employs 90,000 persons in full-time writing, editing, and publishing. It is estimated that by 1970 the number will grow to 160,000 persons. Each day in this country "enough technical papers are written to fill an encyclopedia seven times as large as the 24-volume *Britannica.*" (17) It is any wonder that much of this knowledge lies sterile and unproductive? The annual production of military weapons manuals alone costs us $2.8 billions.

While it is true that electronic machines may be effectively used to retrieve and collate wanted information from a massive store, such machines used as "brains" for the creation of new ideas out of the raw material of stored knowledge are analogous to the player piano as an instrument for playing great music. Both lack the authentic touch of individual human creativity.

Probably the most serious defect inherent in the massive proliferation of modern knowledge is its fragmentation. Specialization is the price man pays for intellectual progress. Not only has specialization proceeded so far that there has arisen a "conflict of cultures" between scientists and humanists, eloquently described by C. P. Snow (8), but scientists are becoming isolated from other scientists, and humanists from other humanists, as each burrows deep into his own specialty. A man spends so much time trying to master his little, isolated fragment of the knowable, that he is forced to neglect great expanses of knowledge from sheer lack of time. Experts make matters worse, often quite unnecessarily, by speaking a technical jargon incomprehensible to anyone not in their particular field. Recently there occurred in a Kansas City hotel three separate scientific meetings of nuclear physicists. When asked why the three groups did not join together in one meeting, one of the participants replied that they could not because they did not speak the same technical language. As a result of this confusion of tongues, a man is driven to depend on the judgment and opinions of "authorities" in almost every field but his own. Thus, the vast expanses of modern knowledge provide splendid opportunities for ignoramuses and intellectual quacks to ply their trades; they create opportunities for pretense and bluff worthy of Phineas T. Barnum. Here is a single sentence from an "authoritative" art criticism which appeared in *Art News* not long ago (9). I defy anyone to make sense out of it.

> "He [the artist] pictures the stultified intricacy of tension at the plasmic level; his prototypical zygotes and somnolent somatomes inhabit a primordial lagoon where impulse is an omnidirectional drift and isolation is the consequence of an inexplicable exogamy."

This of course is pure intellectual quackery; it could not be so common if technical jargon were frowned on rather than cultivated. But even when authorities are conscientious and honest, they are likely to suffer the defects of intellectual myopia and isolation, and, at times, dogmatism. Although modern man is driven to depend on authorities for much of his information, he must constantly recall that authoritarianism has many times in human history poisoned and stunted the growth of man's mind. He must always keep alive his right to doubt, to question, and to challenge "authority."

In nature, the extreme specialization that one occasionally finds in animals is commonly the result and not the cause of isolation. Animals isolated on oceanic islands often become so specialized that when their environment changes, or when competing forms are introduced, they become extinct. The isolated species lack the interflow of hereditary characters that keeps the mainland species tough and resilient. I think it is a fair analogy to say that intensified isolation in the intellectual realm carries comparable hazards.

Coupled with the sheer bulk of our rapidly growing fund of information is an attribute that presents another embarrassment of riches. That is the velocity both of the appearance of new knowledge and of its application to human use. Scientific technology has done more to change the modern world (for both good and evil) than any other intellectual force. And the speed with which scientific discoveries are put into use has itself been accelerating. According to Piel (7) it took about 100 years "for the steam engine to make its arrival felt in economic and social history, and 50 years for electricity to make its impact." The present interval between basic scientific discoveries and their application in technology he estimates to be about 10 years, with even shorter intervals in the fields of communications, electronics, aircraft, and chemistry. The Du Pont Corporation estimates, for example, that one-half of its sales, and three-fourths of its profits come from products that were still in the laboratory ten years ago.

You may object that rapid change is in itself not a bad thing, even though it may be uncomfortable to persons over 40 or 50 years of age. I think that it is here that a disquieting lack of concord begins to appear between the bulk, complexity, and velocity of change of modern knowledge, and the innate nervous and mental equipment that man uses in handling that knowledge. We are living in a world of increasingly great complexity and of incredibly rapid change. While it is true that the greater one's store of information, the greater his freedom of choice, Warren Weaver (7) points out that the greater one's choice the greater his uncertainty, and the greater his uncertainty, the greater his mental instability. Do we have too many choices to make today? Must we make them too hurriedly for our mental equilibrium?

Man's mind evolved in a relatively simple environment that posed relatively simple problems. These generally had simple either-or solutions: eat or go hungry; attack or flee; work or rest; go out and get cold, or stay in a smelly cave and be warm; and so on. Problems for primitive man were generally black or white, and not the many confusing shades of gray that so many of them are for modern man. Although primitive man had to make simple choices between clear-cut alternatives, they were often life and death choices vital to his survival. The primary urgency of scrabbling a living from a reluctant environment not only left for Neanderthal Man no leisure time for such culturally stimulating things as composing chamber music or attending an intertribal disarmament conference, but they riveted in his mind two lamentably durable attributes: a tendency to seek simple solutions to problems, and an egocentric, all-consuming preoccupation with security and with material acquisition.

Is modern man really heir to these stone-age mental attributes? Has evolution changed us much? Are our minds out of tune with the intellectual conditions of modern existence? Let us consider one of Neanderthal Man's chief problems: food. Physiologically, modern man is still chained to the prehistoric past. His digestive machinery still requires about the same calories, minerals, vitamins, and roughage as did that of the Neanderthalers. Our cave man forebear had a palate which told him to eat while the eating was good, because tomorrow the hunting might be poor. Apparently, we still have the cave man's palate, but as far as *American* eating goes, the hunting is never poor. The result? Overeating, overweight, cholesterol, coronaries, exit. This, of course, helps a little to solve the overpopulation problem, but in a rather unintelligent way.

Do we still carry vestiges of a paleolithic acquisitive instinct? Some of you are familiar with that intriguing book by Charles Mackay, *Memoirs of Extraordinary Popular Delusions and the Madness of Crowds* (10). This book, written in England 120 years ago, tells in fascinating detail some of the popular follies of our gullible ancestors: the Mississippi Bubble; the South-Sea Bubble; the Alchymists; Fortune telling; the Crusades; Witch Hunting; Relics of the True Cross; and others. Many of the mass delusions portrayed by Mackay gained their chief impetus from human avarice, or our cave man's acquisitive instinct. For example, during the tulip mania in Holland in the 15th century, this appetite for selfish gain rose to such heights of folly—before the boom collapsed—that a single tulip bulb sold for as much as 5500 Florins. To make this fantastic price more intelligible to modern ears, Mackay tells of a somewhat less valuable tulip bulb, a variety called the Viceroy, worth only 2500 Florins, which was paid for in goods rather than in currency. Here is the amount paid for one bulb:

170	bushels of wheat	1008	gallons of beer
340	bushels of rye	504	gallons of butter
4	fat oxen	1000	pounds of cheese
8	fat swine		A complete bed
12	fat sheep		A suit of clothes
105	gallons of wine		A silver drinking cup

All of this, mind you, was paid for only *one* fragile, perishable tulip bulb.

Surely, you will say, we sophisticated moderns do not behave in any such gullible fashion. We may have our weaknesses, but we are surely not *that* stupid. Perhaps not, but it makes an interesting exercise to observe, if we can, any lingering vestiges of paleolithic man's single-minded concern with himself. Are there any latter-day popular delusions? What of the wild speculation on the stock market, or in Florida real estate, in the late 20's? Or the Gadarene stampede of the Italian people into fascism, or of the German people into Nazism? Do we consistently use reason to guide our conduct? Do we make sensible use of accumulated knowledge?

We Americans are very health conscious. A man may regulate his diet, take regular exercise, eat vitamin pills, brush his teeth, and make sure that his children are inoculated with Salk vaccine. Then, all too often, he may visit a tavern for a quick drink, hop into his car, and speed 70 miles per hour down a crowded two-lane highway while smoking a carcinogenic cigarette. To me, this provides one of the most striking illustrations of a popular delusion available on the modern scene. It is second only to war itself as a present day example of the madness of crowds.

In the past 20 years there have been at least 18 independent studies in five different countries carried out on hundreds of thousands of persons by medical research organizations of unimpeachable qualifications—all to determine the statistical association between smoking and lung cancer (11). The scientific evidence obtained from these studies establishes beyond the slightest doubt the fact that cirgarette smoking causes lung cancer. Whereas among non-smokers, one man in 275 will probably die of lung cancer, among heavy smokers the statistical chances of death from lung cancer are one in ten. The British Ministry of Health, alarmed by such statistics, has displayed over 400,000 posters in an educational anti-smoking campaign. One of these posters states: "Danger! Heavy cigarette smokers are thirty times more likely to die of lung cancer than non-smokers. You have been warned." (19). Add to the hazard of lung cancer the fact that cigarette smokers are twice as likely as non-smokers to die from coronary heart failure, and it becomes clearly evident that cigarettes are causing the needless deaths of well over 100,000 Americans every year (18). This means that every day the lives of more than 250 U. S. citizens are prematurely snuffed out because they smoke cigarettes. Can you not imagine the public outcry for immediate remedy should 250 persons be killed every day in airplane disasters? And yet, last year Americans spent $6.9 billion to buy and consume 528 billion cigarettes (19). Is this not a striking example of collective stupidity? When confronted by such statistics, many smokers will remark, "It can't be as bad as all that, or nobody would be smoking. Fifty million smokers can't be wrong." Exactly the same logic was advanced to justify the speculative mania of the South Sea Bubble and the tulip-buying mania of the Dutch.

Quite aside from the damning fact that in the United States our smoothly purring automobiles injure one and one-half million persons each year, and kill outright 38,000 (and in Italy the death rate is, percentagewise, six times as great), they have become egocentric symbols of conspicuous power and wealth, just as were tulips in Holland 400 years ago. The typical American breezes down a costly super-highway in a chromium chariot pulled by 200 horses. The staggering cost of such transportation was recently brought home to me by an advertisement for the Santa Fe Railroad in *Time Magazine* (12). With a typical four-unit diesel locomotive of 8,000 horsepower, a modern freight train will carry on an average trip, 1,250 pounds of freight for each engine horsepower. On an average trip, my two-year-old Ford will carry less than one pound of freight for each engine horsepower. Whereas my car on a typical trip will carry a 150 pound man 15 miles on a gallon of fuel, a freight locomotive will carry that same man 2,666 miles, and on a gallon of cheaper fuel. The sad part about this is that the difference in the standard of living provided by an automobile of 200 horsepower compared with one of 199 horsepower is barely, if at all, detectable. But if we could give up only one of these horse-power to furnish a poor Indian or African peasant with a one-horsepower garden tractor or irrigation pump, it could easily double his meager standard of living. The law of diminishing returns began to operate in automobiles even before the advent of the Model T, but instead of causing a self-correcting feed-back reaction, as in the case of eating too much licorice, it inaugurated a regime of unparalleled conspicuous consumption and waste. Were our grandparents so much more short-sighted and wicked when they killed a buffalo merely to remove, cook, and eat its tongue? We citizens of the United States account for only 7 per cent of the world's population; yet we consume nearly 50 per cent of the material wealth that the world consumes (13). While we are worrying about obesity an dcholesterol, at least one third of all the world's people go to bed hungry every night. Do not these facts reflect a vestigial Neanderthal mentality rather than that of a modern, intelligent citizen of the world?

By this time some of you are realizing that I have departed somewhat from my announced topic. What have popular delusions and the madness of crowds to do with the increase of knowledge? Where does the population explosion fit into the law of diminishing returns as it applies to the increase of knowledge? Simply in this way. If we use man as the measure of all things, as we universally do, the increase in knowledge has no point whatever unless it ministers to human needs; unless it is put to some use by man. The real difficulty is that knowledge may be put to good use or to bad use; and uses which initially may be very good, if applied to too many people or on too wide a scale, may become harmful.

Medical knowledge has conferred priceless boons on mankind in relieving pain, promoting health, and prolonging lives. At the same time, it is creating at least three very serious problems. First, it is intensifying the problem of too many people. It is because modern medical knowledge, in only two years, has made possible a reduction in infant mortality from 350 per thousand of population to 67 per thousand, that the population of British Guiana is now doubling every seven years. In Ceylon in 1946, the malaria mosquito was practically eliminated through the use of DDT. As a result, in two years that island's death rate dropped from 20 per thousand to 13 per thousand. But the birth rate remained constant, with the consequence that hunger and starvation increased in severity (1).

Secondly, by keeping alive both the strong and the weak, modern medicine has effectively rescinded many of the rigorous laws of natural selection that operated in the days of *Pithecanthropus* to keep the hereditary quality of mankind tough and self reliant. As a result, today the genetic quality of human protoplasm is gradually deteriorating. Imagine the predicament of modern man should nuclear war destroy civilized communities to such an extent that all of the modern medical crutches which now support defective humans were no longer available: glasses, hearing aids, false teeth, wheel chairs, insulin, vitamins, antibiotics, anesthetics, antiseptic surgery. How many of us in this room would survive if we had to go back and compete with Neanderthal man under such conditions?

Even worse is the deliberate misuse of medical knowledge. I do not refer to medical quackery, but to the icily efficient scientists in this country, Russia, and elsewhere who are dedicating their skills to the systematic, organized murder of their fellow men through fiendish inventions for biological warfare. It is not the knowledge itself that is necessarily good or bad, but the use to which man puts it. Knowledge is power, and too often the power it brings is perverted to evil ends. Even when man does not deliberately pervert that power, sometimes he lacks the wisdom to use it properly, like the teen-ager who does not have sufficient respect for the enormous power of a modern automobile.

What is man to do? Build a cabin on Walden Pond? The chances are that the bulldozers have already been there to level off the land for a suburban shopping center. No, none of us cares to go back to the days of Neanderthal Man, or even of Thoreau, and give up antiseptic surgery, blood banks, old age security, libraries, theatres, colleges, or institutions such as the Wisconsin Academy of Sciences, Arts, and Letters.

The human mind still has enormous, unfathomed potentialities for education—for adapting to those problems posed by the quantity, complexity, and rapid change of modern knowledge. Already, in widely scattered parts of the globe, intelligent steps are being inaugurated to diminish the threat of overpopulation. I think, however, that the urgency of the times calls for a change in emphasis in our intellectual pursuits. Our chief problems, I believe, stem from the fact that knowledge, especially scientific knowledge, has grown faster than man's wisdom in its use. The growth of pure knowledge has outdistanced man's ability and willingness to retrieve, digest, coordinate, and apply its truths for the benefit of all mankind. Things are getting out of hand when a biologist, for example, hasn't the time to read all that he should in his own field, let alone the swirling, printed floods of new information in physics, astronomy, archaeology, political science, art, and economics.

I am not suggesting that our great universities close their doors and cease their search for the truth. But I *do* think that a good case can be made for spending less effort and less money in certain fields of intellectual interest.

Since World War II a great change has come over our universities and colleges, especially in the field of scientific research. According to Dr. Max Tishler (14), in 1940 our federal government spent $15 million for research and development in our institutions of higher learning. In 1960 the amount spent was $9 billion—60 times as much. About 75 per cent of all academic research in the physical and life sciences is now paid for with tax money. In 1958–59, the government accounted for 83.6 per cent of Cal Tech's total income; 78.2 per cent of MIT's. The taxpayer has now become the patron of science.

Gerard Piel (7) points out that in these lavish governmental programs the scientist becomes an employee of the government, a fact which conditions his intellectual independence. Tishler adds the further observation that scientific "discoveries are seldom made by direction." I think it is only fair to add that the weight of the government's hand in directing research is often light to the point of non-existence. At other times it is overpoweringly heavy and dictatorial.

With the federal government now pouring $12 billion a year into scientific research, what wonderful new scientific knowledge does this buy? Not much. The trouble is that most of this money is spent, as Piel remarks, on the "lowly, short-term gains of practical advantage in weapons," consumer goods and the like, rather than on the "lofty, long-range goals" of pure science. Before the war, for every dollar spent by the government on pure science, six dollars were spent on applied science. Today the ratio is one dollar for pure science for every twenty dollars on applied science, and nearly half of the applied science is devoted to weapons development.

This, says Tishler, is no "real resurgence of interest in the intellect nor is it a rising dedication to learning. Rather it is an attempt to mobilize science through our educational system for the single-minded purpose of solving the immediate problems of national health and security." We have already seen how the law of diminishing returns applies to discoveries in the field of medicine. It has operated with even greater effect in the field of security. In the laudable pursuit of personal security, primitive man used his opposable thumb to pick up a rock in self-defense. With the gradual increase in knowledge, this rock, as a symbol of security, has evolved through the inventions of the flint arrowhead, bronze spear, wooden crossbow, flint-lock, gatling gun and flame thrower, all the way up until today, instead of security, we have reaped the agonizing insecurity of the hydrogen bomb. I think it is time that we diverted some of this torrent of money and human skills toward more constructive ends.

As a suggestive example of constructive alternatives to the futile production of information about ever more devastating weapons, Piel tells of a project of the Rockefeller Foundation in combating malnutrition in Mexico. Over the past 20 years the Foundation, at a cost of less than $2 million per year, has supplied United States agronomists who have established a sort of county agent system to train young Mexicans in agricultural sciences. In this short time, food production has risen 80 per cent, and the improved diet is already showing up in vital statistics. All this for less than $2 million a year—much less than the cost of a single small satellite.

Speaking of the Rockefeller Foundation recalls a notable article in their annual *Review for 1941,* written by Raymond B. Fosdick (15). This article is a favorite of mine and I quote from it each year to my beginning biology students. It illustrates so well the final point that I wish to make that I would like to read to you an excerpt from it. Speaking of the international character of medical science, Fosdick writes:

"There is not an area of activity in which this cannot be illustrated. An American soldier wounded on a battlefield in the Far East owes his life to the Japanese scientist, Kitasato, who isolated the bacillus of tetanus. A Russian soldier saved by a blood transfusion is indebted to Landsteiner, an Austrian. A German soldier is shielded from typhoid fever with the help of a Russian, Metchnikoff. A Dutch marine in the East Indies is protected from malaria because of the experiments of an Italian, Grassi; while a British aviator in North Africa escapes death from surgical infection because a Frenchman, Pasteur, and a German, Koch, elaborated a new technique.

"In peace as in war, we are all of us the beneficiaries of contributions to knowledge made by every nation in the world. Our children are guarded from diphtheria by what a Japanese and a German did; they are protected from smallpox by an Englishman's work; they are saved from rabies because of a Frenchman; they are cured of pellagra through the researches of an Austrian. From birth to death they are surrounded by an invisible host—the spirits of men who never served a lesser loyalty than the welfare of mankind."

This breaking down of barriers is urgently needed in the intellectual world today. Not just international barriers, but intellectual barriers that prevent intelligent men from comprehending each other. What is needed is a greater integration of existing knowledge—more cross-fertilization of ideas—so that artists, writers, scientists, and laymen can all speak a common language. We must bend our minds toward dissolving the barriers that fragment and isolate our various intellectual specialties. We must reaffirm the unity of knowledge and make it truly liberal. Last year at our annual banquet, Professor Merritt Hughes, (16) then our President, emphasized that the Wisconsin Academy, unlike all other academies in the country save one, is devoted to the integration of all knowledge—sciences, arts, and letters. That is truly one of its glories, and we should continue to emphasize it even more than we have.

Finally, while we have to accept man as he is, with all his primitive appetites and limitations, it is well to remember that man is more than intellect alone. L. P. Jacks, for many years the editor of the *Hibbert Journal,* once wrote that he believed that all the good in the world could be accounted for by honest thinking, hard work, and kindly feelings. The biggest problems in the world today do not stem from ignorant minds, but from uneducated hearts and wills. It is here that we should dedicate more of our substance and energies. After spending many billions of dollars and many years of time by our cleverest minds, we have acquired sufficient knowledge about the atom so that we can use it to ease man's burdens and enrich his life to heights undreamed of—or we can use it to destroy man and his works, completely and finally. There is a Buddhist proverb that says, "To every man is given the key to the gates of Heaven; the same key opens the gates of Hell."

I think we are all aware that in our pursuit of security we have passed the threshold where the law of diminishing returns has operated to produce, instead of security, a precarious balance of international terror; instead of a blessing, a world-wide curse.

It is time to redress the balance. It is time that we realize that knowledge for its own sake is not enough. Knowledge for the sake of security is not enough. We need to recover the full dimensions of a knowledge that ministers to the whole man—his body, mind, and spirit; that ministers to all men of whatever position throughout the whole wide world; knowledge "that never serves a lesser loyalty than the welfare of mankind."

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NATURAL SCIENCES

WILDLIFE RESTORATION IN WISCONSIN

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The restoration of wildlife falls under the following headings: 1) Stocking of species of animals still found in our state in areas where they have been extirpated; 2) Introduction of species that have become extinct in the state; 3) Planting of exotic species. Long experience has shown that it is preferable to concentrate on animals native to the state rather than to import foreign species with the hope that they will fill a void. Foreign introductions are seldom successful and leave a memory only of costly failures. Many plantings are made against the advice of game biologists but carried out under the guise of "good public relations." Present land utilization prohibits attempts to restore any of the large extinct mammals such as the cougar, bison, elk, caribou, and moose.

Three members of the deer family are extinct. The woodland caribou occurred in extreme northern Wisconsin in very small numbers and was soon exterminated. Twenty Newfoundland caribou were liberated on the Pierce estate, on the Brule River, Douglas County in 1906. All are supposed to have died on the estate. The moose was uncommon except in five of the extreme northwestern counties.[1] The native population became extinct about 1900. Since this date an occasional moose has wandered into the state from Minnesota, and from the Upper Peninsula of Michigan where moose from Isle Royale had been liberated. An individual immigrant may be seen in the future but there is no chance for the moose to become established with us. The elk was once common in the open terrain of southern and western Wisconsin.[2] The last certain date of its occurrence is 1866. The state in 1913, 1917, and 1932 released three shipments of elk from Yellowstone Park and Jackson Hole in Vilas County. None remains due to poaching and other causes. The white-tailed deer, on the other hand is remarkably adaptable.[3] After receiving adequate protection it moved southward so that today it is doubtful if there is a county in the state where deer are not present. The problem with this deer is the harvesting of the surplus population. In many areas in the northern part of the state the herds are

[1] A. W. Schorger. 1956. The moose in early Wisconsin. *Trans. Wis. Acad. Sci.* 45: 1–10.

[2] ———. 1954. The elk in early Wisconsin. *Trans. Wisc. Acad. Sci.* 43:1–23.

[3] ———. 1953. The white-tailed deer in early Wisconsin. *Trans. Wis. Acad. Sci.* 42:197–247.

too large to be sustained properly by the local vegetation .This results in stunted growth of the deer and death from starvation in severe winters. A long-range economic problem is the great reduction in tree reproduction as a result of overbrowsing.

At the turn of the century it was inconceivable that the timber wolf was worthy of protection. Today there is a generally held belief that no member of our fauna should be allowed to become extinct if it is practical to save it. The timber wolf once roamed the entire state. Thompson[4] studied the habits of a pack of four wolves in Oneida County and found that it ranged over a territory of 150 square miles. One trapper had pursued this pack over a period of 15 years for the sake of the bounty. The bounty on both wolves and coyotes was withdrawn from July, 1943, to March, 1945, then restored in deference to local public protest. The timber wolf received protection again in 1957 by a closed season but as long as a bounty on coyotes exists it will be impossible to avoid trapping wolves. The present status of the wolf is unknown, but a few are believed to still exist in the state. The range occupied by wolves is virtually void of livestock so that economic damage would be almost nil. A study of the food habits showed deer remains in 97 percent of the scats; however, there was no evidence that the wolves could keep the deer population within desirable bounds. The eradication of wolves on the grounds that they kill deer is thoughtless, as the predation may be a benefit to the deer population where it is too high.

The coyote, morphologically so similar to the timber wolf, is amply capable of holding its own due to its well deserved reputation for cleverness. The unfortunate bounty on the coyote, if continued, will lead to the extermination of its larger brother. In 1945 bounties were paid on 4,134 wolves and coyotes. The number bountied in 1953 dropped to 1,703, but rose to 4,498 adults and 324 cubs in 1960. The total expended on coyote bounties in 1960 was $93,200, a sum that could and should have been expended on worthy conservation projects. The bounty merely removes a surplus population that nature eventually eliminates without a monetary consideration.

Two valuable furbearers, the fisher *(Martes pennanti)* and marten *(Martes americana)*, became extinct about 1920. Their restoration was desirable *per se*. There was also the possibility that if they became sufficiently numerous to permit trapping the returns to the trapper might be sufficient to diminish the pressure for bounties. In 1953, prior to suggesting to the Wisconsin Conservation Department the stocking of marten, I had considerable correspondence with state departments, and private organizations to deter-

[4] D. Q. Thompson. 1952. Travel, range, and food habits of timber wolves in Wisconsin. *Jour. Mam.* 33:429–442.

mine if marten could be obtained at a reasonable price. It finally developed that the state of Montana would provide some of the animals in exchange for eggs of the walleyed pike. The procurement of five marten from Montana and their release on Stockton Island in Lake Superior on November 19, 1953 was performed very efficiently by the Wisconsin Conservation Department that has since made an annual survey of the wildlife of the island. In June, 1956, five pine marten from the state game farm were also released on the island. Dr. William H. Marshall, with others, did live-trapping on the island from September 13 to 18, 1954. One immature marten was caught showing that there had been some breeding from the original stock. Tracks of marten were seen as late as March 18, 1959. It was my suggestion that the marten be released on Stockton Island, an area of 10,560 acres, with the thought that they could breed here unmolested and the surplus trapped and released in a suitable area on the mainland. The project has been far from successful, but seems to illustrate the difficulty in restoring an extirpated species. The area of the island may have been too small, or too few marten were rel eased. Food does not seem to be a problem since even in winter dead deer are available.

In September, 1955, having read of the great increase of the fisher in the state of New York, I suggested to Mr. Cyril Kabat of the Wisconsin Conservation Department, that some fisher be obtained for release in our state. An exchange for quail was made. Two shipments were received on February 28 and March 16, 1956, respectively. The releases consisted of two males and five females. Three additional fisher were received on January 17, 1957. Subsequently 20 fisher were received from the state of Minnesota through the agency of the U. S. Forest Service. All of the animals were released in northwestern Forest County. In 1960 one fisher was trapped accidentally near Crandon, Forest County, and another near Carpenter Lake, northeast of Eagle River, Vilas County. The latter animal was released in April, 1959, near the Nettleton fire tower, hence had traveled 17 miles airline. Since at the present time there is no difficulty in finding tracks of the fisher on and near the release area, there is reason to believe that the transplants will be successful.

The beaver is an excellent example of an animal that can spread and maintain itself with no other aid than protection from overharvesting. A century ago it was extinct in southern Wisconsin, but now is to be found in most of the southwestern counties. During the 1959 season, 11,515 beaver were trapped in 50 of the counties of the state. Crawford and Grant Counties contributed approximately 200 beaver each. It is doubtful if the state ever furnished as many beaver as at present. Indian and white trappers were unrestrained and thought nothing of exterminating a colony. In some areas, due to building dams and flooding lands, the beaver becomes a nuisance and must be removed.

The first known release of the white-tailed jackrabbit *(Lepus townsendii)* in the state was made about 1900.[5] Of 10 releases made prior to 1945 only three resulted in the establishment of new colonies. Lemke[6] traced the history of eight releases made subsequent to 1945 and concluded that additional releases would be useless since this hare had spread into all parts of the state except the extreme northern tip. It is by no means as common as the cottontail and is unlikely to become so. It is at least an addition to our fauna.

A great, tangible achievement of the Wisconsin Conservation Department is the creation and development of waterfowl habitat. Horicon Marsh, Germania Marsh, Pine Island, Meadow Valley Flowage, Wood County Public Hunting and Fishing Grounds, and Crex Meadows, are especially worthy of mention. During the migrations Horicon Marsh draws hundreds of whistling swans and many thousands of geese. It was estimated from an aerial census that at one time in the spring of 1961 there were 100,000 geese at Horicon Marsh and the surrounding area. The marsh has no small aesthetic value for in the fall of 1960 approximately 80,000 people came to see the display of waterfowl. This heartening form of utilization may in the future surpass hunting in importance.

The Wisconsin Conservation Department has been active in attempting to increase the wood duck population. Breeding birds were obtained from the Illinois Conservation Department in exchange for ruffed grouse. The wood ducks were turned over to the Badger State Sportsman's Club, at La Crosse. In 1958 and 1960 this club released 855 wood ducks hatched from eggs laid in captivity. It is too early to determine the results of this program.

The sharp-tailed grouse *(Pedioecetes phasianellus campestris)* was formerly abundant in southern Wisconsin. The oak openings which it inhabited by preference earned for it the name of "bur oak" grouse. This species is far less tolerant of civilization than the prairie chicken so that its range was soon limited to the northern part of the state. The habitat requirement is semi-prairie containing grasses, and many shrubs and open woodlands.[7] Management tools to maintain a suitable habitat comprise spraying with herbicides, bulldozing, and burning. Where feasible burning is the cheapest and most efficient practice. The Wisconsin Conservation Department is managing several areas. Burning has been very successful

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[5] A. Leopold. 1945. The distribution of Wisconsin hares. *Trans. Wis. Acad. Sci.* 37: 1–14.

[6] C. W. Lemke. 1956. White-tailed jackrabbit releases. *Wis. Consv. Dept.* 5 pp. Mimeo.

[7] W. B. Grange. 1950. Wisconsin grouse problems. *Wis. Consv. Dept.* 318 pp.

in the jack pine barrens of Douglas County. Here two or three burnings within a period of three or four years are necessary. Burning releases the seeds from the hard jack pine cones and the young pines that spring up must be destroyed by another burning. Other areas being managed for sharp-tailed grouse are located in the Chequamegon and Nicolet National Forests, the Dorothy Dunn area in the Northern Highland State Forest, Vilas County, the Spread Eagle Area in Florence County, and the Coleman Lake area in Marinette County. There is no immediate prospect that the population of this grouse will become dangerously low.

Disregarding outlying remnants, our prairie chicken *(Tympanuchus cupido americanus)* population is limited to the Buena Vista Marsh, southern Portage County, and the contiguous Leola Marsh in Adams County. The prairie chicken demands large areas of grassland, now very scarce in Wisconsin, of which not over one-fourth is wooded.[8] Vital for survival of the prairie chicken is nesting cover and winter food. An area of 40 acres per section, covered with grass of the proper height, will provide adequate nesting cover. Food patches of standing corn for winter use need be no closer to each other than four miles. The Conservation Department is now managing 5,052 acres of which 3,623 acres are in the Buena Vista Marsh. In addition there are about 5,000 acres in the Soil Bank. This spring the population should begin recovering from the low of the cycle, and if the hatching season is favorable, Mr. F. N. Hamerstrom estimates that the fall population should be 1,000 to 1,500 birds in the two marshes. The full beneficial effects of the management program will not be attainable for several years. There is little doubt but that this species can be retained as a part of our fauna. It is questionable that the population will increase sufficiently to permit an open season, but this is of secondary importance.

Planting of ruffed grouse *(Bonasa umbellus)* particularly on islands, has seldom been successful. Warden William Barnhart stocked some of these grouse on Washington Island in 1900. This grouse, though supposedly present in 1910, eventually disappeared. The state restocked Washington Island in 1956. Madeline Island was also stocked in the years 1954–56. Prior to this time I spent several vacations on the island. None of the inhabitants with whom I talked had ever seen a ruffed grouse on the island. The present status of the species on the two islands is unknown.

The quail is a most difficult bird to manage in Wisconsin. It was incredibly abundant in the period 1845–1854.[9] The most favorable

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[8] F. N. Hamerstrom, O. E. Mattson, and F. Hamerstrom. A guide to prairie chicken management. *Wis. Consv. Dept., Tech. Wildl. Bull.* 15:127 pp.

[9] A. W. Schorger. 1944. The quail in early Wisconsin. *Trans. Wis. Acad. Sci.* 36; 77–103.

factor was a succession of mild winters. It is reasonably certain that at this time there was ample food and cover. In 1854 it was stated that the cultivated portion of Dane County, consisting of about 1,600 farms, comprised only one-eighth of its area. The quail population declined so rapidly that private introductions were begun in 1884 and continued into the early 1900's. Quail were imported from Texas, Louisiana, Tennessee, and Kansas. These plantings were failures. No thought seems to have been given to the unsuitability of southern quail for survival during a Wisconsin winter. The experimental plantings of native birds in recent years by the Wisconsin Conservation Department soon disappeared. Quail released in the Arboretum at Madison in 1950 and in Waukesha County in 1953 and 1955, simply vanished. A planting at Horicon Marsh, Dodge County, in 1950, disappeared within less than a year, while two plantings in Milwaukee County in 1950 and 1952 survived for two years.

The precise requirements for perpetuating quail in an area after it has been stocked are unknown. The two factors, weather and food, are seemingly readily capable of appraisement, yet differences of opinion arise. Errington[10] thought that strong well-fed birds could survive the severest cold. On the other hand, Leopold[11] found that fat, well-fed quail died during the winter of 1935–36. Mortality ranged from 30 to 83 percent. Buss[12] followed the population trends of quail on an area in Dunn County. The greatest loss occurred just prior to the nesting season and was due presumably to predation, though supporting data are lacking. There is general agreement that the greatest need for quail restoration is cover. Between "clean farming" and the fervor for destroying every shrub along the highways, cover has been reduced to a minimum. The recent program for quail management by Kabat and Thompson[13] stresses the necessity of hedgerows. Restoration requires a minimum area of 15,000 acres with one mile of hedgerow for every 550 acres. Management of this magnitude, to be successful, requires the full cooperation of the owners of the farm lands.

Our largest gamebird, the wild turkey, has shown resistance to establishment. It was not common originally except in the wooded hilly areas of southwestern Wisconsin. The extremely severe winter of 1842–43, with its deep, crusted snow reduced the population to a remnant that gradually disappeared. The first attempt at restora-

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[10] P. L. Errington. 1933. The wintering of the Wisconsin bobwhite. *Trans. Wis. Acad. Sci.*, 28:1–35.

[11] A. Leopold. 1937. The effect of the winter of 1935–36 on Wisconsin quail. *Am. Midl. Nat.*, 18:408–416.

[12] I. O. Buss, H. Mattison, and F. M. Kozlik, 1947. The bobwhite quail in Dunn County, Wisconsin. *Wis. Consv. Bull.*, 12(7):6–13.

[13] C. Kabat and D. R. Thompson. 1960. A program for quail and upland game management. *Wis. Consv. Dept., Special Wildl. Rept.* 4:212–253.

tion of which I am aware was made in 1887 when a pair of wild turkeys from the Indian Territory was released in woods at Lake Koshkonong.[14] Crossing with domestic turkeys soon followed so that birds of pure stock never became established. A few turkeys were released by the Wisconsin Conservation Department prior to 1929 but no records were kept of their number. Between 1929 and 1939 there were planted, mainly in Grant and Sauk Counties a total of 2,942 turkeys.[15] Though the best stock of game farm birds available was used, the turkeys refused to become wild and associated with their domestic relatives. An open season in 1939 for bow hunting resulted in the killing of 54 turkeys. It was thought that hunting would remove the least wary birds and render the remainder more wild. Five turkeys from the Sauk County plant appeared in 1937 near Grand Marsh, Adams County, and became permanent residents. The last member mixed with domestic blood, died February 1, 1958.[16]

The project was renewed in 1954. In 1954, 1956, and 1957 a total of 746 game farm turkeys were released in northern Juneau County on the Meadow Valley wildlife management area.[17] The plantings have undergone various vicissitudes. The blackhead disease was introduced in 1937 through the release of infected young raised at the game farm at Poynette. In March, 1959, a blizzard deposited 36 to 45 inches of snow.[18] Some birds died of starvation while the survivors were in poor condition for breeding. On May 7, 1960, seven inches of wet snow fell causing the females to abandon their nests. May and June were exceptionally rainy, wetness being highly injurious to the young that hatched. The desire to restore the wild turkey is understandable. There is no doubt also that the Meadow Valley area was the best available for restoration, as the wild turkey requires a large tract of wilderness with a minimum of human disturbance. The Meadow Valley area was originally a marsh. It has been greatly changed by repeated burnings and the digging of drainage ditches. It is now covered with a growth of trees, jack pine, aspen, oak and other hardwoods. The terrain is by no means ideal for turkeys and the area lies north of their original range. The spread of the turkeys from Juneau County into Adams, Wood, Jackson and Monroe Counties indicates a search for a more suitable habitat. There is a high hunting pressure for deer, within the

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[14] A. W. Schorger. 1942. The wild turkey in early Wisconsin. *Wilson Bull.*, 54:173–182.

[15] F. Hopkins. 1940. The wild turkey problem in Wisconsin. *Wis. Consv. Bull.*, 5(12): 47–48.

[16] A. W. Schorger. 1958. Extirpation of a flock of wild turkeys in Adams County, Wisconsin. *Pass. Pigeon*, 20:170–171.

[17] S. Plis and G. Hartman. 1958. Are the turkeys taking? *Wis. Consv. Bull.*, 23(2): 11–14.

[18] S. Plis. 1960. How are our turkeys doing? *Wis. Consv. Dept.* Ms. 3 pp.

birds' range, which aside from poaching, cannot fail to have a disturbing influence. Long experience in turkey management has shown that the first essential is stocking with completely wild birds. These are difficult to obtain in sufficient number. Game farm birds rarely have the ability to establish themselves. In the long run, therefore, it is unlikely that there will be a successful stocking of the turkey in Wisconsin.

There is always the hope that game birds of foreign origin can be found to fill the areas vacated by native species. The only species that has produced respectable populations is the ring-necked pheasant *(Phasianus colchicus)*. Private introductions of the pheasant in Wisconsin began in 1895 and continued for many years before the species became well established.[19] Little knowledge of the bird was shown when the state planted 50 pheasants near Washburn in the fall of 1897. There was no chance for survival in this locality. Due to the Pabst liberations beginning in 1911, the pheasant became firmly established in the southeastern counties. The state program of raising and liberating pheasants, begun in 1928 and continued without interruption, served to spread them over four-fifths of the state. The peak populations reached in the early 1940's have never been equalled since. This condition is due in part to a steady reduction in suitable cover.

It was once thought that the Hungarian partridge *(Perdix perdix)* would become an abundant bird in the North Central States. Habitat proved to be more subtle than was anticipated with the result that most of the plantings failed. Apparently the summers must not be too warm, the rainfall should be between 15 and 25 inches annually, and the terrain open with rich soil. The first release of this bird was made in 1911 by Gustav Pabst on his farm near Oconomowoc. Based on hunting statistics, a peak was reached in 1939 when 50,478 birds were killed. The kill declined to 2,636 in 1945, a low that was followed by a closed season. The kill was approximately 50,000 birds annually from 1950 through 1954, since which time the population has declined steadily. The data indicate that the species may be cyclic. This partridge continued to increase in Ohio and Indiana until about 1937–40 then declined rapidly. Westerskov[20] concluded that the bird is not cyclic in Ohio. McCabe and Hawkins,[21] in their comprehensive study of the Hungarian partridge in Wisconsin, concluded: "Despite averages, the climographs

[19] A. W. Schorger. 1947. The introduction of pheasants into Wisconsin. *Pass. Pigeon,* 9:101–102.

[20] K. Westerskov. 1956. History and distribution of the Hungarian partridge in Ohio, 1909–1948. *Ohio Jour. Sci.,* 56:65–70.

[21] R. A. McCabe and A. S. Hawkins. 1946. The Hungarian partirdge in Wisconsin. *Am. Midl. Nat.,* 36:1–75.

emphasize the facts that the climate in the north central United States does not conform to the European optimum during the nesting season of the partridge and that severe cold alone is not a limiting factor." It is doubtful if management could effect an increase in the population to any degree commensurate with the cost.

The chukar partridge *(Alectoris graeca chukar)* has refused to become established in spite of numerous plantings. Between 1935 and 1945, 35,285 pen-reared chukars were released in Wisconsin, some in every county. All disappeared within one year after release. Chukars usually disperse widely after release. As a result, too few birds may settle down in any one locality to form a permanent colony. A semiarid, rocky, broken country seems to be essential to the chukar and Wisconsin can not provide a habitat of this kind. In 1950 and 1952 a total of 122 European red-legged partridges *(Alectoris rufa rufa)* were released in Waushara County to determine the length of survival. They vanished within one and one-half years.

A project for stocking the capercaille *(Tetrao urogallus)* and black grouse *(Lyrurus tetrix)* in Wisconsin was initiated by Gardiner Bump of the Fish and Wildlife Service.[22] The capercaille is a large grouse, the males weighing up to twelve pounds. It is a bird of coniferous forests and its food from October to April consists almost entirely of the needles and buds of conifers. The flesh becomes so tainted from this diet as to be unpalatable. Outer Island was selected for release of the birds owing to its isolation and as an apparently suitable habitat. There would be little incentive for emigration since the nearest islands are distant 4.5 miles which is the limit of the flight capability of the capercaille. The stock was obtained from northern Europe. Releases of 26 capercaille and 9 black grouse were made in the fall of 1949, and 4 each of capercaille and black grouse in the spring of 1950. Of the 60 birds purchased only 43 were released, the others having died of disease and accident. The total cost of the project was $7,954.50, or $185 for each bird released. This is not a high figure when we consider that in 1950 it cost a hunter $187 to kill a turkey gobbler in Texas. Prior to release, some predators, raptors and foxes, were eliminated. Two black grouse are known to have been killed by hawks shortly after liberation. A female capercaille, seen in September, 1950, was the last bird observed. Though disease and predation played a part, the main reason for the failure of the plantings remains unknown. The causes of the decline or disappearance of a population remains one of the most baffling problems in wildlife management. Many introductions of the two species into North America have been made

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[22] J. M. Keener. 1955. A study of the introduction, and survival of capercaillie and black grouse. *Wis. Wildl. Res., P. R. Quart. Prog. Repts.*, 14(1):195–204.

and all have ended in failure.[23] A case close to home was the planting of 201 capercaille and black grouse on Grand Island, Lake Superior, in 1904 and 1905 by the Cleveland Cliffs Iron Company. All the birds vanished within a year or two. Hope is eternal, so it should occasion no surprise if, within another generation, the stocking is repeated on the basis that it was not done properly in the first place.

Some members of the Legislature, in a moment of exuberance, decided that since Wisconsin was a prairie state it should have prairie dogs. Some were procured and released in June, 1881 on the grounds surrounding the Capitol. A local newspaper was not long in printing an obituary: "The prairie dogs which the state tried to nurse went up the spout. They wouldn't live."[24] Since the above date several other species have gone "up the spout"; however, in view of the difficulties so frequently encountered, restoration of wildlife in Wisconsin should be judged highly successful.

[23] J. C. Phillips. 1928. Wild birds introduced or transplanted in North America. *U. S. Dept. Agr., Tech. Bull.* 61:64 pp.

[24] Madison *Democrat* June 29, July 20, 1881.

BIONOMICS OF *PODISUS* SPP. ASSOCIATED WITH THE INTRODUCED PINE SAWFLY, *DIPRION SIMILIS* (HTG.), IN WISCONSIN[1]

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The dearth of insect parasites of the larval stages of the introduced pine sawfly, *Diprion similis* (Htg.), is compensated for, in part, by the presence of insect predators, particularly in the family Pentatomidae. It was possible, during studies on the overall effects of biotic factors which help to reduce populations of this forest insect pest, to collect series of predacious pentatomids in the genus *Podisus*. Data on their seasonal history in the plots at Amery, Wisconsin, were accumulated and extensive laboratory studies were undertaken at Madison, Wisconsin, to clarify their biologies. Data were accumulated on four species and one hybrid.

MATERIALS AND METHODS

In the Amery, Wisconsin, area *D. similis* has two distinct but overlapping generations each year. Large collections of sawfly larvae, required for other studies, were made in June and July and again from late August through September to coincide with periods of greatest larval abundance. During these periods, pentatomids of all ages were accumulated in the collections and maintained in the laboratory at Amery. Throughout the field season (May to October) individual pentatomids observed feeding on larvae of *D. similis* were collected and maintained singly in cages.

Collections were made by beating both small white pine trees and the lower branches of large white pine trees with a 10 ft. bamboo pole. The sawfly larvae and pentatomids were collected from a 9 x 9 ft. cotton mat placed under the trees. Another collecting method utilized a circular, 4 ft. diameter, cloth beating sheet mounted on a steel wire loop attached to a 5 ft. handle. A 4 ft. beating stick was used to dislodge the insects from the branches. The latter method was ideal when larval populations were low, when a high degree of maneuverability was desired, or when strong winds were encountered.

[1] Approved for publication by the Director of the Wisconsin Agricultural Experiment Station. This work was supported in part by a grant from the Wisconsin Conservation Department.
[2] Associate Professor and Project Assistant, respectively, Department of Entomology, University of Wisconsin, Madison 6, Wisconsin.

The pentatomids collected with the sawfly larval collections and on which no feeding data were established, were placed in wooden-framed, screen-sided cages (15 x 9 x 9 in. or 7 x 7 x 5.5 in.). The cages were stocked with sawfly larvae to provide food for the predacious species. The predacious species were removed and placed (several males and females of the same species) in cages to obtain mating pairs. Mated pairs were isolated in 4 x 4 x 2.5 in. cages and provided with food, moisture, and oviposition sites. Food consisted of larvae of *D. similis,* moisture was provided by soaking sections of dental wick in water, and oviposition sites consisted of either white pine twigs with needles or strands of excelsior. At the end of the field season all insect material was transferred to Madison.

In the Madison laboratory attempts were made to rear each species throughout the year to provide data on their biology. The mated pairs were transferred to different rearing cages (Figure 1) consisting of one pint ice cream cartons provided with petri-dish covers. Continuous moisture was supplied through a dental wick, stabilized by a glass sleeve. Excelsior was used exclusively in the containers for perching and oviposition sites. Each cage was supported above a water source by a wooden rack constructed to hold four such cages. The racks were set up in series by species (Figure 2). This technique was modified from Scheel, Beck, and Medler (1958).

Larvae and fresh pupae of the greater wax moth, *Galleria mellonella* (L.) were utilized as food. Stock cultures were maintained in the laboratory by a method similar to that described by Beck (1960).

Progeny of mated pairs of pentatomids were reared in the laboratory throughout the year at room temperature (24 ± 7° C.) with no attempt to vary other environmental factors, or to simulate natural conditions such as those required for hibernation. Numerous experiments were undertaken on the effects of low temperature on dormancy and oviposition response, feeding habits etc. and these are treated under the particular species involved.

Seasonal history notes were compiled from field observations. Notes from laboratory studies were accumulated to include data on premating period, mating interval, duration of mating, preoviposition period, number of matings, time from adult to first egg laying, length of life of adult, length of period from egg hatching to adult, number of egg batches, arrangement of eggs, period between egg laying, percentage of eggs hatched, time in days for eggs to hatch and time spent in each instar.

Eggs and nymphal exuviae of each species were measured with a binocular microscope equipped with a calibrated ocular micrometer. Egg measurements were made at the widest and longest points.

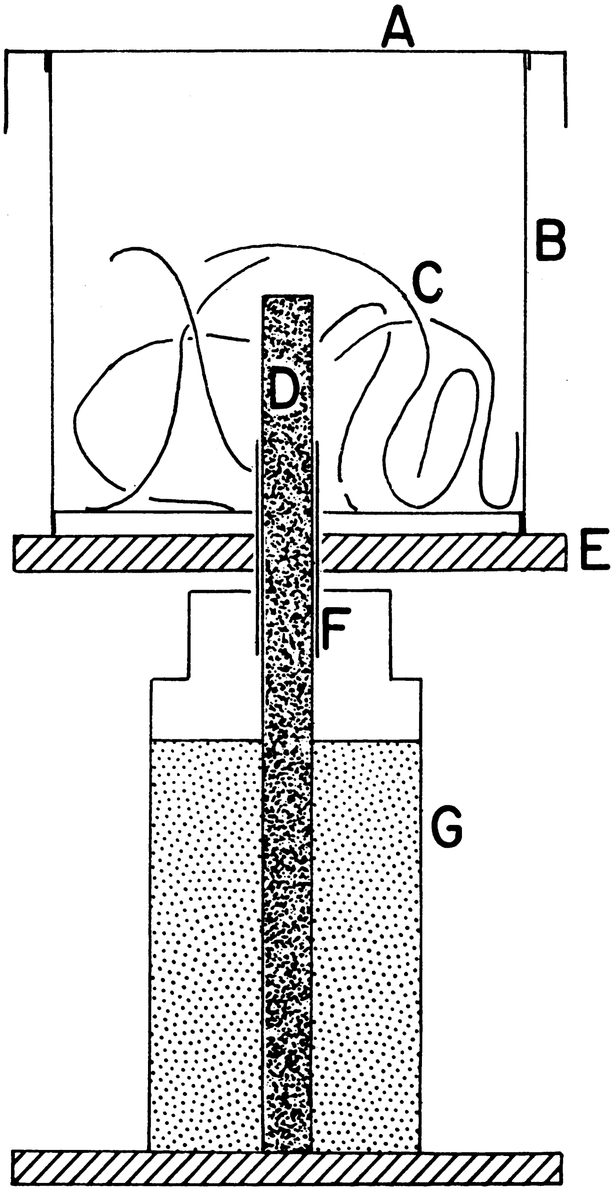

FIGURE 1. Longitudinal section through rearing container. A, petri dish cover; B, 1 pint ice cream carton; C, excelsior; D, dental wick; E, Masonite support; F, glass tubing sleeve; G, 4 oz. jar containing water.

FIGURE 2. Group of rearing containers.

Micropylar processes were measured from their tips to their lowest points of attachment i.e., the bottom outside edge of the process where it becomes confluent with the egg shell. Head width measurements from exuviae were made between the annular sclerites along the mesodorsal margins of the eyes (Figure 10).

Illustrations were made of the eggs and their characteristic structures. To facilitate study of the pseudoperculum, micropylar processes, and egg-bursters, excised sections were placed on slides and examined with a binocular microscope at 160X. To retain the sections on a slide, a strip of transparent mending tape (Scotch Brand Magic Mending Tape No. 810, Minnesota Mining and Manufacturing Co., St. Paul, Minnesota) used as a mounting medium, was inverted on a slide and held at each end with short strips of masking tape. Use of the tape for mounting egg segments was efficient as both transmitted and incident light could be used for examining the sections under the microscope.

Adult insects, at death, were pinned and later identified by P. Ashlock and R. Froeschner of the Insect Identification and Parasite Introduction Research Branch, Entomology Research Division, United States Department of Agriculture, Beltsville, Maryland, and L. A. Kelton, Taxonomy Section, Entomology Research Institute, Canada Department of Agriculture, Ottawa, Canada.

All data were treated with standard statistical procedures (Snedecor and Cochran 1959).

Results and Discussion

The field collected *Podisus* spp. were separated arbitrarily into groups by gross external characteristics and reared as five separate entities before being authoritatively identified as *Podisus maculiventris* (Say), *P. serieventris* Uhl., *P. placidus* Uhl. and *P. modestus* Uhl. A fifth group derived from a mating of a female *P. maculiventris* and a male *P. serieventris* was intermediate between the two and with characters of both.

The most common species in collections made in the summer of 1960 was *P. maculiventris,* whereas the following summer *P. placidus* was more prevalent. Collected in lesser numbers during both summers were *P. serieventris* and *P. modestus* in that order.

Data accumulated during the 1960–1962 laboratory rearings of *Podisus* spp. have been placed in tabular form (Tables 1–5) or are included in the text.

Podisus serieventris Uhl.

Field collections of *P. serieventris* indicate that this species has a single generation each year. It overwinters as a hibernating adult, but can be found in collections most commonly from late July through early September. Nymphs in the third instar were collected on July 22, the earliest collection date in 1960. Fifth stage nymphs were found four days later. The first field record for an adult in 1960 was August 15, compared to a 1961 record of nearly three weeks earlier on July 20. The extended period of three weeks in 1960 between first observing a fifth stage nymph and the first sighting of an adult can be accounted for by irregular collection dates for *Podisus* spp. An adult female was collected from white pine foliage as late as October 24, 1961.

According to Prebble (1933) the majority of adults in Nova Scotia, Canada, are blackish-grey in color with some greyish-brown. All specimens taken in the present study show the former color. From the rearings, which have been carried through the third generation, no color variants were observed. In some instances, after specimens were dead and pinned for some time, the greyish-cast was replaced by a brownish one along with a somewhat oily appearance.

The adults cannot be sexed by size, although the females are usually larger than the males (Table 1). The humeral width of the pronotum was measured with a vernier caliper and corresponds closely with measurements taken by Prebble (1933).

The data on adult longevity (Table 2A) were accumulated from those records which associated specific adults with dates. From the limited data available on longevity differences between the sexes,

TABLE 1. HUMERAL WIDTH OF PODISUS SPP. ADULTS

SPECIES	SEX	N	RANGE (MM.)	MEAN ± S. E.
P. serieventris	♂	20	4.9–6.0	5.35 ± .02
data ex Prebble (1933)	♂	11	4.6–5.5	5.0
P. serieventris	♀	25	5.1–6.7	5.79 ± .21
data ex Prebble (1933)	♀	10	4.9–6.3	5.7
P. placidus	♂	19	4.2–5.3	4.54 ± .26
P. placidus	♀	25	5.0–5.9	5.14 ± .22
P. modestus	♂	22	4.4–5.4	4.88 ± .49
P. modestus	♀	18	4.9–5.7	5.4 ± .57
P. maculiventris	♂	22	5.3–7.0	6.17 ± .11
P. maculiventris	♀	30	5.7–7.8	7.01 ± .11
P. hybrid	♂	26	4.9–6.2	5.72 ± .06
P. hybrid	♀	27	5.5–7.1	6.25 ± .08

TABLE 2. BIONOMIC CHARACTERS OF PODISUS SPP.

2A	Longevity of Adult *Podisus* spp.					
	Species:	*serieventris*	*placidus*	*modestus*	*maculiventris*	*P.* hybrid
	N:	19	30	25	2	13
	Range (days):	53–488	70–320	69–413	230–243	133–329
	Mean ± S.E.:	206.6 ± 23.58	201.6 ± 11.52	178.4 ± 15.18	236	199.2 ± 16.49
2B	Preoviposition Periods of Adult *Podisus* spp.					
	Species:	*serieventris*	*placidus*	*modestus*	*maculiventris*	*P.* hybrid
	N:	13	4	2	19	4
	Range (days):	1–13	11–28	3–6	2–11	7–57
	Mean ± S.E.:	5.5 ± 1.06	19.2	4.5	5.8 ± 1.43	30.0
2C	Periods Between Egg Laying of *Podisus* spp.					
	Species:	*serieventris*	*placidus*	*modestus*	*maculiventris*	*P.* hybrid
	N:	21	25	24	91	19
	Range (days):	1–22	1–17	1–40	1–7	1–12
	Mean ± S.E.:	5.2 ± 1.02	6.2 ± .79	8.1 ± 2.14	2.6 ± .15	5.1 ± .25
2D	Number of *Podisus* spp. Eggs per Batch					
	Species:	*serieventris*	*placidus*	*modestus*	*maculiventris*	*P.* hybrid
	N:	128	31	40	103	74
	Range (Eggs):	3–49	8–60	3–54	1–47	4–38
	Mean ± S.E.:	15.9 ± .78	26.9 ± 2.33	14.8 ± 1.45	19.6 ± .95	18.5 ± 1.02
2E	Number of Days for *Podisus* spp. Eggs to Hatch					
	Species:	*serieventris*	*placidus*	*modestus*	*maculiventris*	*P.* hybrid
	N:	28	17	7	17	14
	Range (days):	2–9	6–9	4–8	7–12	4–8
	Mean ± S.E.:	6.3 ± .33	6.8 ± .20	6.6 ± .37	9.6 ± .41	6.5 ± .39

the females with a mean length of life of 241 days are longer-lived than the males, by approximately 50 days. The length of life varied from 88 to 488 days for the females and 53 to 325 days for the males. For *P. serieventris* to complete its life cycle of one generation per year, the adult should have a longevity period of approximately 320 days. It is probable that the higher longevity values recorded in the laboratory rearing are more realistic and indicative of field conditions than those less than 320 days.

Longevity records do not indicate actual field conditions, since the records are from rearings at room temperature and do not take into account any period of overwintering in a dormant stage. Except for teneral specimens, field collected adults cannot be aged. A few of the shorter longevity periods may be from adults which had overwintered the previous year.

In the laboratory, the premating period, or the time spent as an adult before the first mating, was recorded on two occasions as 21 and 40 days. This was from late February to early April. The mating interval or time between matings varied from 3 to 81 days, with an average of 32 days, based on five observations. This average is disproportionately high as the 3 low periods of 3, 7, and 10 days are offset by two relatively high intervals of 59 and 81 days. As in other observations of this type, discrepancies are bound to occur, since observations have been limited to infrequent intervals during the normal work day.

Three isolated pairs of *P. serieventris* mated more than once. One pair mated three times between March 30 and May 4, another pair mated four times from March 31 to April 20 and a more sexually active pair mated six times, on November 11, 14, February 3, and April 3, 13, and 20.

The duration of mating was noted on four occasions as 5, 6.5, 7 and 8.5 hours. It is probable that the average mating period is 7 hours or more.

In two cases, unmated females reared from their immature stages deposited eggs 10 and 69 days after becoming adults. In addition, a fifth stage nymph collected on July 26 was reared in isolation and moulted to an adult female on August 3. This female deposited the first batch of eggs 12 days later on August 15 and the second batch of eggs 34 days later on September 6. The eggs were infertile and did not hatch. The adult lived for at least another five months when its identity was lost after it was incorporated with another rearing lot.

During the last three weeks of January, 1961, an experiment was undertaken to determine whether a short exposure to cool temperatures would stimulate mating and egg laying. It was apparent in the laboratory that a dormant period existed in the early winter when activity, mating, and egg laying was at a minimum even though the adults were held at room temperature of about 23 to 27° C. One group of adults was held at 4.4° C. for three weeks while a comparable group were maintained at room temperature. Those held at room temperature were sexually active and either mated or laid eggs at 8, 23, 78 and 80 days after beginning the test. Those adults exposed to cold required 51, 55 and 58 days for either mating or egg laying to occur after being returned to room temperature. Exposure to 4.4° C. at this period retarded the sexual development of the adults and consequently was ineffective in increasing the number of laboratory reared generations.

The preoviposition period (from first mating to first oviposition) (Table 2B), recorded from 14 occurrences, varied from 1 to 13 days with one exception; a period of 72 days elapsed between an observed mating and when the first eggs were laid. This latter extreme value was excluded from the statistics in Table 2B.

Similarly, as with the preoviposition data, the periods between egg laying (Table 2C) were marked by one high value of 22 days, the remaining 20 observations falling between 1 and 11 days. If the high value was excluded the mean or average period between egg laying would be 4.4 days instead of the 5.2 days shown.

The eggs of *P. serieventris* (Figure 3) are characteristic of the genus *Podisus* although each species has individual differences as noted in the accompanying key. Eggs are .86 ± S. E. .004 mm. in width and 1.10 ± S. E. .006 mm. in length (Table 5). The micropylar processes (chorionic processes of Esselbaugh 1946) range from 9–13 in number and are .22 to .25 mm. in length, or approximately one fifth the length of the egg.

The micropylar processes (Figure 8) consist of a "central canal" for sperm passage surrounded by a porous protein, the "air sponge", which allows gaseous exchange (Southwood 1956). They are closely appressed to the pseudoperculum until the egg is extruded from the oviduct when they recurve and dry to assume their final positions (Figure 8).

The pseudoperculum, as defined by Southwood (1956), is the type of egg cap occurring in the Pentatomidae, and is differentiated from a true operculum in that it is essentially the same structure as the rest of the chorion. It bears no fixed relationship to the micropylar processes and lacks a distinct sealing bar.

The egg burster (Figure 9) is well developed in the genus *Podisus,* but does not have species characteristics. Its function in hatching has been described and documented by Southwood (1956) with an extensive list of references as have the other structures and processes associated with eggs of the terrestrial Heteroptera.

Usually attached to the egg burster and associated with it is a thin membrane, the embryonic cuticle of the first nymphal instar (Southwood 1956). It would appear from the relative position of this cuticle or exuvium and the egg burster that the latter mechanically assists the shedding of this "first" exuvium by the soft nymph.

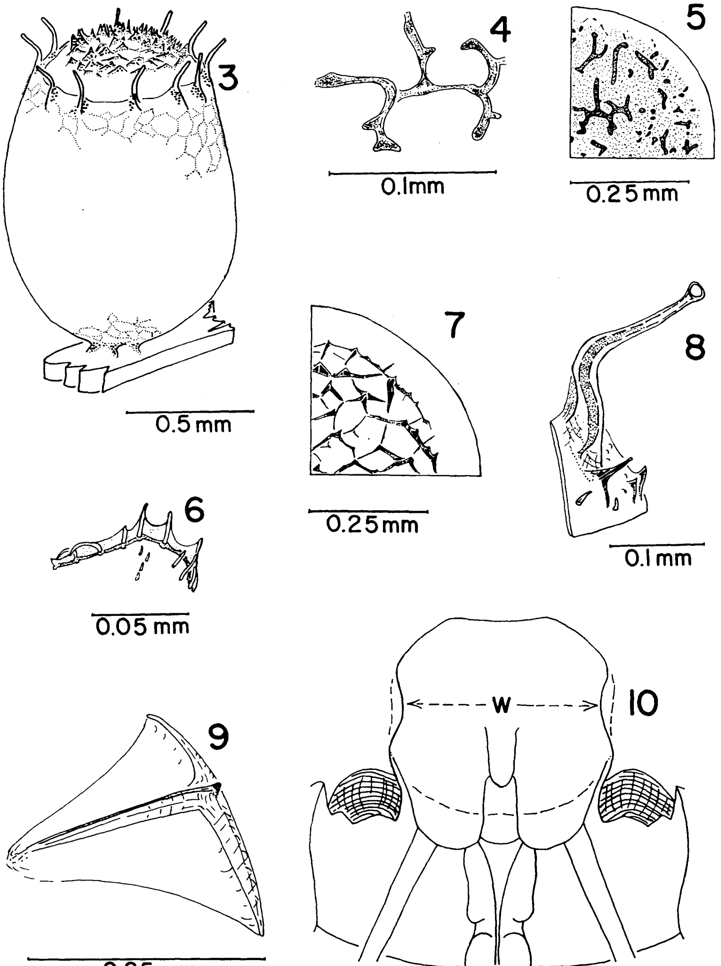

FIGURE 3. *P. serieventris* Uhl. egg; FIGURE 4. *P. placidus* Uhl., Chorionic ornamentation; FIGURE 5. *P. placidus* Uhl., section of pseudoperculum; FIGURE 6. *P. serieventris* Uhl., Chorionic spines draped with serous mantle; FIGURE 7. *P. serieventris* Uhl., section of pseudoperculum; FIGURE 8. *P. serieventris* Uhl., micropylar processes; FIGURE 9. *P. modestus* Uhl., egg burster; FIGURE 10. *Podisus* sp., diagrammatic view of third instar head capsule showing location of head capsule measurement (W).

The chorion of *P. serieventris* is armed with minute spines (Figure 6) which provide some semblance of a pattern (Figure 7). The chorial spines do not cover the entire surface of the eggs in any one egg batch, and as noted by Esselbaugh (1946) they may be longer on the central portion of the pseudoperculum and on the upper half of the side walls. A serous mantle which envelopes the egg (Couturier 1935) is a noticeable feature where it becomes draped over the spines (Figure 6).

The maximum number of eggs recorded from one female of *P. serieventris* was 162 eggs deposited in 10 batches. In two other instances 82 and 104 eggs were each laid in a total of 5 batches. One female was observed depositing eggs on a cage cover. Eight eggs had already been laid when oviposition was first noted. Seventeen eggs, or those from the 9th to the 25th inclusive were deposited in 42.5 minutes. Ten eggs were laid in the first 22 minutes of watching. The last 7 eggs laid were placed on the glass in 20.5 minutes.

When an unrestricted area for egg laying was used, there was no pattern to egg placement. In 128 egg batches of *P. serieventris,* the mean number of eggs per batch was 15.9 $\pm$ S. E. .78 with a range of 3 to 49 (Table 2D). The eggs laid on excelsior were usually in a linear arrangement, though occasionally they were deposited in circular masses. In 21 egg groups examined on excelsior, eggs were in rows of 2 and 3 with frequencies of 8 and 13 respectively.

There appeared to be a pattern to the egg laying interval as shown by the following consecutive times of 4, 3.5, 3.5, 3, 2.5 and 4 minutes. Whether this is indicative of a more general rhythm is not known.

As noted by Prebble (1933), the hatching of an egg mass of *P. serieventris* is characterized by its simultaneity. He suggested that those eggs which failed to hatch and which had collapsed chorions were probably not fertile. In eggs examined in the present study, additional causes of chorion collapse may have been either through dessication of the contents or predation. In six egg batches on which no predation was observed, there were three instances of 100% hatch and three with 83 to 93% hatch. Hatching of *P. servientris* eggs took place after 2 to 9 days incubation with a mean of 6.3 $\pm$ S. E. .33 days (Table 2E). That hatching could occur in less than four days incubation is extremely doubtful, so that those observations below four days should possibly be regarded as observational errors. Under present rearing conditions, eggs are more commonly laid on the undersurface of excelsior than on top and for this reason may be missed for several days.

All nymphs of *P. serieventris* fed equally well on *G. mellonella* pupae or on *D. similis* larvae, the only food supplied. Wax moth larvae were not used extensively as host material because they deteriorated too rapidly if killed, and if not immobilized their silk-spinning habits created additional problems in rearing. If the nymphs and adults of *Podisus* are not supplied with sufficient food, cannibalism will occur.

First instar nymphs normally are gregarious and group together on the eggs from which they hatched for at least the first 24 hours. After this initial period they will move as a unit but remain close to their egg mass until after the first moult, or for at least the first 48 or 72 hours. When two or more egg batches from the same parents were included in one rearing container the newly emerged sibling nymphs of each egg group remained clustered together and did not intermingle until after the second nymphal stage was reached. If simultaneous hatching from an egg batch did not occur the first instar nymphs sometimes fed on the unhatched eggs as also noted by Prebble (1933). This phenomenon appeared of relatively common occurrence. Whether the nymphs were using the host material primarily as a source of moisture rather than food is not known, although nymphs supplied only with moisture survived. First instar nymphs when feeding on an unhatched egg have their proboscis extended forward in the normal manner of predacious Pentatomids. In one case the proboscis sheath was rolled back with an insect pin with the result that the stylets could be seen entering the egg. To corroborate that the stylets actually entered the egg was determined by their relative position to the sheath. Considering that the stylets formed the hypotenuse of a right angle triangle, and the sheath the other two sides then the stylets would project past the apex of the triangle and hence have enough length, unprotected by the sheath, to enter the egg (Baker, 1927a).

After eclosion, nymphs pass through five instars or stages before becoming adults in approximately 28 days (Table 3). When the days spent in each instar are compared with the head capsule development (Table 4) the results can be shown graphically as nymphal growth in terms of instar progression (Figure 11). Here, the average number of days spent in each instar is accumulated on the abscissa while the ordinate shows the average head capsule width for each instar. The distance between each instar number on the ordinate represents one millimeter. Using a separate base line originating at each instar number the average head capsule measurements were plotted directly.

The growth ratio (Table 4) is the average head width of one instar divided by the average head width of the previous instar. The predicted head width range for a given instar was calculated by multiplying the growth ratio observed by the observed head width range of the previous instar. This is a slightly different method than that employed by Prebble (1933) who calculated an average ratio of increase from all instars. There were close agreements between the observed and expected head widths indicating the growth ratios were uniform and that five instars was a true figure. The calculated growth ratios compared favorably with those presented by Prebble (1933) of 1.257, 1.323, 1.296 and 1.230 respectively. The differences in growth ratios between similar stages varied from less than 1 to 2.8 per cent.

The nymphal instars of *P. serieventris* have been described and illustrated by Prebble (1933). A frequency histogram of head capsule widths of nymphs of *P. serieventris* (Figure 12) clearly shows no overlapping between the five stages. Possible confusion was avoided in setting off the limits for each instar as measurements were made from exuviae of known instars, thus each measurement could be associated with a definite stage of the insect.

TABLE 3. NYMPHAL DEVELOPMENT OF PODISUS SPP.

	INSTARS				
P. serieventris	1	2	3	4	5
N	35	34	30	30	29
Range (days)	3–8	3–7	3–7	3–9	6–16
Mean ± S.E.	5.5 ± .19	4.7 ± .18	4.2 ± .18	4.7 ± .23	9.0 ± .41
Acc. Age in Days	5.5	10.2	14.4	19.1	28.1
P. placidus					
N	9	11	7	11	11
Range (days)	5–8	5–7	3–6	4–9	7–11
Mean ± S.E.	6.1 ± .39	6.2 ± .23	4.3 ± .13	5.7 ± .41	9.4 ± .12
Acc. Age in Days	6.1	12.3	16.6	22.3	31.7
P. modestus					
N	11	11	13	10	9
Range (days)	3–5	3–6	3–5	4–6	6–9
Mean ± S.E.	3.9 ± .25	4.1 ± .32	3.9 ± .22	5.0 ± .21	7.6 ± .29
Acc. Age in Days	3.9	8.0	11.9	16.9	24.5
P. maculiventris					
N	8	9	8	8	8
Range (days)	4–6	4–7	3–5	4–5	6–9
Mean ± S.E.	4.5 ± .27	5.0 ± .41	4.0 ± .19	4.4 ± .18	7.5 ± .38
Acc. Age in Days	4.5	9.5	13.5	17.9	25.4
P. hybrid					
N	16	20	17	16	14
Range (days)	4–7	3–7	3–5	4–6	4–10
Mean ± S.E.	4.9 ± .26	4.7 ± .20	3.9 ± .18	4.3 ± .14	7.5 ± .37
Acc. Age in Days	4.9	9.6	13.5	17.8	25.3

TABLE 4. HEAD CAPSULE DATA OF PODISUS SPP. NYMPHS

	Instars				
P. serieventris	1	2	3	4	5
N:	126	115	112	96	80
Head with range: (obs.)	.40–.52	.54–.64	.68–.85	.88–1.05	1.07–1.30
Mean ± S.E.:	.46 ± .002	.59 ± .002	.77 ± .003	.97 ± .004	1.18 ± .005
Growth Ratio:	....	1.279	1.304	1.261	1.219
Head with range: (pred.)	....	.51–.66	.70–.83	.86–1.07	1.07–1.28
P. placidus					
N:	13	17	28	22	22
Head width range: (obs.)	.40–.47	.50–.57	.62–.75	.78–.95	.91–1.10
Mean ± S.E.:	.43 ± .006	.54 ± .005	.68 ± .007	.87 ± .009	1.03 ± .011
Growth Ratio:	....	1.251	1.258	1.271	1.185
Head width range: (pred.)	....	.50–.59	.63–.72	.79–.95	.92–1.13
P. modestus					
N:	65	63	49	42	34
Head width range: (obs.)	.39–.47	.48–.57	.62–.75	.78–.91	.95–1.10
Mean ± S.E.:	.44 ± .002	.53 ± .002	.68 ± .004	.86 ± .005	1.04 ± .007
Growth ratio:	....	1.213	1.284	1.268	1.204
Head width range: (pred.)	....	.47–.57	.62–.73	.79–.95	.94–1.10
P. maculiventris					
N:	54	40	47	44	31
Head width range: (obs.)	.39–.50	.53–.60	.70–.80	.95–1.03	1.15–1.25
Mean ± S.E.:	44. ± .003	.56 ± .003	.76 ± .004	.98 ± .004	1.21 ± .005
Growth ratio:	....	1.282	1.341	1.303	1.232
Head width range: (pred.)	....	.50–.64	.71–.80	.91–1.04	1.17–1.27
P. hybrid					
N:	31	32	26	28	25
Head width range: (obs.)	.40–.50	.52–.63	.70–.83	.94–1.08	1.13–1.33
Mean ± S.E.:	.46 ± .005	.59 ± .003	.78 ± .005	1.01 ± .007	1.24 ± .010
Growth ratio:	....	1.275	1.316	1.302	1.230
Head width range: (pred.)	....	.51–.64	.68–.83	.91–1.08	1.16–1.33

The presence of more than one peak in the histogram for each instar cannot be assessed but it is presumed that there may be a sex difference as noted by Prebble (1933). As there is a size difference between the sexes in the adult stage (Table 1), it is expected that this would be indicated also in the nymphal measurements. Insufficient individual rearings and differentiation as to sex did not allow testing this point.

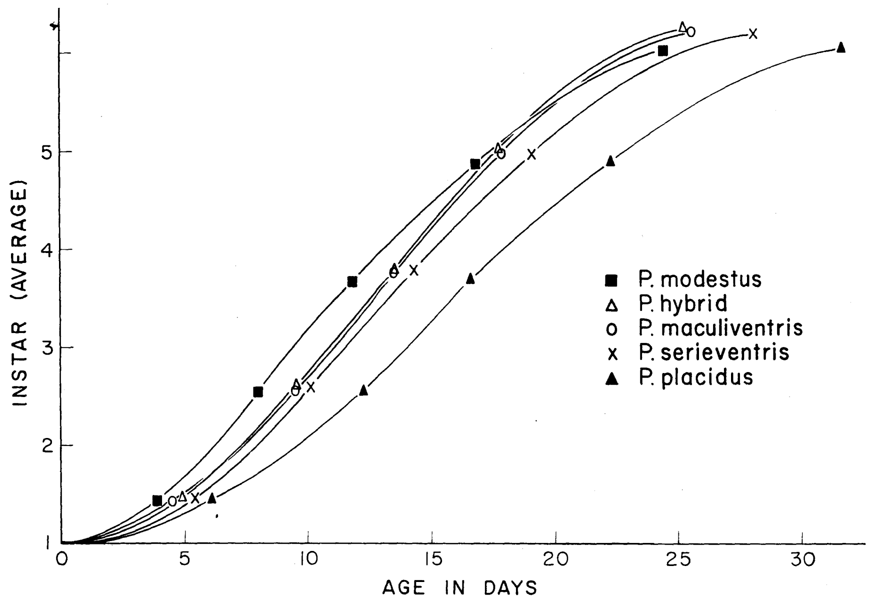

FIGURE 11. Nymphal growth of *Podisus* spp. in terms of instar progression.

Podisus placidus Uhl.

The seasonal history of *P. placidus* Uhl. was determined from the field collections made in both 1960 and 1961. In 1960, the first specimen, a second instar nymph, was collected on June 28, followed two days later by collections of third stage nymphs. Fourth stage nymphs were taken July 18 and 22. Apparently eggs hatch the middle of June through July, as a first stage nymph was also taken July 27. Adults were collected July 20, September 5 and 6, 1960. The following spring on June 16 a pair of adults in copulation were taken. Immatures were collected on only two days in 1961; a third stage nymph on July 19 and a fifth stage on August 23. Besides the pair of adults in copulation, adults in numbers were taken August 23 and October 3. The latter date is the latest this species has been collected in the Amery, Wisconsin area. *P. placidus* has a single generation each year. Kirkland (1897), studying the predators of gypsy moth, considered this species had two and sometimes three broods in a season, although his interpretation of the term brood is not clear.

P. placidus resembles *P. serieventris* but can be separated from the latter by two main characters (Van Duzee 1904). The humeri are obtuse and almost rounded in *P. placidus* compared to the more acute humeri of *P. serieventris*. *P. placidus* has an immaculate membrane whereas *P. serieventris* has a longitudinal dusky vitta on the

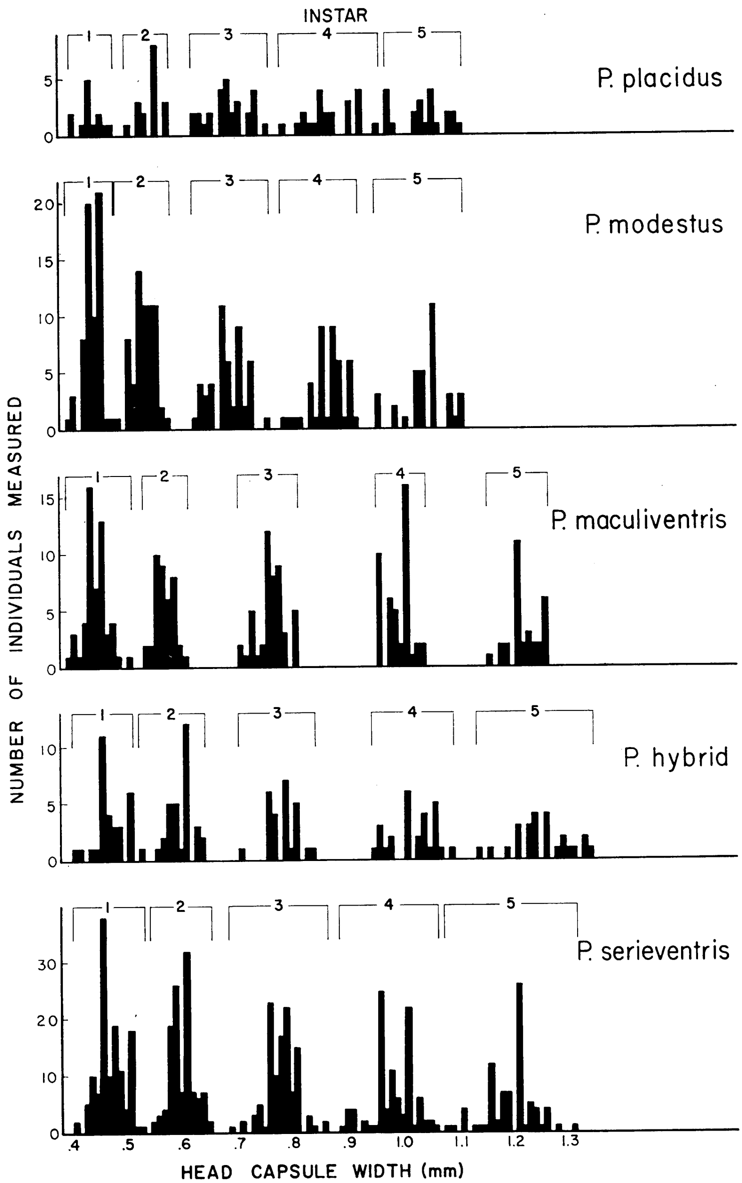

FIGURE 12. Frequency histogram of head capsule width of nymphs of *Podisus* spp.

membrane. Adult *P. placidus* are brown rather than the blackish-grey exhibited in *P. serieventris*. The humeral width of the pronotum was measured in a series of adult *P. placidus*. In both sexes, *P. placidus* averaged .7 mm less in mean width than *P. serieventris* (Table 1).

Longevity records (Table 2A) are incomplete but from the data presently accumulated the mean length of life of laboratory reared adults, sex ignored, is 201.6 $\pm$ S. E. 11.6 days, and for the males and females it is 212 and 216 days respectively. These values are low but not unreasonably so compared with the other species reared in the laboratory.

The premating period for *P. placidus* is not definitely known. One group of field collected immature *P. placidus* was reared through to the adult stage, but the actual date of becoming adults is not known and had to be interpolated. The immatures were collected June 28, 1960, as second stage nymphs. An average development time of 20 days can be assumed (Table 3) as the required time to reach the adult stage. Adults should therefore have been present on July 18. Mating by one pair was first observed on August 1 to give a premating period of 14 days. Subsequently this particular pair mated again on August 5 and 16 followed by the deposition of eggs on August 19.

The mating interval of *P. placidus* as determined from rearing records has varied, with one exception, from 1 to 22 days. The mean mating interval, excluding one long interval of 38 days, was 2.1 $\pm$ S. E. .25 (129) days with confidence limits at the 95% level of 1.6 to 2.6 days. One pair of adults exhibited an unusual behavior pattern by initiating mating on consecutive afternoons, about 4:00 p.m., then mating for periods of 4.5 to 9.5 hours. Mating on the fifth day was followed by egg deposition. This pattern occurred twice. The pair, whose record is cited above, mated an additional 32 times at approximately the same time each day and usually at one day intervals.

The duration of mating was established from 49 records in which the inception and completion of mating was known within a range of 1 to 2 hours. The mean period of mating was 6.7 $\pm$ S. E. .3 hours with 95% confidence limits of 6.1 to 7.3 hours.

The preoviposition period for *P. placidus* is an approximation only, developed from the rearing records of a few individuals. The tentative range for this period is 3 to 28 days, with an average of 14.5.

Data were accumulated on number of matings from five pairs of *P. placidus*. Records have not been completed on two pairs of adults which to date have mated 8 and 14 times from February 12 to March 20, 1962 and March 5 to March 25, 1962, respectively. Previous rearings of three isolated pairs showed matings occurring 3, 3, and 6 times. All of these matings took place in 2 to 3 weeks.

The periods between egg laying for *P. placidus* are of nearly the same duration as for *P. serieventris*. There did not appear to be any radical differences in the intervals at various times of the year in the laboratory reared material. Based on 25 observations involving seven females, two of which had single records only, the mean period between egg laying was calculated as 6.2 ± S. E. .79 days with confidence limits at the 95% level of 4.6 to 7.8 days (Table 2C).

The eggs of *P. placidus* are smaller and squatter than those of *P. serieventris* (Table 5). The mean width and length of the eggs is .81 ± S. E. .004 and .97 ± S. E. .006 mm, respectively. The micropylar processes range in number from 9 to 12, with a mean of 10.28 ± S. E. .17 just subequal to the mean of 10.32 ± S. E. .17 for *P. serieventris*. The processes which range in length from .26 to .32 mm are the longest of the *Podisus* spp. studied (Table 5). The chorion of the eggs of *P. placidus* have a serous mantle, somewhat similar to *P. serieventris,* but the ornamentation appears more convex (Figures 4 and 5) because the eggs of *P. placidus* lack the sharp ridges of spines from which the mantle is draped as in *P. serieventris.*

TABLE 5. EGG CHARACTERS OF PODISUS SPP.

	serieventris	*placidus*	*modestus*	*maculiventris*	*P.* hybrid
N. (Eggs measured):	74	56	29	30	20
Width Range (mm.):	.80–.97	.75–.88	.75–.93	.75–.88	.78–.95
Mean ± S.E.:	.86 ± .004	.81 ± .004	.84 ± .009	.82 ± .006	.86 ± .011
Length Range (mm.):	1.00–1.20	.90–1.08	.85–1.00	.90–1.01	.90–1.12
Mean ± S.E.:	1.10 ± .006	.97 ± .006	.90 ± .006	.95 ± .006	1.02 ± .015
Ratio width/length:	.782	.835	.933	.863	.843
Micropylar Processes:					
N. (eggs counted):	37	27	60	41	69
Range (no. per egg):	9–13	9–12	10–13	11–15	11–15
Mean ± S.E.:	10.32 ± .17	10.28 ± .17	11.68 ± .12	13.78 ± .16	12.77 ± .11
Micropylar process Length, Range Approx. (mm.):	.22–.25	.26–.32	.20–.25	.25–.28	.24–.28

In 31 egg batches of *P. placidus,* the mean number of eggs per batch was 26.9 ± S. E. 2.33, with an observed range of 8 to 60 eggs (Table 2D). The arrangement of the eggs was normally linear and in 2 or 3 rows. Very infrequently a batch of eggs was laid in a circular pattern 5 to 6 eggs in diameter.

The maximum number of eggs recorded from one *P. placidus* was 362 in 14 batches from March 7 to April 23, 1962. The adult involved is still living and may deposit more eggs. Four other adults laid totals of 104, 204, 260, and 335 eggs. One female laid six eggs in 16 minutes which is approximately the same rate as that observed for *P. serieventris*. During egg deposition, six seconds are required from when the egg is first observed leaving the oviduct, to the final movement away from the egg by the adult.

After deposition, eggs required 6 to 9 days to develop before hatching occurred. The mean number of days for hatching as observed in 17 egg masses, was 6.8 ± S. E. .2 days (Table 2E). Normally, 87.5 to 100 per cent of the eggs in a batch hatched.

Similar to the other *Podisus* spp. studied, *P. placidus* passed through five instars before becoming an adult 31.7 days after hatching. *P. placidus* had a longer developmental period in each instar than *P. serieventris* (Table 3). As with *P. serieventris* the days spent in each instar (Table 3) are compared with the head capsule development (Table 4) and the results are shown graphically as nymphal growth in terms of instar progression (Figure 11).

The predicted head width ranges (Table 4) showed a generally close agreement with the measured head width ranges from which they were calculated by use of the growth ratio, as explained under *P. serieventris.* The only overlapping in head widths between instars occurred with one individual, when a known fifth instar nymph showed a head capsule width of .91 mm. Although the overlapping is shown in Table 4, the singular measurement was eliminated from the data for the frequency histogram of head capsule widths (Figure 12). This was the only case of overlapping in all the *Podisus* spp. studied.

Podisus modestus Uhl.

Field collections of adult *P. modestus* Uhl. from white pine trees were made from June to October. The composite data from 1960 and 1961 signified one generation per year. In 1961, adults were taken June 9 and 16, the earliest records for this species. These were most likely overwintering adults, as eggs and immature stages were not collected until the first two weeks of July. In 1960, the first adult was taken July 18, with other adults collected from August 6 to September 5. The latest collection dates were recorded in 1961 when male and female adults were collected October 3 and a female on October 9.

P. modestus is separated from the other *Podisus* spp. in this study on the basis of shape of humeri and overall size (Table 1). The humeri are more acute than in *P. placidus* but lack the spines of *P. maculiventris. P. modestus* is smaller in size than *P. serieventris. P. modestus* resembles *P. placidus* most closely in size, both in width of humeri (Table 1) and in head capsule width (Table 4).

The mean length of life for an adult *P. modestus* was 178 days (Table 2A). The premating period recorded from rearings in the fall, late winter, and spring varied from 14 to 53 days. A short period of 14 days occurred in mid-August, the longest, of 53 days was in the winter from December 13 to February 3, and two spring occurrences lasted 44 and 47 days, from March 19 to May 2 and May 5, respectively. Only one consecutive mating by a pair of *P. modestus* was noted. The second mating took place 85 days after the first mating on August 24. The duration of mating was known from seven matings and lasted from 3 to 9 hours or an average of 6.4. The data from which a preoviposition period could be calculated were inadequate, but periods of three and six days were noted for two adults. The period from when adults were first present to the first egg laying varied from 56 days in the spring to 106 and 207 days through the winter. These are laboratory records and would, of course, not apply to field conditions. From 24 observations, the mean period between egg laying was approximately 8 days (Table 2C). It should be noted that the standard error is large, relative to the mean, in both *P. modestus* and *P. serieventris*.

The eggs of *P. modestus* are the most globular of the species studied, the width to length ratio most nearly approaching one (Table 5). The eggs are the shortest of those *Podisus* spp. measured but are of medium width. The mean number of micropylar processes is 11.68 $\pm$ S. E. .12 (Table 5), which is close to the group mean of 11.76. The processes range in length from .20 to .25 mm., the shortest group measured. There are no prominent spines on the chorion of the egg, thus they appear devoid of vestiture, even though covered by a serous mantle. The mean number of eggs in 40 batches counted was 14.8 $\pm$ S. E. 1.45 eggs with an observed range of 3 to 49. (Table 2D). The egg masses obtained were arranged in 2 to 4 rows with an occasional, roughly circular grouping, 4 to 5 eggs in diameter. One adult deposited 16 egg batches, totalling 235 eggs between June 12 and August 1. This was the largest number of eggs recorded from one individual. Two other females laid only 49 and 55 eggs each with the 49 laid in four batches during a period of 16 days. Eggs of *P. modestus* hatched approximately 6.5 days after deposition (Table 2E). Although records were available from only seven egg batches, the mean and calculated range compared favorably with the other species of *Podisus* studied. In general, all of the eggs hatched in each batch, though in some, hatch was as low as 60 per cent.

After emerging, nymphs require a mean period of 24.5 days to reach the adult stage (Table 3). During this period they pass through five instars. The days spent in each instar (Table 3) are compared with the head capsule development (Table 4) with the results shown graphically as nymphal growth in terms of instar progression (Figure 11).

The predicted head width ranges (Table 4) corresponded closely with the measured head width ranges. The head capsule measurements were arranged as a frequency histogram (Figure 12) which showed clearly the instar groupings as well as the characteristic bimodal distribution within each instar.

Podisus maculiventris (Say)

Field collections of *Podisus maculiventris* (Say) were made from mid-July to early October. The earliest and latest collection dates were in 1961 when female adults were obtained July 13 and October 3. Fifth stage nymphs which moulted to adults within one to three days of collection were taken August 6, September 4 and September 6 in 1960. Adults are common in August and September. It seems unlikely that *P. maculiventris* would have more than one generation per year in the study area. Stoner (1919) reported a double brood for Iowa with nymphs present in June and July and again in late September.

The adults of *P. maculiventris* as described by Stoner (1919), are noted for their remarkably pronounced spinose humeri from which their common name, the spined soldier bug, was probably derived. This species can be separated from the other *Podisus* spp. studied by the presence of a long ventral spine which extends forward between the posterior coxae (Stoner 1919, 1922). The sex ratio as determined from nearly 400 progeny of three females was essentially 1:1. The humeral width of the pronotum is the widest of those species measured (Table 1). The average width of the males was .8 mm less than the females.

Sufficient longevity records were not obtained to allow incorporation of the data into Table 2. From the rearing data available, the average length of life was 236 days with a range comparable to the other species studied. The premating period was not established from the rearing data. A premating period for *P. maculiventris* of five days was observed by Whitmarsh (1916). Mating intervals of 8 and 9 days were noted for two separate pairs of adults. The duration of mating varied from at least 6 to a maximum of 30 hours. The preoviposition period, established from 19 observations, had a mean duration of 5.8 $\pm$ S. E. 1.4 days with a range of 2 to 11 days (Table 2B). A closely allied statistic, the period from becoming adult to first egg laying, was observed as 12 days during the present investigations, and nine days by Morrill (1906). The data on periods between egg laying were compiled from observations of four females. The observed range of 1 to 7 days included a large number of periods close to the mean of 2.6 days as shown by the low value of .15 for the standard error and 95% confidence limits of 2.3 to 2.9 days.

The eggs of *P. maculiventris* are almost identical in size to those of *P. placidus*, but the mean width and length (Table 5) show they are a fraction shorter and a little wider. The eggs of this species have the greatest number of micropylar processes (Table 5). The processes are shorter than those on *P. placidus* eggs but are approximately the same length as the other species studied. The chorion of the egg is spinose and covered with a serous mantle, thus they are similar in appearance to those of *P. serieventris*. Eggs have been laid singly and in batches up to 47 eggs. The mean number of eggs laid in 103 batches was 19.6 ± S. E. .95 eggs (Table 2D). The eggs are generally arranged in two rows although there are occasional exceptions to this, such as eggs being laid in a triangular shaped mass, with two eggs at the apex of the triangle and four rows of 5, 5, 6, and 6 eggs consecutively towards the base of the triangle. The maximum number of eggs recorded from one *P. maculiventris* was 593 laid in 35 batches during the period March 3 to May 18, 1960. Three other females deposited 142, 544 and 576 eggs during periods of 28, 69 and 58 days respectively. Of 17 egg batches observed the mean time from egg deposition to hatching was 9.6 days with a range from 7 to 12 (Table 2E). In any one batch, 80 to 100 per cent of the eggs will hatch.

Temperature is an important factor in the development of eggs (Couturier 1938). Sixteen batches of eggs were reared in incubators, eight at 18° C. and eight at 24° C. The eggs developed faster at the higher temperature and took 3 to 5 days or an average of 4.4 to hatch. Those held at the lower temperature took 10 to 11 days or an average of 10.4 to hatch. Twenty-seven batches of eggs, reared at room temperature hatched in 7 to 12 days or an average of 8.9.

Nymphal development through five instars occurs before the adult stage is reached in a mean of 25.4 days (Table 3). Nymphal head capsule measurements agreed closely with those predicted (Table 4). The required calculations are explained in the *P. serieventris* section. The head capsule measurements when placed in a frequency histogram fall into distinct grouping corresponding to the five instars (Figure 12). The number of days spent in each instar by the nymphs is compared with the corresponding head widths (Table 4) and the results are shown graphically as nymphal growth in terms of instar progression (Figure 11). The process of moulting from the fifth nymphal stage to the adult takes 35 to 48 minutes to complete.

The food requirements of *Podisus* spp. were investigated using *P. maculiventris* as the test species. Nymphs were supplied with various combinations of green beans, *D. similis* larvae and water. Those nymphs which were without food or moisture died within 2 to 3 days. Those with water only died in 8 to 11 days without developing beyond the first instar. The nymphs which had access to beans and water died in an average of 18.7 days and progressed only to the second instar whereas those nymphs which were supplied moisture and also had beans and larvae available, or larvae only, completed development in 30 to 37 days. The nymphs developed fastest in those containers which had larvae and beans and slowest in those with larvae. The average number of days required for development were 32.9 for those nymphs which fed on beans and larvae and 34.3 days for those nymphs which fed on larvae. These developmental periods are longer than the average 25.4 days shown in Table 3. The data for Table 3 were gathered from nymphs fed on larvae only. The differences can be ascribed to dissimilar rearing conditions.

As well as studying the food requirements, some data were gathered on the effectiveness of *Podisus* spp. as predators. Individual nymphs during their period of development were able to kill but not necessarily consume 11 to 15 larvae of *D. similis,* or an average of 13.4 larvae. Nymphs if individually reared can pass through their entire development period using only one *D. similis* larva for food. There was no apparent difference in weight of the teneral adults which had developed on one larva compared with those which fed on two larvae during their nymphal period.

If nymphs are not disturbed while feeding and if reared as small groups they will consume an average of 2.8 larvae before becoming adults. If reared singly, then they will normally consume 4 larvae before reaching the adult state. This apparent discrepancy in number of larvae used for food may be due to dessication of the sawfly larvae if not consumed immediately, once they are killed by the attacking nymph.

If food was withheld from either nymphs or adults reared in a group cannibalism occurred. There is no differentiation as to size or stage of the nymphs or adults, as to which will be the attacker or attacked.

Podisus hybrid

In October, 1960, a small number of field-collected *Podisus* spp. adults were confined in a large laboratory cage before being set up in smaller containers. Two adults of different species were observed in copulation. As records of this nature are not common, the mating pair was removed and reared separately. The female was later identified as *P. maculiventris* and the male as *P. serieventris*. There have been previous reports of hybridization in Pentatomidae, particularly in the genus *Euschistus* (Foot and Strobell 1914, Sailer 1954), but apparently not in the genus *Podisus*.

The mating occurred on October 27 and three batches of eggs, consisting of 8, 26, and 32 eggs were deposited one, four, and eight days later. Nymphs hatched from 62 of the 66 eggs. Progeny from the original pair are now in the F_4 generation. The progeny examined have taxonomic characters common to both species (Kelton 1962 Personal communication).

The humeral width was measured on all hybrid adults retained for study. In both males and females the range in widths and the mean widths were between those measured for *P. serieventris* and *P. maculiventris* (Table 1).

Longevity records indicate that the length of life of the adults has not been shortened or lengthened because of the hybridization; the mean length of life of the adults was 199 $\pm$ S. E. 16.5 days (Table 2A).

The premating period is not known for this group of *Podisus.* The mating interval was obtained on only four occasions and showed a wide range of values, 5, 11, 41 and 88 days. Compared with data from the other species these figures are not unusual. The duration of mating was 8 to 9 hours.

The preoviposition period from four observations was 7, 28, 28 and 57 days, or an average of 30 days (Table 2B). This is probably not an accurate assessment in view of the premating periods for the other species. Also a second generation female deposited eggs at intervals from August 1961 to February 1962. There was no emergence from any of these eggs. A first generation male was placed with the female on February 5, 1962. Mating occurred four hours later, followed by egg deposition one day and seven days later. The eggs laid the day following mating did not hatch, but those produced seven days after mating were viable and hatched in four days. This indicates that the period between first mating and deposition of viable eggs is approximately seven days.

The periods between egg laying ranged from 1 to 12 days, plus one additional occurrence of 65 days. This latter extreme value was excluded from the statitsics for Table 2C. The mean number of days between egg laying was almost identical to that of *P. serieventris.*

The eggs of the hybrid have a mean width of .86 mm., similar to *P. serieventris,* and wider than the mean width of .82 mm of *P. maculiventris* (Table 5). It is of interest to note that the mean length of the hybrid egg is intermediate between those of the original parent species. When comparing the width to length ratio, which is a general indication of the shape of the egg, the ratio for the hybrid egg approaches most closely that of *P. maculiventris* with ratios of .843 and .863 respectively. The number of micropylar processes is intermediate between those of *P. serieventris* and *P. maculiventris* (Table 5). Their lengths are similar to those of the other *Podisus* spp. except for the longer ones of *P. placidus.* The spines and serous mantle on the exterior of the egg are similar in appearance to those of both *P. serieventris* and *P. maculiventris* and cannot be used for differentiation. The maximum number of eggs laid in any one batch was 38, the lowest maximum of the species studied. The mean number of eggs laid per batch was 18.5 compared to 15.9 for *P. serieventris* and 19.6 for *P. maculiventris* (Table 2D). The eggs are normally deposited in a linear arrangement of 2 to 5 rows with three rows the usual number. The maximum number of eggs deposited by one female was 292. These were laid in 212 days in 1961. They were deposited in 17 batches. Another female laid 261 eggs in 12 batches in 45 days. In contrast, a third female deposited 11 batches containing a total of 128 eggs in 24 days. The data included records from three other females which deposited 66, 104 and 122 eggs in three, six and five batches, respectively. Eggs hatched 4 to 8 days after deposition (Table 2E). This range was more restricted than that of *P. serieventris* but the mean of 6.5 days was similar, compared to the 9.6 mean days for development of the eggs of *P. maculiventris*. In any single batch of eggs, 85 to 100 per cent of the eggs could be expected to hatch.

Nymphs pass through five instars before becoming adults. The total developmental period, a summation of the mean time spent in each instar, was approximately 25 days, the same as for *P. maculiventris*, but three days shorter than for *P. serieventris* (Table 3). The periods spent in nymphal development are compared with the head capsule development (Table 4) with the results shown graphically as nymphal growth in terms of instar progression (Figure 11). As in the other species, there was close agreement between the observed and predicted head width ranges. The frequency histogram of head capsule measurements (Figure 12) showed a bimodal distribution in each instar, probably a reflection of sex differences.

Key to Eggs of *Podisus* spp.

A. Eggs immaculate, without ornamentation; usually yellowish-white in color ______________________________ *modestus* Uhl.

AA. Eggs not immaculate, with ornamentation on surface; appear brownish in color.

B. Ornamentation rounded, chorionic spines not present. (Fig. 4) ____ *placidus* Uhl.

BB. Ornamentation spinose, formed by chorionic spines with serous mantle draped over spines. (Fig. 6)

C. Eggs barrel-shaped, chorionic processes usually 9 to 13 in number, mean of 10. (see table 5) ____________ *serieventris* Uhl.

CC. Eggs not barrel-shaped, more globular; chorionic processes usually 11 to 15 in number, mean of 14. (See table 5) _______ __________________________________ *maculiventris* (Say)

Key to Adult *Podisus* spp.

(Adapted from Key by A. D. Baker, 1927 b)

A. Membrane without a distinct vitta ----------- *placidus* Uhl.

AA. Membrane with a longitudinal dusky vitta.

B. Humeral angles of pronotum rounded, color blackish grey -- *serieventris* Uhl.

BB. Humeral angles of pronotum prominent and acute, color greyish to reddish brown.

C. Basal spine of abdomen long, extending between hind coxae; color greyish brown; humeral width 5.3–7.8 mm. ---------- ----------------------------------- *maculiventris* (Say)

CC. Basal spine of abdomen short, not extending between hind coxae; color generally pale reddish brown; humeral width 4.4–5.7 mm. ------------------------------ *modestus* Uhl.

Summary and Conclusions

1. Four species of Pentatomidae, *Podisus serieventris* Uhl., *P. placidus* Uhl., *P. modestus* Uhl. and *P. maculiventris* (Say), commonly occur as predators of the introduced pine sawfly, *Diprion similis* (Htg.), in northwestern Wisconsin.
2. Though in general, the biology and habits of the four species are uniform, specific differences occur in these and in morphological characteristics to enable their separation.
3. All species have at least one generation per year; however, their developmental period is such that the possibility of two exists.
4. All species may be reared readily in the laboratory with *Galleria mellonella* (L.) as a substitute food.
5. A hybrid (*P. malculiventris* ♀ X *P. serieventris* ♂) was reared through four filial generations and was intermediate in characters between its parents.
6. Five instars were obtained for all species. In an attempt to shorten the period between generations in the laboratory exposure of adults to low temperature for short periods in January did not incite apparently dormant adults to mate and lay eggs.
7. The adult female is usually larger than the adult male. Difference is reflected in bimodal distribution of nymphal head capsule measurements.
8. Data were presented on bionomic characters including adult longevity, preoviposition period, interval between matings, mating period, period between egg laying, number of eggs per batch, development periods for eggs and nymphal stages, head capsule growth, food requirements and feeding habits of the nymphs and adults.
9. Keys to eggs and adults are included.

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NOTES ON WISCONSIN PARASITIC FUNGI. XXVIII*

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The collections referred to in this series of notes were, unless indicated otherwise, made during the season of 1961. A considerable number of the fungus specimens cited were noted on phanerogamic specimens in the University of Wisconsin Herbarium and are designated (U. W. Phan.).

Undetermined powdery mildews have been noted on the following hosts, not previously reported as bearing any of these fungi in Wisconsin: *Eupatorium altissimum.* Dane Co., near Lodi, September 22, 1946. Coll. M. H. Ingraham (U. W. Phan.); *Ranunculus fascicularis.* Dane Co., near Cross Plains, May 23. A very early date for powdery mildews in this area; *Valeriana officinalis* (cult.). Sauk Co., Baraboo, July 15. Coll. K. C. Nelson. Very destructive on this host.

SPHAEROTHECA HUMULI (DC.) Burr. has been considered to be the powdery mildew infecting roses in Wisconsin. However, D. L. Coyier of the University of Wisconsin Plant Pathology Department, who has made an intensive study of the biology and control of rose powdery mildew, is unable to differentiate satisfactorily, on a morphological basis, between *S. humuli* and *S. pannosa* (Wallr.) Lev. The latter has been widely reported in Europe as the principal, if not the only, powdery mildew of roses there.

SPHAEROTHECA HUMULI (DC.) Burr., as the late J. J. Davis once pointed out, seems to produce cleistothecia on *Rubus* in Wisconsin only on *R. parviflorus* and *R. pubescens (triflorus)*, and is common on the last-named only. Powdery mildews on other Wisconsin species of *Rubus,* although labeled *S. humuli,* have conidia only and their identification must be considered as tentative. In three successive years in June in the Madison School Forest near Verona, Dane Co., the writer has observed a massive development of powdery mildew amphigenously on leaves of *Rubus allegheniensis,* which commonly also bear the *Caeoma* stage of *Gymnoconia peckiana* which, in turn, is usually parasitized by *Tuberculina.* Most of the infected shoots are killed back, but on such as persist not even incipient development of cleistothecia has been noted in the course of periodic inspection of the host plants throughout the growing

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season and, in fact, by mid-July there is little evidence remaining of the earlier powdery mildew infection.

SCORIAS SPONGIOSA (Schw.) Fr. on *Pinus strobus* was collected in August at Roche a Cri State Park, Adams Co., by J. D. Rogers of the University of Wisconsin Plant Pathology Department. Rogers belives the fungus is mildly parasitic on this host, and it may be so, as it occurs on the green needles in very sharp and well-defined fashion, as opposed to the "messy" superficial development so often characteristic of sooty molds.

MYCOSPHAERELLA sp., believed to be probably connected with *Cylindrosporium interstitialis* Greene (Trans. Wis. Acad. Sci. Arts Lett. 42:79. 1953), developed on overwintered leaves of *Spartina pectinata*, collected at the type station of *C. interstitialis* in the University of Wisconsin Arboretum at Madison, April 13, and held in a moist chamber for two weeks. The host plants had been under observation late in the preceding fall, at which time they still showed traces of the *Cylindrosporium* infection, which has appeared regularly every year, plus extensive development of the immature perithecia in the same areas on the leaves. Mature perithecia are black, subglobose, ostiolate, intercostal and seriate in long rows, and are approx. 85–100 μ diam. Asci are hyaline, clavate, straight or curved, 40–45 x 9–11 μ, the ascospores subhyaline, uniseptate, subfusoid, 11–13 x 3.5–4 μ. This is plainly not *Sphaerella spartinae* Ell. & Ev., described as having elliptical perithecia, 100–112 x 170–190 μ. A further specimen collected in early September 1961 reinforces my impression that there is a connection, for here the *Cylindrosporium* is abundantly present and the presumptive perithecia, which contain many micronidia, are developing in direct association with it.

LEPTOSPHAERIA sp. which possibly developed parasitically occurs on oval, dark purplish-bordered ashen spots on *Schizachne purpurascens*, collected by J. J. Davis near Laona, Forest Co., July 13, 1915. The blackish, globose perithecia are epiphyllous and gregarious, approx. 150 μ diam. The asci are short-pedicellate and narrowly cylindric, 65–70 x 8–9 μ. The greenish-olivaceous ascospores are about 25 x 5 μ and rather obscurely 5–7 septate.

NECTRIA CINNABARINA (Tode) Fr., with its accompanying *Tubercularia* stage, occurred in profusion on dead upper portions of otherwise still living stems of *Solanum dulcamara* at Madison, October 24, and may have been parasitic.

PHACIDIUM BALSAMEAE J. J. Davis (Trans. Wis. Acad. Sci. Arts Lett. 20:424. 1922) described on *Abies balsamea* from Vilas Co. has been studied by R. P. Korf, who states that the fungus belongs under *Sarcotrochila* Hoehn. of the Hemiphacidiceae.

PUCCINIASTRUM AMERICANUM (Farl.) Arth. II, III has been noted heavily infecting the fruits of cultivated red raspberries of the everbearing type in a specimen collected by G. C. Klingbiel in October at Westfield, Marquette Co.

MELAMPSORA (MEDUSAE Thum. ?) III was collected on *Populus nigra* var. *italica* at Madison, October 24. Oudemans reports *Melampsora* on Lombardy poplar in Europe and the U. S. D. A. Index of Plant Diseases lists *M. medusae* on the black poplar group in Massachusetts, Missouri and Pennsylvania.

Phyllostictae, undetermined as to species, have been collected on several hosts as follows: 1) On *Podophyllum peltatum* at Gov. Dodge State Park, Iowa Co., July 20. Pycnidia are on broad, distal reddish-brown dead areas of the leaf lobes, hypophyllous, clustered, black, globose, widely ostiolate, approx. 65–100 μ diam. with hyaline, rod-shaped microconidia, .6–1 x 3.5–5 μ. 2) On *Rubus allegheniensis,* near Verona, Dane Co. August 3. Spots are dull reddish-brown, often with a yellowish halo, wedge-shaped and involving the entire apical area of a leaflet, orbicular, or oval-elongate, approx. .7–1.5 cm. wide by up to 3 cm. long. Pycnidia very inconspicuous, scattered, pallid, visible only by transmitted light, subglobose, about 100–175 μ diam., the conidia hyaline, variable, from almost isodiametric to long-cylindric, 5–11 x 2–3.5 μ. Mostly on, but not confined to, small, 3-foliate, axillary leaves produced near the tips of the fruiting canes. Except for the size of the pycnidia, 100–175 vs. 60–85 μ, this is quite similar to a fungus on *Rubus strigosus,* discussed in an earlier note (Trans. Wis. Acad. Sci. Arts Lett. 47:121. 1958). 3) On *Angelica atropurpurea* collected near Swan Lake, Pacific Twp., Columbia Co., July 18. This is definitely not *Phyllosticta angelicae* Sacc., a microconidial form mentioned in my Notes IX (Trans. Wis. Acad. Sci. Arts Lett. 38:240. 1946). In the current specimen the spots are rounded, sordid-brownish below but somewhat paler above, with narrow darker margins, about 1 cm. diam. The thin-walled, carneous, subglobose pycnidia are about 100 μ diam., hypophyllous and scattered, the conidia hyaline, broadly ellipsoid or short-cylindric, (3.5–)4–6(–7) μ. 4) On *Valeriana edulis* at the Faville Prairie Preserve near Lake Mills, Jefferson Co., September 20. In small amount on ashen to brownish orbicular spots about 1 cm. diam. Pycnidia are pallid-brownish, subglobose, approx. 100 μ diam., with a large ostiole about 15 μ diam. marked by a ring of darker cells. Conidia hyaline, often biguttulate, oblong, narrow-ellipsoid or subfusoid, approx. 4–6 x 2–3 μ. 5) On *Campanula rotundifolia* collected at Nelson Dewey State Park near Cassville, Grant Co., September 19, on dead current season's leaves and still green stems. Pycnidia black, globose, non-ostiolate, about 85–100 μ diam., closely gregarious on both leaves and stems. Conidia are hyaline and rod-shaped, 4–6 x 1–2 μ. It seems possible this may be identical with *Phoma groenlandica* Allesch., described as occurring on dead stems of *C. rotundifolia* from Greenland, which has conidia ovoid-oblong or oblong, 5–6 x 1.5–3 μ. There seems no question that the Wisconsin specimen developed parasitically. 6) On *Aster sagittifolius* from Gibraltar Rock County Park, Columbia Co., August 7. The spots are small and purplish with ashen centers, the pycnidia epiphyllous, pallid, small, about 75 μ diam. Conidia are hyaline, broadly ellipsoid, 1.8–2 x 3.5–4 μ. Very similar to a *Phyllosticta* on *Aster novae-angliae* mentioned in my Notes XXIV (Trans. Wis. Acad. Sci. Arts Lett. 47:102. 1958). The latter, however had slightly larger conidia.

CONIOTHYRIUM sp., possibly parasitic, occurred on *Rubus occidentalis* near Cross Plains, Dane Co., June 17, 1960. The small, irregularly rounded or angled spots are often confluent in lines and are sordid whitish with narrow red, or reddish-brown, margins. The pycnidia are epiphyllous, sparingly scattered on the spots, dark brown, widely ostiolate, approx. 100–125 μ diam. The deep-greenish spores are broadly ellipsoid, 4–5 x 2.5–3 μ.

CONIOTHYRIUM sp., on the decolorized fruits and involucral bracts of *Cornus obliqua,* collected by R. Peters near Merrimac, Sauk Co., August 24, 1958, suggests a parasitic development. The black, globose pycnidia are almost superficial and are gregarious on the affected tissue. The olivaceous conidia are broadly ellipsoid, 4.5–6 x 3–4 μ. (U. W. Phan.)

ASTEROMA PADI Grev. is evidently common on *Prunus padus* in Europe. In Wisconsin a macroscopically similar and very conspicuous *Asteroma*-like fungus occurs commonly in the fall on leaves of *Prunus serotina,* but so far no fruiting has been noted, so identity remains speculative.

ASTEROMA TILIAE Rud., or what is taken to be that species, is quite common on *Tilia americana* in Wisconsin and elsewhere in North America. The fungus was originally described on a specimen on *Tilia europea* from Bavaria and since there was no fruiting in the type specimen it would seem to be of dubious validity. In American specimens the radiating fibrillae of a typical *Asteroma* are usually evident only in rather immature, early-season collections. Later, the lesions appear as large, fuscous, orbicular blotches which may or may not, still provide a suggestion of *Asteroma,* but which, in numerous North American specimens examined, have always shown characteristic pycnidia, usually discerible, however, only on the lower side of the leaf. The pycnidia are scattered to gregarious, rather thin-walled, pallid-brownish, apparently non-ostiolate, but with the wall tending to be imperfectly formed at a point adjacent to the host epidermis. Pycnidia are very deeply seated, usually occupying most, or all, of the space from epidermis to epidermis. They are globose, subglobose, or somewhat flattened, approx. (70–)90–110 (–125) μ diam. The conidiophores are rather loosely ranked, vaguely bottle-shaped, hyaline structures, about 10–15 x 3–5 μ, which almost completely line the pycnidial cavity. The conidia are hyaline, short-cylindric or slightly curved and suballantoid, (3–) 4–5(–6) x (1.3–)1.5–2 μ Occasional larger, hyaline, subfusoid conidia have been observed in a few mounts, but none have been seen in place within a pycnidium, so their origin is uncertain. Of six European specimens in the University of Wisconsin Cryptogamic Herbarium only one, on *Tilia platyphylla,* shows any fruiting. Here the pycnidia are from 125–150 μ diam., distinctly larger than in American specimens, and they are moreover rather plainly ostiolate, while the conidia are smaller, approx. 4–4.5(–5) x 1.2–1.5 (–1.8) μ. Thus, it is morphologically close to, but apparently not identical with, the fungus on *Tilia americana.* Clements and Shear indicate that a decisive key character in *Asteroma* is lack of an ostiole, but this is not specified in the generic description.

STAGONOSPORA sp. occurs on pallid areas of overwintered leaves of *Carex trichocarpa,* collected in the University of Wisconsin Arboretum at Madison, March 16, 1961. The scattered to subseriate, subglobose, black pycnidia are about 200–225 μ diam. and the hyaline, broadly subfusoid conidia mostly 2–3, occasionally 4-septate, 40–50 x (6.5–)7.5–8.5 μ. This infection had been noted in the fall of 1960, but at the time of inspection such pycnidia as were examined did not have the contents delimited, and the plants were marked for future reference. In the material as brought in from the field in the spring conidia were poorly defined, but after the leaves had been in a moist chamber for 48 hours very good conidial development was noted, with the septa clear and sharply defined.

SEPTORIA sp. occurs on the brownish tips of otherwise still living leaves of *Castilleja coccinea,* collected by M. F. Johnson near Bancroft, Portage Co., June 23. The gregarious pycnidia are thin-walled, grayish, inconspicuous, subglobose, small, about 50–70 μ diam. The hyaline spores appear continuous or rarely obscurely septate and are straight and somewhat larger at one end than at the other, 15–21 x 1–1.5 μ. I have found no report of any *Septoria* on this or other species of *Castilleja.*

COLLETOTRICHUM sp., which appears parasitic, is on leaves of *Apios tuberosa* collected near Juda, Green Co., August 12. The conspicuous spots are orbicular to somewhat angled, dull reddish-brown and mottled with lighter areas, approx. .5–1 cm. diam. The acervuli are small, scattered to gregarious, amphigenous, loosely organized, with from a single seta to half a dozen or so in a cluster, where they are moderately divergent, tapered uniformly from base to pointed tip, slightly sinuous, but in overall appearance straight and rigid, uniform clear brown, not appreciably paler near tip, 1–2 septate, approx. 65–85 x 4.5–5 μ. The conidia are hyaline, cylindric to subfusoid, contents granular, (10–)12–13 x 3–4.5 μ.

CYLINDROSPORIUM RUBI Ell. & Morg. was abundantly present on fruiting canes of dead and dying *Rubus* (cult. red raspberry) collected July 27 near Mt. Horeb, Dane Co. In section the acervuli are subepidermal and deeply seated in the corky layer. Whether the fungus was primary is somewhat doubtful, as the dry, cold, open winter of 1960–61 was very hard on many cultivated woody plants, and the plants in question were on a high, exposed site.

BOTRYTIS sp., possibly parasitic, was present in heavy development on terminal portions of leaves of *Hyacinthus orientalis* (cult.) near Cross Plains, Dane Co., June 9. It does not appear to be the same species often found on tulips in this region.

HELMINTHOSPORIUM sp. occurs on small, oval, grayish-brown spots on leaves of *Agrostis alba* collected near LaValle, Sauk Co., July 8. On heavily infected leaves the spots merge, with die-back of the entire leaf. The cylindric or subcylindric conidia are pallid grayish-brown, with hilum recessed, 55–75 x 11.5–13.5 μ, 4–6, mostly 5 septate, with little or no constriction at the septa. The conidiophores are dark brown below, from almost straight to somewhat tortuous, 2–3 times geniculate near the paler tip, about 140–215 x 7–8 μ, 4–7 septate, arising scattered individually, not in tufts. The spores seem similar in general characters to those described for *Helminthosporium gramineum* Rabh., but that species has the phores definitely tufted. Obviously not *H. sativum* Pamm., King & Bakke.

CERCOSPORA sp. occurred on leaves of *Salix adenophylla* (cult.) collected in the University of Wisconsin Arboretum at Madison, September 3. There are usually one to two or three spots per leaf. The spots are small, 1–2 mm. diam., with narrow dark borders and somewhat sunken whitish centers. The conidiophores are amphigenous, but mostly epiphyllous, in dense but spreading fascicles which are gregarious and mostly about 25–30 μ diam. at the base, but without any definite stroma. Viewed individually by transmitted light the conidiophores are pale olivaceous, non-septate, or rarely 1-septate, spreading and often tortuous and markedly geniculate near the tip, approx. 40–75 x 3.5–4.5 μ, many per fascicle. The better developed conidia are narrowly obclavate below, long-tapering toward the apex, truncate at base ,hyaline, indistinctly multiseptate, up to 100 x 4.5 μ. Others are merely obclavate, approx. 25–35 μ long, with the tips somewhat obtuse, truncate at base and about 3-septate. This does not correspond with either of the two species that Chupp mentions as occurring on *Salix* in his monographic treatment of *Cercospora*. These are *C. salicina* Ell. & Ev. and *C. salicis* Chupp & Greene, the latter based on a collection on *Salix alba* from Madison. The host plants were moved from the Lake Michigan shore in Manitowoc Co., and it is hoped it will be possible to visit this area to ascertain whether the fungus is naturally present there.

CERCOSPORA sp. has been noted on a phanerogamic specimen of *Primula mistissinica* Michx. var. *noveboracensis* Fern., collected by N. C. Fassett near Somerset, St. Croix Co., June 2, 1935. The numerous spots are sordid brownish and rounded and the infected leaves have been mostly killed back. The conidiophores are in small fascicles from small stromata, olivaceous-brown, straight, approx. 12–25 x 3–3.5 μ. Conidia few remaining, those seen subhyaline, slender-obclavate, truncate at base, approx. 35–45 x 2.5–3 μ, 2–3 septate. Chupp mentions only *C. primulae* Fautr. as described on *Primula*, and he considers it to be a species of *Ramularia*, which this specimen certainly cannot be.

CERCOSPORA sp. occurs on *Valeriana edulis* collected September 20 at the Faville Prairie Preserve near Lake Mills, Jefferson Co. The sharply defined spots are rounded or oval with ashen-brown centers and dark brown borders, small, mostly about 2–3 mm. diam., and usually only one or two per leaf. The epiphyllous condiophores are olivaceous-brown below, somewhat paler above, widely spreading in clusters of approx. 5–15 from a small, compact, dark brown, substomatal stroma. The phores are decidedly geniculate and somewhat tortuous, about 5–7 septate, 95–140 x 4–5 μ. The conidia are hyaline, ranging from slender-obclavate and long-tapering to almost acicular, moderately curved, obscurely multiseptate, rounded at the base, with a noticeable scar, approx. 75–110 x 3–4 μ. Most of the conidia had fallen away and only half a dozen were measured, but these seemed characteristic. Chupp, in his monographic treatment of the Cercosporae, does not list any species on *Valeriana*.

Leaves of *Rhus copallina,* in plantings in the University of Wisconsin Arboretum at Madison, September 30, 1960, were infected by a sporodochium-producing fungus, so far undetermined, but well-marked and evidently strongly parasitic (Plate III, Fig. 6). The lesions are large, approx. 1–4 cm. diam., orbicular, or irregularly elongate and marginal, light brownish or sordid brownish above and usually subzonate with a narrow dark margin, the adjacent leaf areas often bright red. On the underside of the leaf the

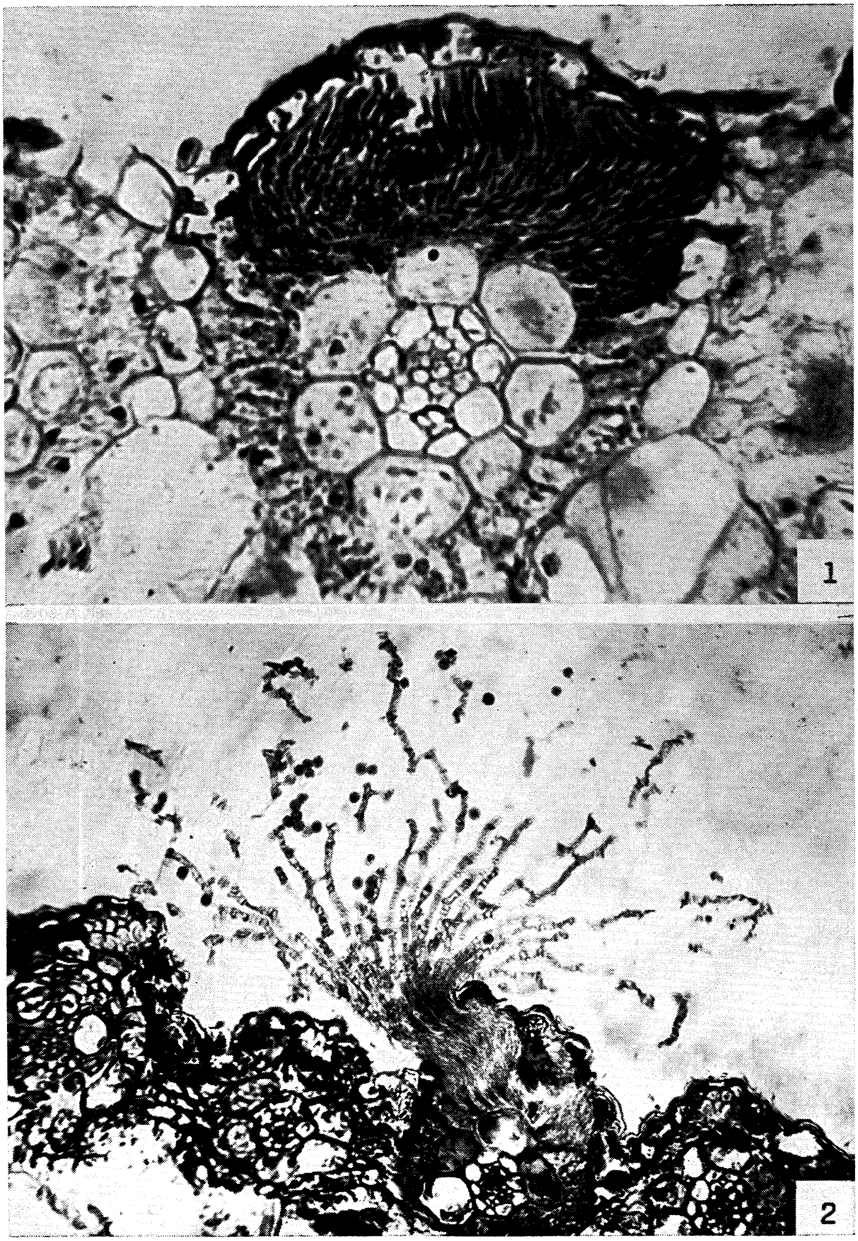
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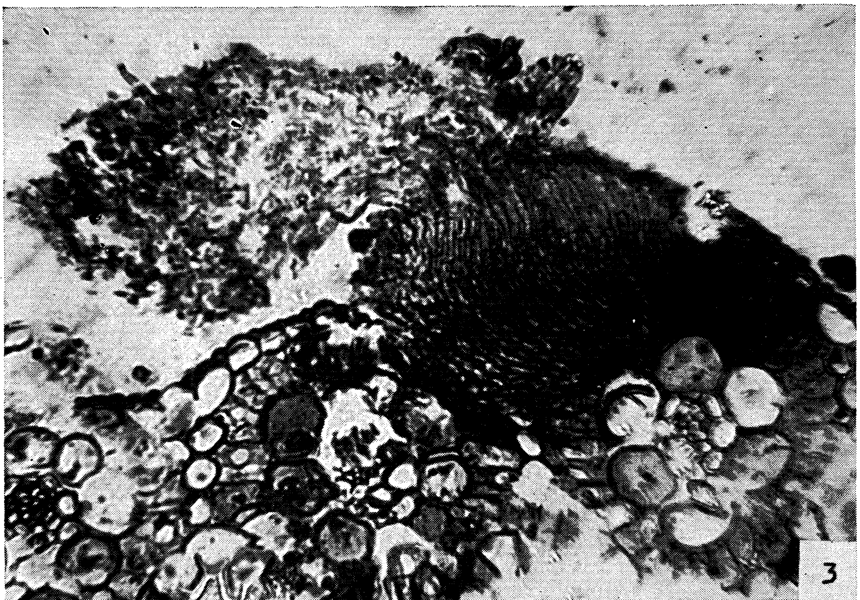
PLATE I

Explanation of Figures

Botrytis uredinicola Peck

FIGURE 1. Infection well advanced, but host epidermis still unruptured. The cells surrounding the vein sheath are filled with the hyphae of the parasite. Section 10 μ thick. $\times$ 410.

FIGURE 2. Mature fungus, showing spreading, anastomosing conidiophores, with conidia. Section 10 μ thick. $\times$ 235.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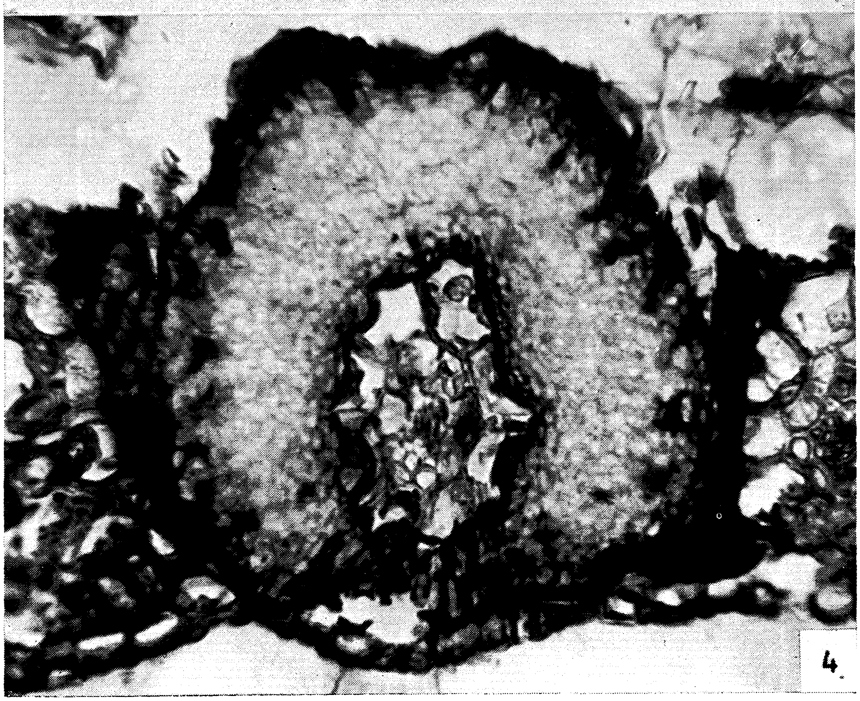
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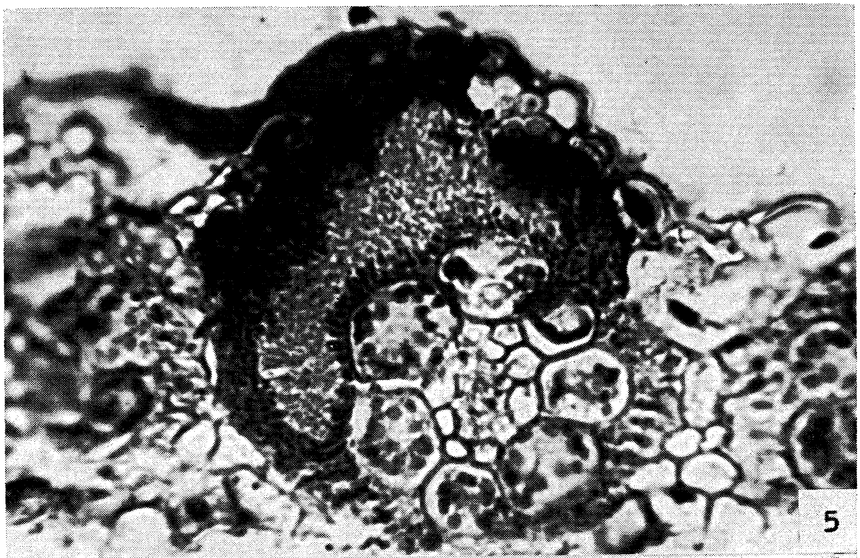
PLATE II

EXPLANATION OF FIGURES

Botrytis uredinicola Peck

FIGURE 3. Late season collection, showing breakdown of conidiophores and sclerotization of the mycelium around the veins. Section 15 μ thick. $\times$ 335.

FIGURE 4. Overwintering stage, with vein completely enveloped and the sheath crushed. The pseudoparenchymatous inner cells are filled with granular material. Section 10 μ thick. $\times$ 425.



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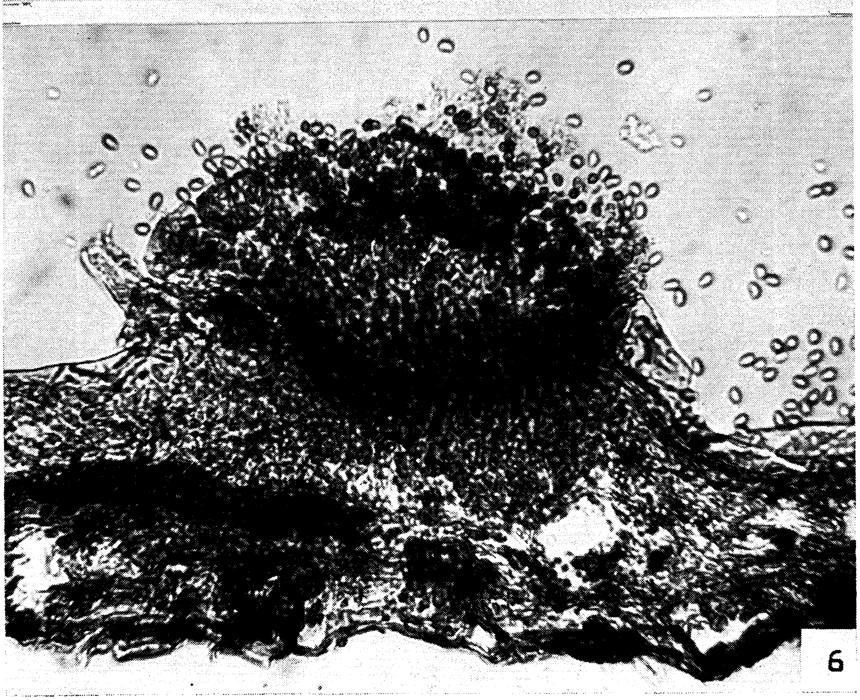

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PLATE III

EXPLANATION OF FIGURES

FIGURE 5. Botrytis uredinicola. Microconidial stage. The microconidia are escaping in a cirrhus, above and to the left. Section 10 μ thick. $\times$ 420.

FIGURE 6. Habit photo of free-hand section, in mounting fluid, of sporodoctium-forming fungus on Rhus copallina. $\times$ 315.

lesions are uniformly fuscous, immarginate and not zonate. The sporodochia are amphigenous, but more conspicuous and noticeable when epiphyllous, scattered to gregarious, rounded above and pulvinate, dull blackish, subcuticular and intraepidermal, or perhaps in some cases subepidermal in origin, elevated, but variable and sometimes wider than high. Thus, one sporodochium was approx. 180 μ high by 250 μ wide, while another was 230 μ high by 190 μ wide. There are many where the overall dimensions are less, but the measurements given seem representative. The conidiophores are in such a compact, non-separable, deep-brownish mass as to make individual description impractical. The conidia are brownish-olivaceous, smooth, broadly ellipsoid, or rarely subfusoid, (3–) 3.5–4 (–4.5) x (4.5–)5–6(–7) μ, very numerous, but appearing non-catenulate.

SCLEROTIOMYCES COLCHICUS Woronichin, the photosynthesis-retarding sooty mold mentioned in several previous notes has been collected at Gov. Dodge State Park, Iowa Co., September 19, on the following additional plant leaf substrates: *Corylus americana, Ranunculus septentrionalis, Geum canadense, Acer saccharum, Viola* sp. and *Phryma leptostachya.*

Sanguinaria canadensis, collected near Poynette, Columbia Co., June 7, 1960, bears numerous small, rounded to short-oblong, dark-bordered, ashen-brown spots on the still-green leaves. Present on the spots are *Phyllostictas,* a well-defined *Ascochyta,* a *Septoria,* an immature *Ascomycete,* a *Coniothyrium,* and probably others. Since the first three mentioned usually, if not always, are associated with parasitism, it seems possible but scarcely demonstrable that one or more were acting so in this instance. Winter described *Phyllosticta sanguinariae* on this host from Missouri, and one of the Phyllostictae mentioned has conidia in the size range specified by Winter.

ADDITIONAL HOSTS

The following hosts have not been previously recorded as bearing the fungi mentioned in Wisconsin.

PERONOSPORA PARASITICA (Pers.) Fr. on *Arabis shortii.* Rock Co., near Avon, May 26, 1947. Coll. J. Wickham. (U. W. Phan.)

SYZYGITES MEGALOCARPUS Ehrenb. ex Fr. (*Sporodinia grandis* Link) on *Lactarius trivialis.* Vilas Co., August 1910. On *Boletus felleus.* Sauk Co., Devils Lake, October 6, 1906. Both coll. R. A. Harper.

ERYSIPHE GRAMINIS DC. on *Poa nemoralis.* Fond du Lac Co., near Oakfield, July 4, 1932. Coll. N. C. Fassett (U. W. Phan.)

HYPOMYCES CHRYSOSPERMUS Tul. on *Boletus sphaerosporus.* Dane Co., Madison, October 1900. Coll. R. A. Harper.

PUCCINIA RECONDITA Rob. ex Desm. I on *Anemone riparia*. Rock Co., near Beloit, June 8, 1932. Coll. B. Anthoney. (U. W. Phan.)

PUCCINIA DIOICAE P. Magn. ii, III on overwintered leaves of *Carex debilis*. Juneau Co., Rocky Arbor Roadside Park, June 8, 1958. Coll. T. G. Hartley (U. W. Phan.). On *Carex cristatella*. Dane Co., Madison, July 16. Host det. J. H. Zimmerman.

PUCCINIA VIOLAE (Schum.) DC. I on *Viola adunca*. Washburn Co., near Spooner, June 18, 1897. (U. W. Phan.). II, III on *Viola sororia*. Lincoln Co., Schley Twp., August 23, 1955. Coll. F. C. Sey mour (U. W. Phan.)

GYMNOSPORANGIUM JUVENESCENS Kern I on *Amelanchier amabilis* Wieg. (*A. grandiflora* Wieg.) (cult.) Dane Co., Madison, June 26.

MELAMPSORA MEDUSAE Thum. II on *Populus balsamifera* (cult.). Dane Co., Madison, September 7. On leaves of rooted cuttings from a mature tree in the University of Wisconsin Arboretum. There has been a question as to the actual occurrence of *M. medusae* on balsam poplar in Wisconsin. Fungi Columbiani 3915, collected at Madison in 1910 on this host, was issued as *M. medusae,* but by later workers was somewhat tentatively placed under *M. occidentalis* Jacks., principally on the basis of spore size (Amer. Midl. Nat. 48: 39. 1952). In the present specimen the urediospores are well within the size range of *M. medusae* and show the extensive smooth areas on the wall, characteristic of the species.

EOCRONARTIUM MUSCICOLA (P. ex Fr.) Fitzp. on *Climacium dendroides*. Douglas Co., Brule, July 19, 1897. On *Hypnum cupressiforme*. Bayfield Co., between Herbster and Port Wing, July 8, 1897. On *Thuidium microphyllum*. Bayfield Co., Mason, July 6, 1896. All. coll. L. S. Cheney. Hosts det. R. I. Evans.

CERATOBASIDIUM ANCEPS (Bres. & Syd.) Jacks. on *Ranunculus abortivus*. Sauk Co., near LaValle, July 8.

NYCTALIS ASTEROPHORA Fr. on *Russula adusta*. Dane Co., Madison, August 1, 1903. Coll. R. H. Denniston. On *Russula sordida*. Same station, August 5, 1903. Coll. R. A. Harper.

PHYLLOSTICTA PHASEOLINA Sacc. on *Strophostyles leiosperma*. Waushara Co., near Hancock, September 14, 1957. Coll. M. Spalding. (U. W. Phan.)

PHYLLOSTICTA MINUTISSIMA Ell. & Ev. on *Acer spicatum*. Sauk Co., Parfrey's Glen, Town of Merrimac, September 16, 1959.

PHYLLOSTICTA VIOLAE Desm. on *Viola selkirkii*. Clark Co. near Stanley, June 5, 1948. Coll. M. Bergseng. (U. W. Phan.)

PHYLLOSTICTA DECIDUA Ell. & Kell. on *Myosotis scorpioides*. Ozaukee Co., Thiensville, June 20, 1925. Coll. S. C. Wadmond. (U. W. Phan.)

PHOMOPSIS HIERACII H. C. Greene on *Hieracium aurantiacum*. Columbia Co., Gilbraltar Rock County Park, August 7. Scoleco-spores were not observed in mounts made from this specimen, but in all other respects it is identical with the type on *Hieracium longipilum*.

CONIOTHYRIUM FUCKELII Sacc. on *Rubus allegheniensis*. Dane Co., near Verona, August 3. Appearing parasitic and similar to material collected many years ago on *Rubus pubescens* at Madison.

ASCOCHYTA EQUISETI (Desm.) Grove on *Equisetum fluviatile*. Sawyer Co., near Barker Lake, Draper Twp., September 1, 1959. Coll. D. Ugent. On a specimen in the University of Wisconsin Herbarium. Many of the acervuli show a microconidial, rather than the *Ascochyta* stage. The writer (Amer. Midl. Nat. 44:639. 1950) also made this combination, overlooking the fact that Grove had done so some years previously.

ASCOCHYTA GRAMINICOLA Sacc. (*A. sorghi* Sacc.) on *Poa palustris*. Dane Co., Madison, July 14. Very heavy infection on the lower leaves, which were entirely killed back. On *Muhlenbergia mexicana* (L.) Trin. Dane Co., Madison, September 8. An earlier report on *Muhlenbergia "foliosa"* probably referred to *M. mexicana*, but this cannot be ascertained from the herbarium specimen.

ASCOCHYTA ASCLEPIADIS Ell. & Ev. on *Asclepias syriaca*. Iowa Co., Gov. Dodge State Park, July 20.

ASCOCHYTA COMPOSITARUM J. J. Davis on *Aster lateriflorus*. Dane Co., near Verona, August 3.

SEPTORIA MISSISSIPPIENSIS R. Sprague on *Muhlenbergia mexicana* (L.) Trin. Columbia Co., near Wyocena, July 18. Host determinations of *Muhlenbergia* are based on the treatment in Fassett's "Grasses of Wisconsin".

SEPTORIA SALICINIA Pack on *Salix serissima*. Dane Co., Madison, September 3. An examination of various specimens of *S. salicina* in the Wisconsin Herbarium indicates no great violence would be done if this species were transferred to *Cylindrosporium*.

SEPTORIA LUDWIGIAE Cooke on *Ludvigia polycarpa*. Milwaukee Co., Milwaukee, August 1884. Coll. E. E. Hasse. On a phanerogamic specimen in the Herbarium of the Milwaukee Public Museum.

SEPTORIA OENOTHERAE West on *Oenothera strigosa*, Dane Co., Madison, August 1, 1907. Coll. J. R. Heddle. Host det. D. Ugent. On *Oenothera caespitosa*. Madison, August 23. On a planting in the University of Wisconsin Arboretum.

SEPTORIA CORNICOLA Desm. var. AMPLA H. C. Greene on *Cornus rugosa* (cult.). Dane Co., Madison, October 4.

SEPTORIA DODECATHEONIS J. J. Davis on *Dodecatheon amethystinum* Fassett. Crawford Co., Prairie du Chien, June 2, 1928. Coll. N. C. Fassett. This is the type specimen of the host, which consists of two plants mounted on one sheet, only one of which, however, bears the *Septoria.*

SEPTORIA HELIANTHI Ell. & Kell. on *Helianthus giganteus.* Buffalo Co., near Mondovi, August 25, 1956. Coll. H. H. Iltis. (U. W. Phan.)

SEPTORIA HIERACICOLA Dearn. & House on *Hieracium scabrum.* Iowa Co., Tower Hill State Park, October 5. On *H. florentinum.* Forest Co., near Cavour, August 27, 1958. Coll. K. S. Snell. (U. W. Phan.)

SELENOPHOMA BROMIGENA (Sacc.) Spr. & Johns. on *Bromus latiglumis.* Sauk Co., near Leland, July 12, 1942. (U. W. Phan.). R. Sprague reports a collection of *S. bromigena* on *Bromus purgans* from Iron Co. near Hurley, August 1959, but the presence of *B. purgans* in this part of Wisconsin seems questionable.

HAINESIA LYTHRI (Desm.) Hoehn. on *Oenothera caespitosa.* Dane Co., University of Wisconsin Arboretum, Madison, August 23.

CRYPTOCLINE BETULARUM (Ell. & Mart.) v. Arx (*Gloeosporium betularum* E. & M.) on *Betula lenta* (cult.). Dane Co., Madison, July 26.

GLOEOSPORIDIELLA VARIABILE (Laub.) v. Arx (*Gloeosporium variablile* Laub.) on *Ribes missouriense.* Lafayette Co., Ipswich, August 15. This was found on cultivated *Ribes alpinum* in Wisconsin in 1960. It seems worth noting that in all five collections of this species in the University of Wisconsin Cryptogamic Herbarium the fruiting is uniformly hypophyllous, in contrast to the normally epiphyllous *Gloeosporium ribis.*

COLLETOTRICHUM GRAMINICOLA (Ces.) Wils. on *Elymus villosus.* Columbia Co., Gibraltar Rock County Park, August 7. On *Paspalum stramineum.* Crawford Co., Prairie du Chien, September 15, 1940. Coll. N. C. Fassett. (U. W. Phan.)

COLLETOTRICHUM VIOLAE-ROTUNDIFOLIAE (Sacc.) House on *Viola affinis.* Outagamie Co., near Freedom, August 16, 1948. Coll. F. C. Seymour. (U. W. Phan.). On *V. septentrionalis.* Vernon Co., near Viroqua, June 2, 1929. Coll. H. P. Hansen. (U. W. Phan.)

SPHACELOMA MURRAYAE Jenkins & Grodsinsky on *Salix petiolaris.* Jefferson Co., Faville Prairie Preserve near Lake Mills, September 20.

MARSSONINA KRIEGERIANA (Bres.) Magn. on *Salix serissima.* Shawano Co., Shawano, September 1, 1921; also Door Co., Fish Creek, September 27, 1919. Both specimens were collected by J. J. Davis as occurring on *Salix lucida,* but later redetermined, no doubt correctly, as *S. serissima,* and heretofore overlooked in the Wisconsin lists.

DIPLOCLADIUM MINUS Bon. on *Polystictus pergamenus.* Dane Co., Madison, May 2. Although Clements & Shear in their "Genera of Fungi" list *Diplocladium* as a saprophyte, specimens seen by the writer strongly suggest otherwise, so the fungus is recorded as at least a questionable parasite.

RAMULARIA AEQUIVOCA (Ces.) Sacc. on *Ranunculus sceleratus.* Dodge Co., near Reeseville, May 17, 1931. Coll. J. W. Rhodes. (U. W. Phan.)

CERCOSPORA BETICOLA Sacc. on *Chenopodium botrys.* Grant Co., near Wyalusing, September 1, 1957. Coll. H. H. Iltis and P. Salamun. (U. W. Phan.)

CERCOSPORA DUBIA (Riess.) Wint. on *Chenopodium berlandieri* var. *zschackei.* St. Croix Co., near Hudson, September 12, 1956. Coll. C. W. Lemke. (U. W. Phan.)

CERCOSPORA VIOLAE Sacc. on *Viola rostrata.* Sheboygan Co., near Ada, August 9, 1959. Coll. H. H. Iltis. (U. W. Phan.). On *V. adunca.* Vilas Co., near Boulder Junction, August 17, 1956. Coll. J. T. Curtis. (U. W. Phan.).

CERCOSPORA GRANULIFORMIS Ell. & Holw. on *Viola novae-angliae.* Lincoln Co., Pine River Dells, August 18, 1952. Coll. F. C. Seymour. (U. W. Phan.)

ADDITIONAL SPECIES

The fungi mentioned here have not been previously reported as occurring in the state of Wisconsin.

CELIDIUM PULVINATUM Rehm in Rabh. on *Lecanora* sp. Lafayette Co., near Belmont, July 20, 1960. Coll. K. G. Foote. Det. J. W. Thomson.

PYRENIELLA LECANORI Keissler on *Lecanora* sp. Grant Co., across Wisconsin River from Bridgeport, July 24, 1960. Coll. K. G. Foote. Det. J. W. Thomson.

NORRLINIA PELTIGERICOLA (Nyl.) Theiss. & Syd. on *Bacidia* sp. Richland Co., near Yuba, July 27, 1960. Coll. K. G. Foote. The large, many celled, muriform ascospores are up to about 70 x 30 μ, mostly two, but occasionally three per ascus. A rarely seen and apparently little-known species.

HYPOCREA SULPHUREA (Schw.) Sacc. on *Exidia glandulosa.* Iowa Co., Blue Mounds, November 1904. Coll. R. A. Harper.

ORBILIA EPIPORA (Nyl.) Karst. on *Fomes fomentarius.* Sauk Co., Devils Lake, July 2, 1904. Probably parasitic. Coll. R. A. Harper.

TAPHRINA DEARNESSII Jenkins on *Acer rubrum.* Douglas Co., near Solon Springs, June 12. Coll. Mrs. R. McMinn; Barron Co., June 10. Coll. W. Klanderman. Both specimens comm. E. K. Wade. The disease was said to be quite severe in Barron Co.

Microthyrium rubicolum sp. nov.

Fructificationibus nigris, orbibus, applanatis, superficialibus, gregariis, ca. 225–450 μ diam., plerumque 350 μ; scutellis compositis cellis nigris, muris crassis, isodiametris vel oblongatis vel irregularibus, fissilibus irregulariter; aparaphysatis; ascis subhyalinis, formis variabilibus, subsphaericis vel clavatis late vel clavatis tantum, 20–40 x 11–17 μ, crassitudinibus muris variabilibus; ascosporis subhyalinis, subcylindraceis, uniseptatis, constrictis leniter, 12–14 x 3.5–4.5 μ.

Fruiting bodies black, rounded, applanate, superficial, gregarious, approx. 225–450 μ diam., mostly about 350 μ; scutellum composed of black, thick-walled isodiametric to oblong or irregularly shaped cells, splitting irregularly at maturity of ascoma; aparaphysate; asci subhyaline, variable in shape from subspherical to broadly obclavate, or merely clavate, 20–40 x 11–17 μ, ascus wall usually moderately to much thicker in one region than in remainder of wall; ascospores subhyaline, subcylindric, uniseptate, slightly constricted at septum, 12–14 x 3.5–4.5 μ.

On still green, early-season fruiting canes of *Rubus allegheniensis.* Madison School Forest near Verona, Dane County, Wisconsin, U. S. A., June 22, 1961.

One of the cells of the ascospore is slightly wider and more obtuse than the other. Arrangement of spores in the ascus is variable, depending on the shape of the particular ascus. This fungus bears little similarity to *Microthyrium rubi* Niessl which has fruiting bodies about 100 μ diam., and asci 48–50 x 7–8 μ.

RHIZOSPHAERA ABIETIS Mangin & Hariot on *Abies balsamea.* Vilas Co., near Eagle River, May 4. Coll. R. F. Patton. Described in the Bull. Soc. Mycol. France 23: 54–61. 1907 as a new genus and species. Shortly thereafter Maublanc made the new combination *Rhizosphaera pini* (Cda.) Maub., asserting that *Coniothyrium pini* Cda. is identical with *R. abietis.* As *R. pini* the fungus is reported, in the U. S. D. A. Index of Plant Diseases, as occurring on *Abies fraseri* in North Carolina, but there seems to be no previous record on *A. balsamea.*

Phomopsis thalictri sp. nov.

Maculis conspicuis, sordido-cinereis vel obscuro-brunneis, orbicularibus vel cuneatis vel elongatis, marginibus fuscioribus, angustis, ca. .5–1.5 cm. diam.; pycnidiis epiphyllis, sparsis vel gregariis, nigris, applanatis vel subglobosis, ca. 150–215 μ diam., ostiolatis latis; A-conidiis subfusoideis, hyalinis, saepe biguttulosis, 9–16 x (2.5–) 3.5–4.5 μ, B-conidiis curvis laxe, hyalinis, attenuatis, ca. 18–35 x 1–1.5 μ, raro latior.

Spots conspicuous, sordid ashen to dull brown, orbicular, wedge-shaped, or elongate, with narrow darker margin, approx. .5–1.5 cm. diam.; ostioles wide, delimited by a conspicuous ring of blackish, thick-walled cells; A-type conidia subfusoid, hyaline, often biguttulate, 9–16 x (2.5–) 3.5–4.5 μ, B-type conidia laxly curved, hyaline, tapered, about 18–35 x 1–1.5 μ, or rarely a little wider.

On living leaflets (rarely on petioles) of *Thalictrum dasycarpum.* University of Wisconsin Arboretum, Madison, Dane County Wisconsin, U. S. A., August 21, 1961.

The plants bearing this leaf parasite appeared otherwise healthy, but among them and adjacent to them, were current season's plants of *T. dasycarpum* which were completely dead and brown. On their stems and on the branches of the inflorescence are numerous applanate, black pycnidia very similar in appearance to those described on the leaves. However, so far as is shown by examination of a number of them, these pycnidia contain only very numerous scolecospores which are produced on closely ranked, flask-shaped conidiophores, and are quite similar in size and appearance to the B-spores described above. While it seems possible there is a connection with *Phomopsis thalictri,* it cannot be regarded as demonstrated, since no intergradation between the two has been observed. Specimens of the fungus on stems have been filed in the University of Wisconsin Cryptogamic Herbarium as *Rhabdospora* sp. for the time being.

Septoria chaenorrhini sp. nov.

Maculis nullis; pycnidiis subepidermidibus, amphigenis, nigris, globosis, gregariis prope vel confertis, ostiolis indistinctis, muris tenuioribus supra, parvis, ca. 45–75 μ diam.; conidiis gracilibus, hyalinis, continuis, rectis fere vel curvis leniter, raro curvis admodum, (15–) 18–28 x (1.2–) 1.5–2 μ.

Spots none, pycnidia subepidermal, amphigenous, black, globose, closely gregarious to crowded, no distinct ostiole, the wall thinner above, small, approx. 45–75 μ diam.; conidia slender, hyaline, continuous, from almost straight to slightly curved, or rarely strongly curved, (15–) 18–28 x (1.2–) 1.5–2 μ.

On the leaves and inflorescence of *Chaenorrhinum minus (Linaria minor).* On Milwaukee R. R. right-of-way one mile east of Juda, Green County, Wisconsin, U. S. A., August 12, 1961.

S. chaenorrhini does not correspond to species of *Septoria* described on *Linaria* from the Old World, and is very different from *Septoria linariae* H. C. Greene (Trans. Wis. Acad. Sci. Arxa Lett. 35:130. 1944) which occurs on *Linaria canadensis* in Wisconsin.

COLLETOTRICHUM VIOLAE-TRICOLORIS R. E. Smith on *Viola tricolor* (cult.). Waupaca Co. near Ogdensburg, September 16, 1960. Coll. L. Hansen. On green stems.

Colletotrichum helianthi J. J. Davis var. **macromaculans** var. nov.

Maculis orbicularibus, marginibus flavo-brunneis, latis aliquanto, centris fusco-brunneis magnis conspicuisque, definitis, 1–2.5 cm. diam.; acervulis amphigenis, sparsis; setis 65–100 x 3.5–4.5 μ, 1–3 septatis; conidiis sublunatis vel falcatis, 18–23 x 2.5–3.5 μ.

Spots orbicular, with rather wide yellowish-brown margins and sooty-brown centers, large and conspicuous, sharply defined, 1–2.5 cm. diam., acervuli amphigenous, scattered but numerous; setae 65–100 x 3.5–4.5 μ, 1–3 septate; conidia sublunate or falcate, 18–23 x 2.5–3.5 μ.

On living leaves of *Helianthus strumosus*. Gibraltar Rock County Park, Columbia County, Wisconsin, U. S. A., August 7, 1961.

This is not sufficiently different from *C. helianthi* to warrant description as a new species, but it does seem to be of varietal rank and has been collected once earlier at the same station in 1952 (Amer. Midl. Nat. 50:503. 1953). In *C. helianthi* the spots, while likewise sharply delimited, are not ordinarily over 3–5 mm. diam. and the acervuli are strictly epiphyllous. *C. helianthi,* aside from the spots it produces, is larger and coarser than var. *macromaculans,* with the setae 80–150 x 3–5 μ, the conidia 25–35 x 2.5–3.5 μ, and often, but not always, somewhat fusoid in shape.

MYCOGONE ROSEA Link on *Cortinarius* sp. Dane Co., Madison, October 10. Coll. M. Hemphill.

BOTRYTIS UREDINICOLA Peck occurred in considerable profusion on leaves of *Panicum virgatum* in the University of Wisconsin Arboretum at Madison in the summer of 1960. This fungus is sadly misnamed, inasmuch as it does not appear to belong in *Botrytis,* as that genus is generally understood, and is not parasitic on a rust, or necessarily even associated with one. Careful examination of ample specimens of the Fungi Columbiani series, Nos. 2907 and 4607, both labeled as indicating the fungus to be on or associated with *Uromyces graminicola* Burr., shows no trace of rust, but excellent development of the *"Botrytis"*. No. 2907 is presumably type material. Most of the Wisconsin collections likewise bear no rust, although some leaves do have sori of *Puccinia panici* Diet. which is very common on *P. virgatum* in Wisconsin. The fungus is amphigenous, but mostly on the adaxial leaf surface. It is obviously a strong parasite and sections show it to be very deep-seated in the xeric leaves. The fructification tends to be elongate, probably a response to the spatial situation resulting from the prominent, closely parallel veins. As fall progressed it was noted that the fruiting structures were becoming black and sclerotized, suggesting the development of an overwintering condition and possible formation of a perfect stage. In an attempt to learn some details of the life history of this interesting fungus material, ranging from that of young, new infections to that obviously old and strongly sclerotic, was fixed, imbedded, sectioned and stained. As the accompanying photographs show, from a very early stage, preceding rupture of the epidermis, the fungus is in close contact with the sheath of a host vein and, as development proceeds, in most cases tends to completely envelop the sheath and ultimately to crush the sheath cells. With increasing sclerotization the compacted, isodiametric, but still hyaline inner cells of the fructification display a markedly granular content. In some instances, however, as illustrated in Plate III, Fig. 5, less completely sclerotized overwintering bodies are filled with small, hyaline, rod-shaped microconidia (spermogonial cells?). In the latter part of March 1961 a collection of naturally overwintered leaves bearing the sclerotic structures developed the previous fall was collected in the field. On microscopic examination there was no evidence of an incipient perfect stage, other than the microconidia just mentioned, but some of the leaves were placed in a moist chamber at room temperature to see whether further development could be stimulated. After about two weeks the characteristic snow-white conidiophores and conidia of *B. uredinicola* were produced from the overwintering structures. The spring was abnormally dry and cold, but on June 16 the fungus was observed in the field in full development on overwintered leaves. Thus, it is evident that the fungus may, and perhaps regularly does, overwinter without subsequent formation of a perfect stage. Early in July abundant infection of the new 1961 leaves was noted, completing the cycle. Dr. Roderick Sprague has studied this material and considers that is is very close to, but perhaps not identical with, *Sporotrichum peribebuyense* Speg. which occurs in North America on species of *Setaria* and which Sprague has discussed in his "Diseases of Cereals and Grasses in North America".

FOREST CUTTING AND SPREAD OF SPHAGNUM IN NORTHERN WISCONSIN[1]

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A large total area in northern Wisconsin is now occupied by semi-swamp soils of a rather unusual morphology and uncertain origin. The surface "mor" layer of these soils is largely made up of live bog moss, comprising the "stratum superficiale" or S-horizon or Førsslund (1945). This layer, attains a thickness of 7 inches and is underlain by a narrow zone of dark-brown, nearly black macerated organic remains (H). The substratum consists of a leached, usually water-logged silty clay loam with pronounced mottling (G). Whether these soils are of a "climax' 'nature, or temporary post-logging developments is a matter of conjecture.

A solution to this problem, however, was suggested by observations of effects of partial cuttings of spruce and balsam fir stands on fine textured gley-podzolic soils, initiated in the late forties in the Gagen Forest Management Unit of the Consolidated Water Power & Paper Co., Oneida County. After a few years, the results of these cuttings indicated that a heavy opening of the canopy invites an invasion of mosses, particularly *Sphagnum* spp. Alteration of this kind threatened a deterioration of site conditions and subsequent decrease of increment of the thinned stands. Therefore, as a reconnaissance measure, in the spring of 1955 four 7 by 7 feet plots were staked out on a fine textured gley-podzolic soil, underlain by a ground water at a depth of 2½ feet. The soil was supporting an open, 40-year old stand of volunteer black spruce with sporadic small patches of *Sphagnum, Polytrichum, Hypnum, Hylocomium* and *Dicranum* spp., and a rather dense cover of *Vaccinium myrtilloides, Cornus canadensis, Clintonia borealis, Equisetum silvaticum, Ledum groenlandicum and Maianthemum canadense.* Two of the plots were placed under a fairly dense canopy of trees, and two in small openings where the timber was partly removed. The existing cover of *Sphagnum* was carefully mapped on cross-hatched paper

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by subdividing the plots into quadrats measuring 144 sq. inches each.

The results of a re-survey of these plots in summer of 1961 revealed no changes in the distribution of bog moss under dense cover of trees, but an appreciable enlargement of its area in the thinned stand, as shown in Figure 1. This indicated that at least some gley-podzolic soils of northern Wisconsin upon the removal of forest cover are being converted into semi-swamps of "moss-mor" soils in

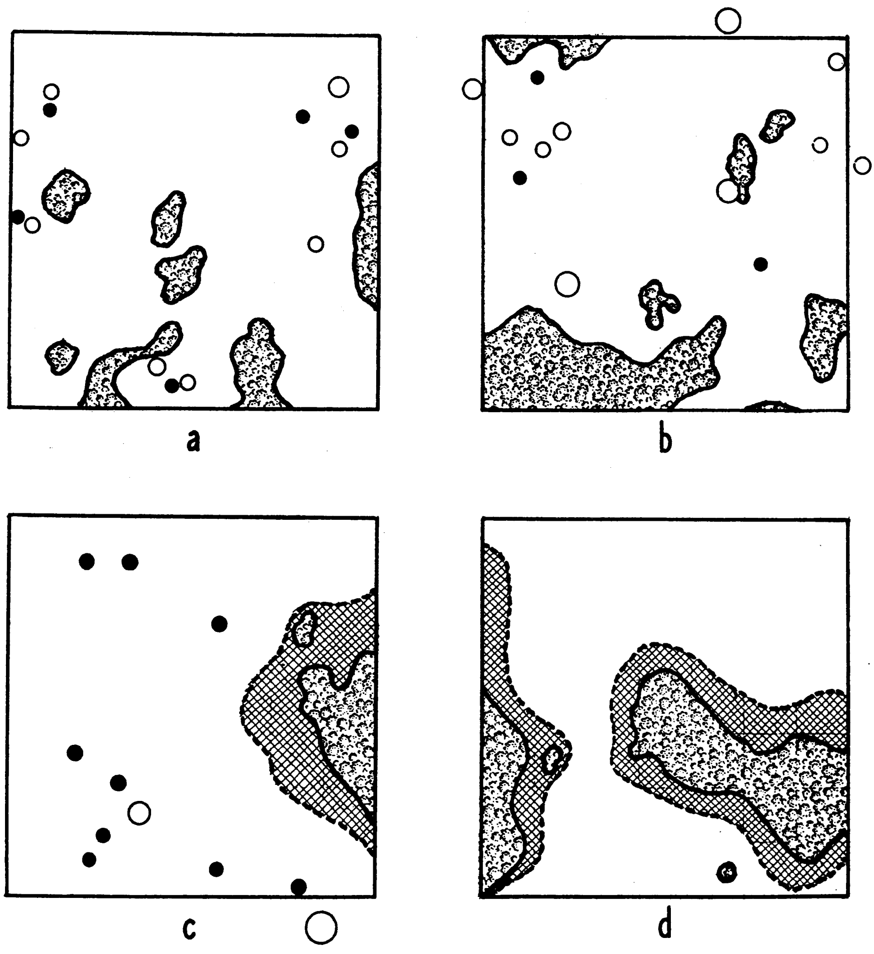

FIGURE 1. Effect of forest cover on the distribution of *Sphagnum:* a and b plots were established under the canopy of trees, c and d plots were established in open area. Cross-hatching indicates the spread of bog moss during the period 7.1955–6.1961. Open and block circles denote live and dead trees, respectively.

a manner similar to soils of Scandinavian countries (Hesselman, 1928; Malström, 1931).

The spread of *Sphagnum* on this site proceeded at a rather slow rate. Within a 6-year period it invaded about 6 square feet in each of the squares and at this rate it would take nearly 50 years to occupy the entire area of 50 sq. feet.

This calculation, however, proved to be in discord with observations made on an adjacent area where the basal area of a dense stand of black spruce was reduced by thinning in 1954 to about 50 sq. feet per acre. Nearly all cut stems and branches, left on the ground, were found to be covered with a 2 to 4 inch thick blanket of *Sphagnum*. This proved that, under conditions favoring its distribution, the *Sphagnum* can take over the area of a heavily thinned stand in a period of less than 10 years.

The different behavior of bog moss may be attributed to the occurrence of much more vigorous ground cover of low shrubs on the study site in comparison with that of the thinned stand. This would imply that the distribution of bog moss is checked not only by the canopy of trees, but also by the competition of ground cover plants; blueberries with their powerful root systems which dry the surface soil layer, are likely to present a particularly formidable barrier to the encroachment of the water demanding *Sphagnum*. Therefore, it can be assumed that areas of dense stands with no understory of low shrubs would exhibit upon a heavy cutting a much faster spread of bog moss than the areas on which its rate of spread has been already slowed by competing plants.

Observations of the ground water level in soils of fully stocked and periodically cut stands suggested that the process of swamp formation or paludization is accomplished by a combined influence of the true or phreatic ground water and puddled or vadose water.

The bog moss is known to exert several unfavorable effects on the growth of most higher plants: it imparts to the surface soil layer a strong acidity, produces a local saturated condition which impedes soil aeration, and impoverishes the invaded soils by storing nutrients in its accumulating tissues; it possesses a high insulating capacity which keeps the underlying soil at a temperature below 60° F even when the air temperature exceeds 85° F, and thus interferes with the normal transpiration of trees. According to previous observations (Wilde et al., 1954), the invasion of *Sphagnum* can reduce the annual increment of black spruce on podzolized soils from 0.4 to a mere 0.1 cord per acre.

Consequently, in localities vulnerable to invasion of bog moss, considerable caution should be exercised in partial cuttings of stands on soils underlain at a shallow depth by the ground water table or possessing inadequate permeability. The higher cost of conservative cuttings, precluding the spread of *Sphagnum,* is likely to be fully compensated by a higher increment and better quality of wood. In some instances, the use of herbicides may attain far-reaching importance in silvicultural management of stands on gley-podzolic soils.

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PRELIMINARY REPORTS ON THE FLORA OF WISCONSIN. NO. 47. THE ORDERS THYMELAEALES, MYRTALES, AND CACTALES[1]

DONALD UGENT
Herbarium of the University of Wisconsin

This treatment includes all the families in Wisconsin with free petals and inferior ovary, or ovary superior and enclosed by a tubular or campanulate persistent calyx, except the Nyssaceae, Araliaceae, Umbelliferae and Cornaceae. The Haloragidaceae and the Hippuridaceae, although included, have been treated in greater detail by Fassett (1930). Nomenclature and descriptions generally follow *The New Britton and Brown Illustrated Flora* (Gleason, 1952) and *Gray's Manual of Botany,* Ed. 8 (Fernald, 1950).

Distribution maps, habitat data, and flowering dates are based on specimens in the following herbaria: University of Wisconsin (WIS); Milwaukee Public Museum (MIL); University of Minnesota (MINN); Northland College, Ashland; Platteville State College; and Saint Norbert's College, De Pere. Other sources of information are cited in the text. Dots indicate specific location, triangles county records without specific locality. Small dots in Lincoln County represent sight records of Frank C. Seymour. Triangles in Illinois counties are based on Jones and Fuller (1955). Numbers in the enclosures on the maps indicate the number of specimens in flower and fruit. Specimens in bud, very young fruit, or vegetative condition are not included. These figures give a rough, though low, estimate of the amount of material that was available for this study and an indication of when a species is apt to flower or fruit in Wisconsin.

Grateful acknowledgement for the loan of their Wisconsin specimens are due to Albert M. Fuller and Emil P. Kruschke, Milwaukee Public Museum; Thomas Morley, acting curator, University of Minnesota; Peter J. Salamun, University of Wisconsin–Milwaukee; Henry C. Greene, curator, Cryptogamic Herbarium, University of Wisconsin; Russell D. Wagner, Platteville State College; and Franklin C. Lane, Northland College. Thanks are also due Mrs. Katherine S. Snell, herbarium assistant, for her cheerful encouragement and assistance; Miss Kathryn L. Wollangk who assisted in the preparation of *Epilobium* scatter-diagrams; Mrs. Janice Paynter for illus-

[1] Published with the aid of the Norman C. Fassett Memorial Fund.

Frontispiece. Water-Willow (*Decodon verticillatus* var. *laevigatus*), of the Lythraceae, forming a solid border along Allequash Creek, on Trout Lake in Vilas County, photographed by H. H. Iltis in June, 1962. Later in the summer, the branches elongate and arch into the water, where they root. Eventually they break off, and overwinter to start a new plant next spring. The species is well-known from the Pleistocene fossil record of Europe, but to day only occurs in Eastern North America.

trations of *Oenothera* and *Epilobium;* and especially to Dr. Hugh H. Iltis for his assistance and advice in the preparation of this report as well as for his critical reading of the manuscript.

This project was supported during 1959–1961 by the Research Committee of the University of Wisconsin on funds from the Wisconsin Alumni Research Foundation. The drawings of *Oenothera* and *Epilobium* were prepared with the financial help of the J. J. Davis Fund.

CONTENTS

ORDER THYMELAEALES

Trees or shrubs with alternate or opposite, exstipulate leaves. Flowers commonly 4–5-merous, perfect or unisexual, regular, perigynous, petalous or apetalous. Stamens usually as many or twice as many as the sepals. Ovary superior, 1-celled, carpels 2-many, with a single suspended ovule. Fruit a nutlet or drupe.

KEY TO FAMILIES

A. Leaves green; flowers perfect, the calyx bearing 8 stamens and free from the ovary, which forms a berry-like drupe in fruit ------------------------THYMELAEACEAE, page 85

AA. Leaves silvery-scurfy with stellate hairs or scales; flowers perfect or dioecious, the calyx bearing 4 or 8 stamens and in the perfect or pistillate flowers becoming pulpy and berry-like in fruit, strictly enclosing the achene --ELAEAGNACEAE, page 86

THYMELAECEAE—MEZEREUM FAMILY

Small trees or shrubs with simple, alternate, entire leaves. Flowers regular, perfect, perigynous, 4–5-merous. Petals lacking or represented by scales. Sepals often petal-like, united into a tube at least at the base, and bearing usually twice as many stamens as its lobes. Ovary superior, 1-celled, 1-ovuled. Fruit a drupe.

1. DIRCA L. LEATHERWOOD

1. DIRCA PALUSTRIS L. Leatherwood; Rope-Bark. Map 1.

Shrub 1–3 m high; branchlets jointed, the bark fibrous and very tough (hence common name). Leaves alternate, broadly oval-obovate, entire, 2–9 (–11) cm long, on very short petioles 1–3 mm long, *their bases concealing the dark-hairy buds of the next season.* Flowers light yellow, 5–10 mm long, preceding the leaves. Petals none. Stamens 8, exserted, the alternate ones longer. Drupe ellipsoid, pale green or yellowish, often drying red, 5–11 mm long(see McVaugh, 1941).

Throughout the state, though most common north of the "tension zone", in rich mesic Northern Hemlock Hardwood and Maple-Basswood forests, in the east in Oak-Beech and Beech forests, sporadic in southern Wisconsin in rich Oak or Maple woods, occasionally in moist or wet thickets. Flowering from late March through May (mid-June), and fruiting from late April to mid-June.

The remarkably pliable and strong bark was used by the Indians for thongs in making canoes, bow strings, and fish lines. The bark is poisonous, acting as a violent emetic.

ELAEAGNACEAE—OLEASTER FAMILY

Trees or shrubs covered with silvery or golden-brown peltate or stellate scales. Leaves entire, alternate or opposite. *Flowers* small, *perfect or dioecious,* regular, perigynous, in axillary clusters or rarely solitary. Petals none. Sepals often petal-like, 2–4-lobed, alternating with as many or twice as many stamens. Ovary 1-celled, 1-ovuled, becoming fleshy in fruit.

Represented in our area by one native species and two introduced ornamentals: *Shepherdia argentea* Nutt., the Buffalo Berry, an occasionally cultivated shrub, has dioecious flowers, thorny branches and opposite leaves silvery-lepidote on both sides; *Elaeagnus angustifolia* L., the Russian Olive, a small tree, has alternate leaves and perfect flowers.

1. SHEPHERDIA Nutt. Buffalo berry

1. Shepherdia canadensis (L.) Nutt. Soapberry. Map 2.

Thornless dioecious shrub 1–2 m high. *Leaves opposite,* elliptical to ovate, 2–7 cm long, *green and nearly glabrous above, densely silvery-downy with scattered rusty scales beneath.* Flowers greenish-yellow, in small clusters on twigs of the previous season, the pistillate with a 4-cleft calyx, the mouth of the hypanthium closed by dense hairs. Staminate flowers with a 4-parted calyx and 8 stamens. Fruit berry-like, ovoid, yellowish-red, inedible. 2n=22 (Cooper 1932, ex Darlington, 1955).

Occasional and locally common along the shoreline of Lake Michigan and Lake Superior; on calcareous cliffs and shores, more or less wooded sandy dunes, clay bluffs, or ravines along Lake Michigan, on sandy gravelly moraines (Sheboygan Co., NE of Elkhart Lake, *Shinners 2960* [WIS]), and on wooded sandy or clay shores of Lake Superior, in northern Wisconsin rarely in marshes (Ashland Co., Loon Lake, Mellen, *Bobb 244* [WIS]), Aspen-Paper Birch deeryards, or upland woods. Flowering from mid-April to early June, and fruiting from early June through July (October).

ORDER MYRTALES

Aquatic or terrestrial herbs. Flowers regular, mostly perfect and petalous, perigynous or epigynous, with a well developed hypanthium or "calyx-tube" bearing the flower parts high above the ovary. Stamens usually as many or twice as many as the petals. Ovary superior or inferior, 1-several-celled. Fruit a 1-many-seeded capsule or rarely indehiscent.

KEY TO FAMILIES

A. Ovary superior; flowers perigynous.
  B. Leaves entire, with only one central vein; anthers dehiscent longitudinally ____________LYTHRACEAE, page 87
  BB. Leaves sharply serrulate, prominently 3 veined; anthers opening by terminal pores __________________________ ______________________MELASTOMATACEAE, page 93
AA. Ovary inferior; flowers epigynous.
  C. Leaves alternate or opposite, entire to serrate, or whorled and pinnately disected; stamens 2–8; aquatic or terrestrial herbs.
    D. Leaves alternate or opposite, entire to serrate; style 1; mainly terrestrial herbs ____ONAGRACEAE, page 93
    DD. Leaves alternate or whorled, pinnately dissected; styles 3 or 4; aquatic herbs__HALORAGIDACEAE, page 127
  CC. Leaves whorled, entire, never pinnately dissected; stamen 1; aquatic herb ___________HIPPURIDACEAE, page 128

LYTHRACEAE—LOOSESTRIFE FAMILY

Herbs (ours) with simple, entire, opposite or whorled leaves. Flowers axillary or whorled, *4–7-merous, perfect,* regular, *perigynous, with a well developed hypanthium,* dimorphic or trimorphic. Calyx tubular or campanulate, often with appendages between the lobes. Petals present or absent. Stamens usually as many as petals. Ovary completely or incompletely 2–6-celled, the ovules several to many per carpel. *Fruit a capsule enclosed by the persistent hypanthium.*

KEY TO GENERA

A. Calyx with 4 teeth or lobes; stamens 4; petals minute or none.

B. Calyx with appendages between the lobes; leaves narrowed to a petiole ________________________________1. ROTALA.

BB. Calyx-lobes without appendages; leaves sessile; small aquatic, rarely emergent ______________________2. DIDIPLIS.

AA. Calyx with 5–7 teeth; stamens 5–12; petals conspicuous, reddish-purple.

C. Hypanthium cup-shaped; flowers verticillate; leaves opposite or in 3's (the upper rarely alternate), tapered to a petiole___________________________________3. DECODON.

CC. Hypanthium tubular; flowers in dense terminal spikes or solitary in axils of upper leaves; leaves all opposite or alternate, sessile __________________________4. LYTHRUM.

1. ROTALA L.

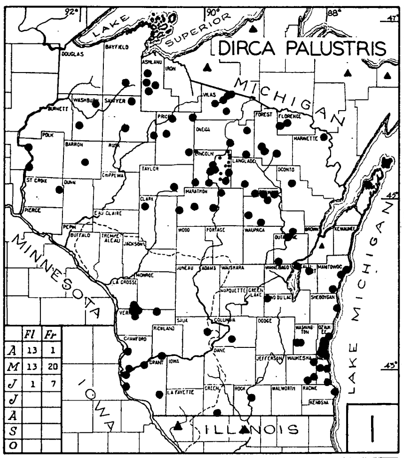
[Fernald, M. L. and Griscom, L., Rhodora 37:169, 1935.]

1. ROTALA RAMOSIOR (L.) Koehne. Tooth-Cup. Map 3.

Small annual herbs, branched or simple, depressed to erect, glabrous, 5–20 cm high. Leaves opposite, linear-oblanceolate to spatulate, 1–3 cm long, 2–4 mm wide. *Flowers 4-merous, axillary, solitary, sessile. Calyx campanulate or globose, with minute triangular appendages between the sinuses.* Petals minute, white or pink, soon deciduous. *Capsule enclosed by the persistent calyx,* 2–4 mm long, 2–3 mm broad, sessile.

Sandy or muddy open shores of lakes, ponds, or rivers, often on mudflats or sandbars, mostly in southwestern Wisconsin. Along Lake Barney (Dane Co., *Zimmerman 3448* [WIS]) on low edge of cornfield with *Polygonum coccineum, P. pensylvanicum, Eleocharis intermedia, E. engelmanni, Lindernia anagallidea,* and *Scirpus hallii.* Flowering from mid-July through September, and fruiting from late July to mid-October.

Easily confused with *Ludwigia palustris* (p. 94) which has the calyx-tube actually fused to the ovary and only the lobes free. Emergent *Ludwigia* generally roots at the nodes and has prostrate stems.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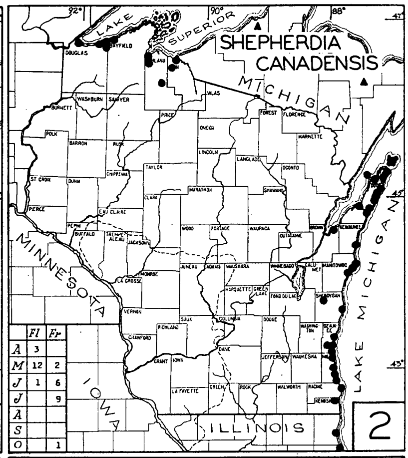
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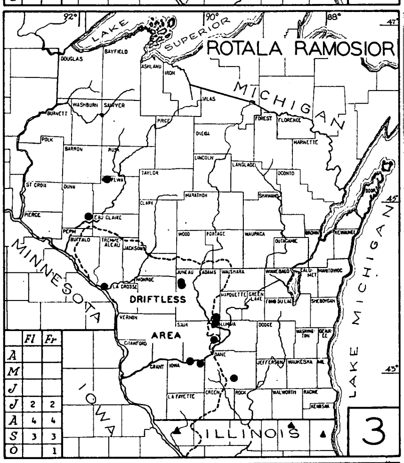
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MICHIGAN
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DRIFTLESS AREA
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Fl Fr
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O 1
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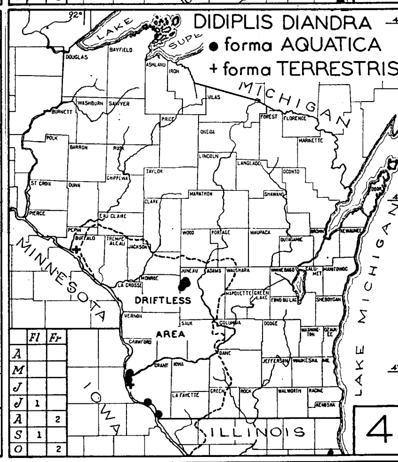
DIDIPLIS DIANDRA
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+ forma TERRESTRIS
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MICHIGAN
MINNESOTA
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A 2
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O 2
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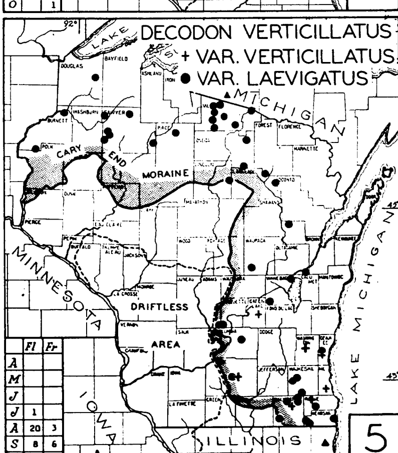
DECODON VERTICILLATUS
+ VAR. VERTICILLATUS
● VAR. LAEVIGATUS
LAKE
MICHIGAN
CARY END MORAINE
MINNESOTA
DRIFTLESS AREA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A
M
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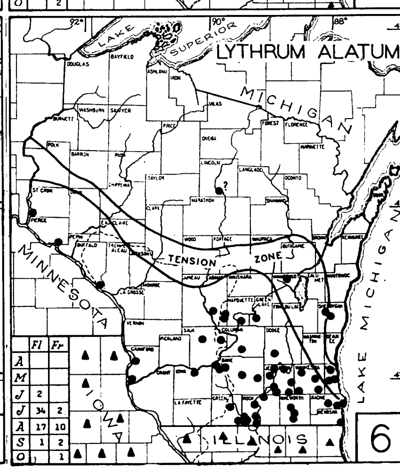
J 1
A 20 3
S 8 6
O 1 1
5


LYTHRUM ALATUM
LAKE SUPERIOR
MICHIGAN
TENSION ZONE
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A
M
J 2
J 34 2
A 17 10
S 1 2
O 1
6

2. DIDIPLIS Raf. Water Purslane.

[Fassett, N. C., "A Manual of Aquatic Plants." Rev. ed. p. 255, 1957.]

1. Didiplis diandra (Nutt.) Wood. Water Purslane Map 4.
Peplis diandra Nutt.

Small aquatic or mud dwelling herbs with *opposite leaves* and minute greenish axillary flowers. Petals none. *Hypanthium campanulate,* the calyx-lobes triangular, *without appendages.* Capsule globose, indehiscent, about 1.5–2 mm long and broad, sessile. Leaves of submersed plants quite different in aspect from the emersed.

A. Submersed aquatic with ribbon-like, thin, limp leaves not narrowed at base__D. diandra forma aquatica (Koehne) Fassett.

AA. Emersed form with firmer broader leaves somewhat tapered at the ends____D. diandra forma terrestris (Koehne) Fassett.

Shallow water and muddy shores of pools in the Mississippi River bottoms in Grant, Crawford, and Buffalo Counties; in Juneau Co., in reservoir at Potters' Cranberry Marsh, 6 miles S. of Mather. Flowering from July to early September, and fruiting from August through October. A monotypic genus of the eastern United States, resembling and easily confused with *Callitriche,* the Water-Starwort, which lacks a perianth and has flattened and deeply grooved capsules.

3. DECODON J. F. Gmel. Swamp-Loosestrife

1. Decodon verticillatus (L.) Ell. Water-Oleander. Map 5.

Perennial herbs with arching stems 6–14 (–18) dm long, these often rooting at the tip when reaching the water or mud, *the massive submersed parts woody, thickened with conspicuous, spongy and soft, brown aerenchyma.* Leaves short-petioled, opposite or in whorls of 3 or 4, lanceolate, entire, 5–20 cm long, 1–5 cm wide. Flowers trimorphic, verticillate in the axils of the upper leaves. *Calyx cup-shaped,* the 5–7 teeth *with slender appendages between their sinuses.* Petals 5, reddish-purple, lanceolate, cuneate at base. Stamens 10, exserted, unequal. Capsule globose, 3–5-celled, loculicidal, on pedicels ca. 1 cm long. A monotypic North American genus, known in the European fosil record from the Pleistocene, but there now extinct.

In Wisconsin 2 varieties can be recognized differing only by pubescence. Intergrading specimens are occasionally encountered.

Key to Varieties

A. Stems, pedicels, and leaves glabrous, or nearly so ---------------------------------1a. D. VERTICILLATUS var. LAEVIGATUS.

AA. Stems, pedicels, and lower leaf surfaces more or less downy -------------------1b. D. VERTICILLATUS var. VERTICILLATUS.

1a. DECODON VERTICILLATUS var. LAEVIGATUS T. & G.

Northern and eastern Wisconsin, in swamps, shallow pools, edge of streams, lake margins, and cattail marshes with *Zizania* and *Sagittaria,* mostly at the edge and trailing or arching into the water, occasionally rooting in water up to 1 m deep, often forming extensive pure stands (e.g. in Allequash Creek, Vilas Co.). Flowering from late July to early October, and fruiting from mid-August to mid-October. The Sawyer Co. records are those reported by Fassett (1932).

1b. DECODON VERTICILLATUS var. VERTICILLATUS.

Southeastern Wisconsin, on edge of lakes. Flowering dates as in the above variety.

In Wisconsin, *Decodon* is not only completely lacking from the Driftless Area, but appears to be restricted only to those glaciated areas north and east of the Cary End Moraine of the Wisconsin glaciation, which is indicated on map 5 by stippling. The significance of this distribution, if any, is unknown.

4. LYTHRUM L. Loosestrife

[Shinners, L. H., 1953. Synopsis of the U. S. species of *Lythrum* (Lythraceae). Field and Lab. 21:80–89.]

Herbs with 4-angled stems and opposite, whorled, or alternate leaves. Flowers often dimorphic or trimorphic. Petals 5–7, pink or magenta (rarely white). *Hypanthium cylindrical, striate,* 5–7 toothed, *with slender appendages between the sinuses.* Stamens as many, or twice as many as the petals, inserted on the calyx-tube. Ovary 2-celled, the ovules numerous. Capsule septicidal, enclosed by the persistent hypanthium.

Key to Species

A. Leaves alternate on the branches, on the stem either alternate, or opposite, or rarely in 3's; flowers solitary in the axils of the upper leaves; calyx glabrous ----------------1. L. ALATUM

AA. Leaves opposite, or in whorls of 3's; flowers in long dense spikes; calyx more or less downy------------2. L. SALICARIA.

1. LYTHRUM ALATUM Pursh. Winged-Angled Loosestrife. Map 6.

Branched erect perennial 2–10 dm tall, *glabrous,* the stem angled and often slightly winged. Leaves entire, sessile, linear-oblong to ovate-lanceolate, acute, with a rounded or cordate base. *Flowers* short-pedicelled, *solitary,* dimorphic, either the stamens or the style exserted. Calyx-tube cylindrical, striate. Petals purple, obovate, about 5 mm long.

Southeastern Wisconsin and Mississippi River bottoms, in moist or wet sedge meadows, prairies, marshes, lake shores, river banks, bogs, and wet ditches; at Ennis Lake (Marquette Co., *Iltis 12681* [WIS]), on alkaline sedge meadows with *Lobelia kalmii, Gentiana procera, Solidago riddellii, Aster junciformis, Scleria verticillata,* and *Potentilla fruticosa;* and south of Kenosha (Kenosha Co., *Kruschke s.n.,* 1941 [MIL]), on moist sandy prairies with *Pycnanthemum virginianum, Solidago graminifolia, S. riddellii, Liatris spicata, Petalostemum* sp., *Allium cernuum,* and *Lobelia kalmii.* Flowering from late June to early October.

A collection from Lincoln Co. (Merrill, moist shore, not common, *Goessl 2808* [MIL]) cited by Seymour (1960:254) is very likely based on a mislabelled specimen, as are many other records of Goessl. Seymour, who gathered nearly 10,000 specimens in that county, never was able to relocate that species.

2. LYTHRUM SALICARIA L. var. TOMENTOSUM (Mill.) DC. Spiked or Purple Loosestrife. Map 7.

Erect robust *puberulent* perennial 6–13 dm high. Leaves lanceolate, opposite or in whorls of 3's, sessile and cordate or clasping at base. *Flowers in dense terminal, interrupted spikes,* trimorphous in the relative lengths of the stamens and style. Appendages of calyx-tube twice as long as the sepals, or longer. Petals reddish-purple, showy, 7–10 mm long. $2n=30, 50, 60$ (Shinke, 1929; Levan & Love, 1942; La Cour, 1945, ex Darlington, 1955).

Sporadic throughout the state, though often occuring in very large colonies, in moist or wet ground, frequently along muddy lake shores, river banks, ponds, cattail marshes, sedge meadows, and roadside or railroad ditches. A native of Europe frequently cultivated for its showy flowers, and established as an escape, it has been rapidly spreading in recent years, the first record in the state collected in 1928 (Milwaukee Co., Whitefish Bay, *Throne s.n.* [WIS, MIL]). Flowering from late June to early September, and fruiting in August and September.

MELASTOMATACEAE—MELASTOME FAMILY

Herbs (shrubs or trees in tropical regions) with opposite or whorled, prominently *3–9-ribbed* exstipulate leaves. Represented in our area by a single genus and species.

1. RHEXIA L. MEADOW-BEAUTY

[James, C. W., A revision of *Rhexia*. Brittonia 8:201–230. 1956.]

1. RHEXIA VIRGINICA L. Meadow-Beauty; Deergrass. Map 8.

Perennial herb with tuberous roots, 2–5 dm tall, sparsely glandular-hirsute, with tufts of hairs on the nodes. *Leaves opposite,* ovate-laceolate to ovate, 2–5 cm long, *3–5-nerved, the margins serrulate-ciliate. Flowers* in cymes, *perigynous. Calyx urn-shaped, persistent. Petals 4, showy, dark rose to purple,* spreading, 8–17 mm long. *Anthers bright yellow,* 5–7 mm long, linear, curved. Capsule 6-celled; seeds coiled, papillose.

Central Wisconsin, mainly in the bed of Glacial Lake Wisconsin, in moist sedge meadows, and sandy roadside and railroad ditches, near Mauston (Juneau Co.), growing under Jack Pine along edge of bog, and south of Princeton (Green Lake Co.), on a moist meadow with *Rynchospora* and *Polygala.* Flowering from July through August, and fruiting from late August to early September.

The genus centers in the Atlantic coastal plain. The pine forests of the Glacial Lake Wisconsin area markedly resemble those of the coastal plain, being flat, sandy, and wet!

ONAGRACEAE—EVENING-PRIMROSE FAMILY

Annual or perennial herbs with *(2–) 4-merous,* perfect *epigynous,* and symmetrical flowers. Hypanthium-tube adhering to the (1–) 2–4-celled *inferior ovary,* often prolonged beyond it and bearing the floral organs at its summit. Stamens 2, 4, or 8, often alternately unequal. *Leaves simple, opposite or alternate.*

KEY TO GENERA

A. Petals 4; stamens 4 or 8; leaves opposite or alternate.
  B. Hypanthium-tube scarcely or not at all extended beyond the ovary.
    C. Seeds without a tuft of hairs at the summit; calyx persistent on the fruit; petals minute or absent; stamens 4 ---------------------------------1. LUDWIGIA.
    CC. Seeds with a tuft of hairs at the summit; calyx deciduous; petals conspicuous; stamens 8 --2. EPILOBIUM.

BB. Hypanthium-tube conspicously prolonged beyond the ovary.

D. Petals yellow, sometimes pink or white (then more than 1 cm long); capsule eventually dehiscent, containing several to many seeds. --------3. OENOTHERA.

DD. Petals white, pink, or red (never yellow), less than 1 cm long; capsule indehiscent, containing 1–4 seeds ---------------------------------------4. GAURA.

AA. Parts of flower in 2's; leaves opposite; fruits indehiscent, bristly ------------------------------------5. CIRCAEA.

1. LUDWIGIA L. FALSE LOOSESTRIFE

[Munz, P. A., The American species of *Ludwigia*. Bull. Torr. Bot. Club 71:152–165. 1944.]

Aquatic or marsh herbs with opposite or alternate leaves and axillary *4-merous flowers. Calyx-lobes persistent in fruit;* petals minute or absent. Capsule many-seeded, septicidally dehiscent, often with two bracts near its base.

KEY TO SPECIES

A. Leaves opposite; stems creeping on mud or submersed ---1. L. PALUSTRIS.

AA. Leaves alternate; stems erect or ascending --2. L. POLYCARPA.

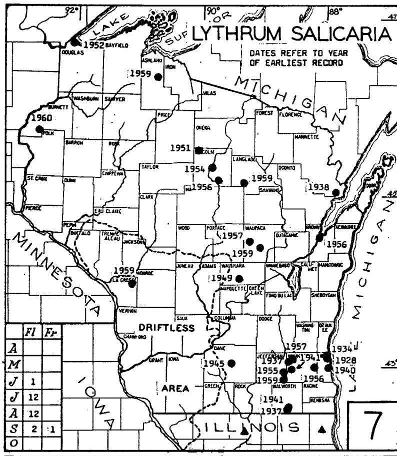
1. LUDWIGIA PALUSTRIS (L.) Ell. var. AMERICANA (DC). Fern. & Griscom. Marsh or Water Purslane. Map 9.

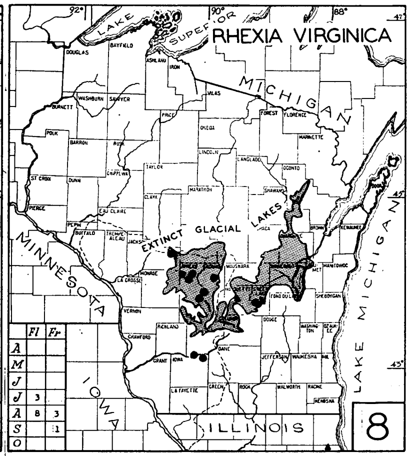
Plants weak-stemmed, nearly prostrate on mud or growing in shallow water, with roots from all but the upper nodes. Leaves lanceolate to ovate, 1–5 cm long, tapering to slender petioles. Flowers minute, axillary, solitary, and sessile, the petals wanting. Capsule 4-sided; *bracteoles minute or wanting.*

Submersed plants in deep water, with limp sterile stems, and broad thin long petioled leaves, are known as forma *elongata* Fassett.

Throughout Wisconsin, though sporadic, on muddy or sandy shores of lakes or rivers, along wet ditches, in marshes, and submersed in shallow standing water of ponds and lakes. Flowering from July through September, and fruiting from July to mid-October.

Autumnal forms of this species are often minute and may flower and fruit when only 1 cm tall. The aquatic phase of the species is often sold as an aquarium plant.


LYTHRUM SALICARIA
DATES REFER TO YEAR OF EARLIEST RECORD
DRIFTLESS AREA
7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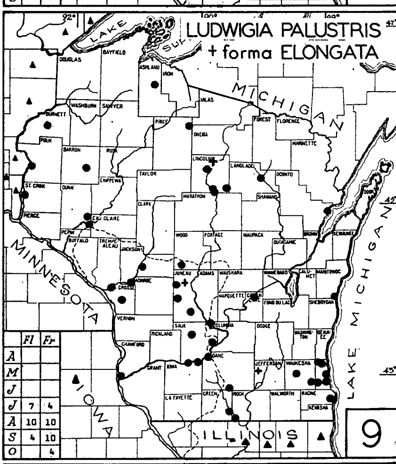
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+ forma ELONGATA
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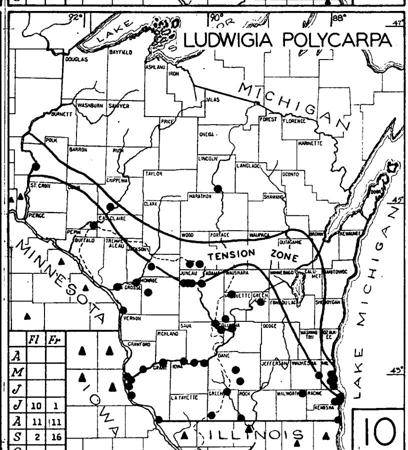
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TENSION ZONE
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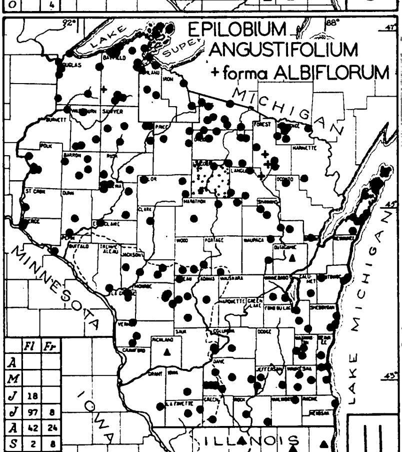
EPILOBIUM ANGUSTIFOLIUM
+ forma ALBIFLORUM
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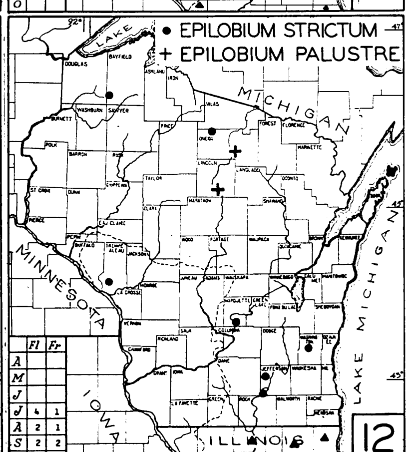

• EPILOBIUM STRICTUM
+ EPILOBIUM PALUSTRE
12

2. LUDWIGIA POLYCARPA Short & Peter. Ludwigia. Map 10.

Stems erect, commonly much branched above, 4-angled, glabrous, 2–9 dm tall, the stem base often in standing water and then swollen with thick soft spongy aerenchyma. Cauline leaves narrowly lanceolate to oblanceolate-elliptic, acuminate to acute, tapering to a sessile or short petiolate base. Petals minute, yellowish, ca. 1 mm long, or absent. Capsule 5–6 mm long, somewhat 4-sided, *with 2 bracts near its base.* Completely submersed plants have thin, narrowly lanceolate to linear leaves, and sterile weak stems.

Southern half of Wisconsin south of the "Tension Zone", on muddy or sandy lake shores, river banks, pond or bog margins, marshes, swamps, and flowages, rarely submersed in stagnant pools or ponds, as on the Kenosha Prairie. Flowering from Mid-July to early September, and fruiting from late July through September.

2. EPILOBIUM L. WILLOW-HERB

[Fernald, M. L., *Epilobium glandulosum* and *E. adenocaulon.* Rhodora 20:31–35. 1918; The identities of *Epilobium lineare, E. densum,* and *E. ciliatum.* Rhodora 46:377–386. 1944. Trelease, W., The species of *Epilobium* occurring north of Mexico. Ann. Rept. Mo. Bot. Gard. 2:69–117. 1891.]

Perennial (rarely annual) herbs with alternate or opposite leaves, and 4-merous flowers in terminal racemes or solitary in the upper leaf axils. Petals purple to pink or white. Capsule slender, many seeded. *Seeds with a tuft of silky hairs (coma) at the summit.*

KEY TO SPECIES

A. Flowers in a terminal raceme; petals 8–17 mm long, very showy; stigma 4-cleft ....1. E. ANGUSTIFOLIUM.

AA. Flowers solitary in the upper leaf axils; petals 3–8 mm long.

B. Stigma 4-cleft ;stem glabrate; leaves entire, nearly linear, rarely more than 3 mm wide; adventitious annual, rare.......................................2. E. PANICULATUM.

BB. Stigma entire; stem variously pubescent; leaves narrowly lanceolate, ovate-lanceolate, or elliptic, over 3 mm wide (linear and often narrower in no. 4).

C. Leaves entire or subentire, the margins often revolute; stem round, without decurrent lines from the base of each leaf.

D. Stems softly pubescent with straight spreading hairs ....3. E. STRICTUM.

DD. Stems minutely pubescent or canescent with appressed or incurved hairs.

E. Upper leaf-surface densely pubescent with incurved hairs ______________________4. E. LEPTOPHYLLUM.

EE. Upper leaf-surface glabrous or with few remote incurved hairs ___________________5. E. PALUSTRE.

CC. Leaves conspicuously toothed, flat; stem 4-angled, with decurrent lines, angles, or strips of pubescence running down from the leaf bases.

F. Mature seeds striate or striate-papillose (10X), often with a very short hyaline beak, the coma white, tawny, or brown; stem with spreading (often glandular) hairs as well as smaller incurved eglandular ones, the sides and angles equally pubescent; flower buds rounded or obtuse or with divergent sepal-tips.

G. Mature seeds striate, the coma white or whitish; flower buds obtuse or rounded; mature capsules rarely containing an aborted seed; stem simple or loosely branching (fig. 4) _6. E. GLANDULOSUM.

GG. Mature seeds striate-papillose, the coma white, tawny, or brown, buds rounded, or divergent tipped, or somewhat intermediate; mature capsules often containing many aborted seeds; stem bushy-branched at summit (fig. 4 and 5) ____ ______________________7. E. X WISCONSINENSE.

FF. Mature seeds papillose, beakless, the coma brown (white in immature capsules); stem minutely pubescent with incurved hairs above, tending to be pubescent in lines; flower buds with divergent sepal-tips (fig. 4) __________________8. E. COLORATUM.

1. EPILOBIUM ANGUSTIFOLIUM L. Great Willow-Herb; Fireweed. Map 11.

Erect perennial from creeping rhizomes, 0.2–2 m high, *with numerous flowers in a terminal raceme.* Leaves alternate, 3–20 cm long, lanceolate or linear-lanceolate, acuminate, entire or minutely denticulate, very short petioled. Petals 8–17 mm long, pink to purple or white in forma *albiflorum* (Dumort.) Haussk. Mature capsule 3–8 cm long, canescent. Seeds smooth or nearly so, the coma whitish or tawny. 2n=36 (Michaelis, 1925, ex Gaiser, 1926).

Very common throughout Wisconsin in almost any habitat and often weedy, on roadsides, railroad tracks, abandoned fields, prairies, open woods, bracken-grasslands and edge of swamps and bogs, especially abundant in recently cleared or burned woods (hence the common name). Flowering from mid-June to early September, and fruiting from late-July to mid-October.

2. EPILOBIUM PANICULATUM Nutt. var. SUBULATUM (Haussk.) Fern. Panicled Willow-Herb.

Slender dichotomous-paniculate branched annual. Stem glabrous or glabrate with exfoliating "bark" near the base. Leaves alternate or opposite, nearly linear, rarely more than 3 mm wide. Petals purple, 5 mm long. *Capsule spindle-shaped,* about 2 cm long. 2n=36 (Johansen, 1929, ex Gaiser, 1930).

Widely distributed in the Western States, collected but once in Wisconsin, along a railroad siding in Milwaukee (Aug. 13, 1940, *Shinners 2569* [WIS]).

3. EPILOBIUM STRICTUM Muhl. Downy or Soft Willow-Herb. Map 12.

Epilobium densum Raf.
Epilobium molle Torr., not Lam.

Perennial with erect stems 2–10 dm high, simple or branched above, *pubescent throughout with soft, dense, straight, spreading or somewhat ascending hairs.* Leaves narrowly lanceolate, 1–6 cm long, 2–7 mm wide, entire or minutely denticulate. Petals pink, 5–8 mm long. Coma becoming very pale dingy brown.

Rare and scattered in Wisconsin, in Tamarack-Sphagnum bogs, marshy or springy shores of lakes, at Ennis Lake (Marquette Co., *Iltis 12666* [WIS] in alkaline edge meadows with *Lobelia kalmii, Gentiana procera, Solidago riddellii, Aster junciformis, Liatris spp., Lythrum alatum,* and *Epilobium leptophyllum.* Flowering from late July to mid-September, and fruiting from late July to early October.

4. EPILOBIUM LEPTOPHYLLUM Raf. Linear-Leaved Willow-Herb Map 13.

Epilobium densum, of Gray's Man. ed. 7, not Raf.
Epilobium lineare, of authors, not Muhl.

Slender erect perennial 2–10 dm high, simple to much branched, minutely pubescent with incurved hairs. *Leaves linear or linear-lanceolate,* acute, with entire or subentire revolute margins, *canescent to sparsely pubescent above,* 1–3 mm wide, or in forma *umbrosum* (Haussk.) Fern. the thin and flat primary leaves 4–10 mm wide. Flowers in the axils of the upper leaves; petals pink or whitish, 4–6.5 mm long. Capsules 2–6 cm long, on pedicels 5–25 mm long. Seeds with a minute beak, the coma pale dingy brown.

Throughout Wisconsin though most common in the northern and eastern parts in almost any wet habitat both alkaline and acid, such as Tamarack, Sphagnum or Spruce bogs, swamps, margins of streams, ponds, lakes, *Alnus-Salix* thickets, wet prairies, sedge meadows, cattail marshes, damp sandstone cliffs, roadside and railroad ditches, wet Northern Hardwoods, and Conifer swamps. Flowering from mid-July to mid-September, and fruiting from late July to early October.

5. EPILOBIUM PALUSTRE L. Map 12.

Erect perennial 3–4.5 dm high with stems *decumbent at base*, simple to few branched above, glabrescent below, minutely incurved pilose above. Leaves linear to oblong-lanceolate, 1–4 cm long, 3–12 mm wide, entire to remotely denticulate, *nearly or quite glabrous above.* Flowers solitary in the upper leaf axils, *nodding in bud.* Calyx 3–4 mm long. Petals lilac to pink or white. Capsules 2–7 cm long, on pedicels 15–35 mm long. 2n=36 (Böcher, 1938, ex Löve, 1955).

A widely distributed boreal species extremely rare in northern Wisconsin, forms of which may closely resemble *Epilobium leptophyllum* forma *umbrosum.* The following collections, especially the first, are placed here with considerable reservation.

Lincoln Co.: spruce bog, [flowering and fruiting] Aug. 2, 1953, Merrill, *Seymour 15426* (WIS). Oneida Co.: shady mossy woods, [flowering and fruiting] Sept. 1, 1915, Rhinelander, *Goessl 2626* (MIL).

6. EPILOBIUM GLANDULOSUM Lehm. Northern Willow-Herb. Map 14.

Perennial with stems 0.3–10 dm high, simple to much branched, glabrous below, with spreading (often gland-tipped) as well as smaller incurved hairs above, *the sides as well as the angles pubescent.* Leaves varying from narrowly lanceolate to ovate-lanceolate, 1–10 cm long, 3–30 mm wide, shallowly denticulate to sharply serrulate, sessile or short petioled. *Flower buds obtuse or rounded at the summit.* Petals lilac to pink (white), 1.5–6 mm long. Capsules 1.5–8.5 cm long; *seeds* with a very short beak, *striate, the coma white or whitish.*

Despite numerous integrading forms the following 4 poorly defined geographic varieties are recognized as occurring in Wisconsin (see discussions under vars. *"glandulosum"* and *perplexans*).

KEY TO VARIETIES

[Modified from Fernald, M. L., *Epilobium glandulosum* and *E. adenocaulon*. Rhodora 20:34. 1918.]

A. Leaves crowded, not conspicuously decreasing in size into the crowded inflorescence, the larger 6–10 cm long, 2–3 cm wide; stems 4–10 dm high .... 6a. var. "GLANDULOSUM."

AA. Leaves remote, conspicuously decreasing in size into the loose and open inflorescence; stems 0.3–10 dm high.

B. Leaves thin and rather flaccid, light green, 0.5–4 cm long, 3–15 mm wide, broadly rounded at base or tapering to a slender petiole; stems weak, erect or ascending, simple or branching from near the base, 0.3–3 dm high, tending to become crisp-pubescent in lines below .... 6b. var. PERPLEXANS.

BB. Leaves firm, dark green, 1.5–10 cm long, rounded or barely subcordate at base, sessile or with short petioles; stems (except in dwarf plants) erect and strict, freely branching, 1–10 dm high, the pubescence not in lines.

C. Median leaves elongate-lanceolate, 2–6 cm long, 3–13 mm wide .... 6c. var. OCCIDENTALE.

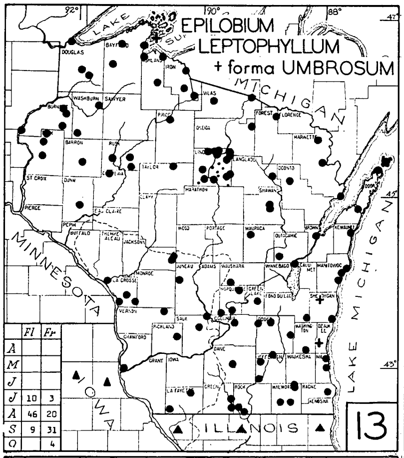
CC. Median leaves narrowly ovate or ovate-lanceolate, 1.5–10 cm long, 4–30 mm wide .... 6d. var. ADENOCAULON.

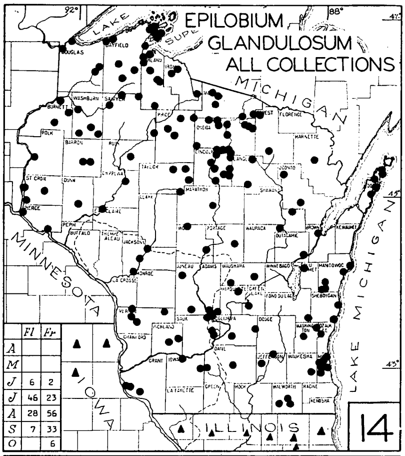
6a. EPILOBIUM GLANDULOSUM Lehm. var. "GLANDULOSUM." Map 15.

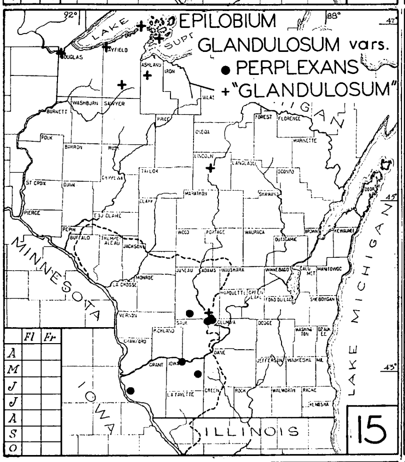
Stems thick (but soft), 4–10 dm high, relatively glabrous below the inflorescence. Larger leaves broadly ovate-lanceolate, 6–10 cm long, 2–3 cm wide, *not conspicuously decreasing in size into the crowded inflorescence.* Mature capsules 4–7 cm long.

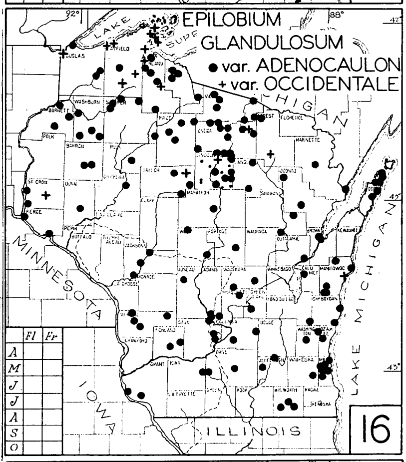
Rare in northwestern Wisconsin, with one specimen from the Dells of the Wisconsin River (Coldwater Canyon); in moist woods, Aspen stands, open low ground, and damp pastures. Flowering from mid-July to early September, and fruiting from late August.

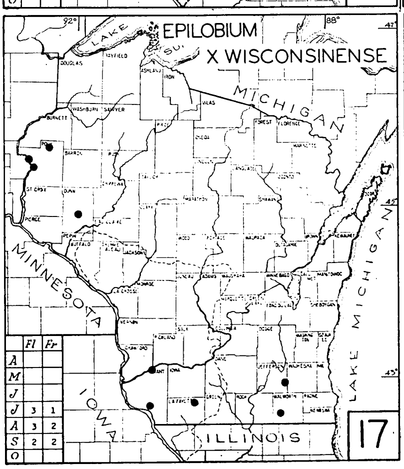
Our plants differ from those described by Fernald in his interpretation of the variety in having smaller flowers (petals 4–5 mm long instead of 6–9) and laxer leaves more like those of var. *adenocaulon.* Fernald (Rhodora 20:32. 1918) discusses a similar situation in the Gulf of St. Lawrence region, where these two varieties freely intergrade. He found that in the colder northern parts of its range, *Epilobium glandulosum* is fairly consistent in its large flowers and crowded leaves, whereas in the more southerly habitats, the plants have smaller flowers and less crowded leaves, or exhibit various other combinations of characters which approach those of

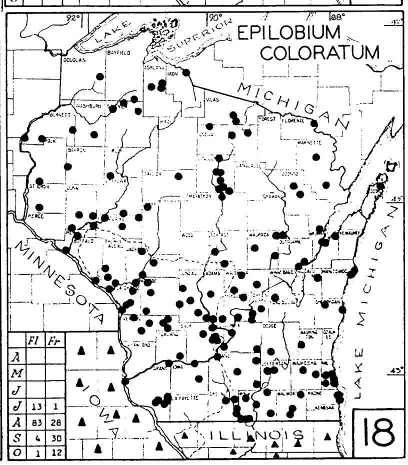

EPILOBIUM
LEPTOPHYLLUM
+ forma UMBROSUM
Fl Fr
J 10 3
A 46 20
S 9 31
O 4
13


EPILOBIUM
GLANDULOSUM
ALL COLLECTIONS
Fl Fr
J 6 2
J 46 23
A 28 56
S 7 33
O 6
14


EPILOBIUM
GLANDULOSUM vars.
● PERPLEXANS
+ "GLANDULOSUM"
15


EPILOBIUM
GLANDULOSUM
● var. ADENOCAULON
+ var. OCCIDENTALE
16


EPILOBIUM
X WISCONSINENSE
Fl Fr
J 3 1
A 3 2
S 2 2
17


EPILOBIUM
COLORATUM
Fl Fr
J 13 1
A 83 28
S 4 30
O 1 12
18

var. *adenocaulon*. Prompted by the unstable characters of these two taxa, Fernald reduced the *Epilobium adenocaulon* of Haussknecht, and its two varieties named by Trelease, to separate varieties of *Epilobium glandulosum* Lehmann. The present study suggests that Fernald's varieties may well be either "ecotypes," or phenotypic variants whose size and habit differences are due to a combination of soil, shade, and climatic factors. When various morphological characters are reduced to quantitative measurements and graphed, the relationship is seen to be nearly linear, which tends to support this hypothesis (see fig. 1). However, further field and laboratory work is needed in order to establish the true nature of these forms.

6b. EPILOBIUM GLANDULOSUM var. PERPLEXANS (Trel.) Fern. Map 15.

Epilobium adenocaulon Haussk. var. ? *perplexans* Trel., sensu Robinson and Fernald, 1908.
Epilobium hornemanni Reichenb., of authors.
Epilobium ciliatum Raf., sensu Fernald, 1950.

Usually very small plants 3–20 (–30) cm, *the stems weak,* ascending to erect, simple or branching from near the base, tending to become crisp-pubescent in lines below. *Leaves thin and rather flaccid, light-green,* ovate-lanceolate, 0.5–4 cm long, 3–15 mm wide, broadly rounded at base or slightly tapering to a slender petiole. Petals 1.5–4.6 mm long. Mature capsules only 1.5–4 cm long.

Rare in the Driftless Area of Wisconsin, on damp sandstone cliffs, often in full sun, at the Dells of the Wisconsin River, near Lone Rock and Barneveld (Iowa Co.), and Mauston (Juneau Co.), near North Andover (Grant Co.) reported from a limestone cliff. Flowering from late July through August, and fruiting from mid-July to early October.

The nomenclature and the taxonomy of this taxon are so confused that only special studies beyond the scope of the present could possibly untangle it (cf. Trelease 2:94, 96, and 106, 1891). Therefore, it seemed best to recognize this variety even though its distinctions are weak and often subjective. Concerning this species, the following comments were made by Hugh H. Iltis: "That var. *perplexans* might represent a cliff ecotype is strengthened by the fact that depauperate specimens, with only slightly firmer leaves and sometimes stouter and more pubescent stems, have been collected from sandstone cliffs one yard above the waters of Lake Mendota (Eagle Heights, Madison) and on the St. Croix River (north of Houlton), in the latter case together with normal plants of var. *adenocaulon*. On the other hand, the dwarfness of the plants

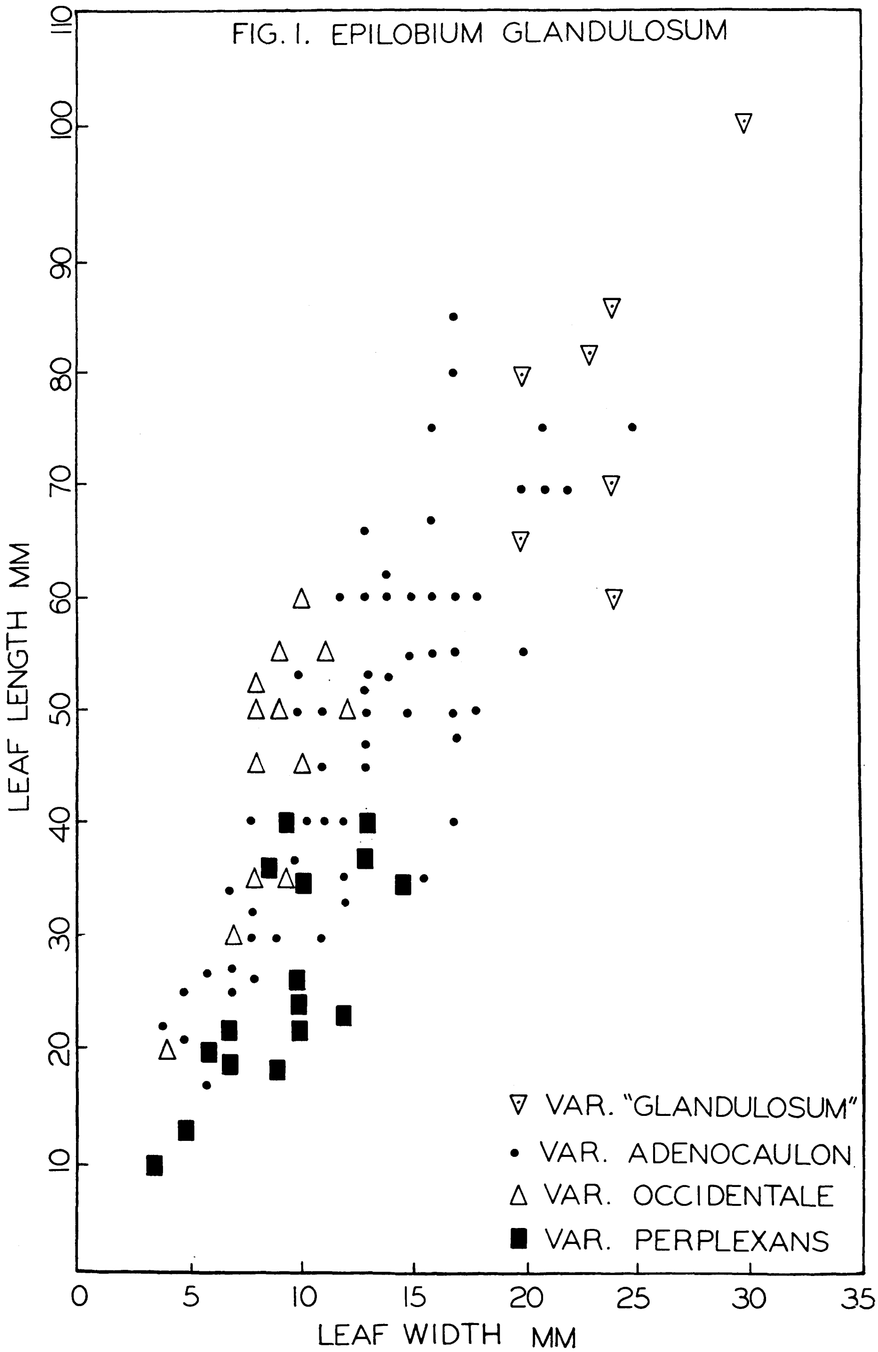


FIG. I. EPILOBIUM GLANDULOSUM
LEAF LENGTH MM
LEAF WIDTH MM
0
5
10
15
20
25
30
35
10
20
30
40
50
60
70
80
90
100
110
VAR. "GLANDULOSUM"
VAR. ADENOCAULON
VAR. OCCIDENTALE
VAR. PERPLEXANS

of var. *perplexans,* their weak stems, and their preference for cliffs may indicate that actually we are dealing with a distinct species perhaps with subarctic or Rocky Mountain affinities. A final taxonomic disposition here will have to await detailed cytological studies and taxonomic monographing. It is, however, significant that these, the most extreme plants are restricted to the Driftless Area (this not too surprising, of course, since nearly all cliffs in Wisconsin are found here!), and that, furthermore, var. *perplexans* grows in moist habitats with other rare, evidently relictual species that have decided western or northern affinities [see Iltis & Shaughnessy 1960:117]. Thus, across from Lone Rock (Iowa Co.), it grows on a vertical north-facing sandstone cliff associated with *Sullivantia renifolia;* at the Wisconsin Dells on a sunny west-facing sandstone cliff, wet with seepage and not 50 feet from the only Midwestern station of the arctic *Rhododendron lapponicum,* both overlooking the waters of the Wisconsin River; while at nearby Blackhawk Island, across the river from famed Coldwater Canyon, it was found with roots wedged in tiny crevices of a sandstone cliff within a few feet of the present level of the Wisconsin River. There, in the dense shade of overhanging vertical cliffs clothed with *Tsuga* and *Thuja,* the cool humid rock faces sheltered in addition such rarities as *Primula mistassinica, Asplenium trichomanes,* and again *Sullivantia renifolia.*"

6c. EPILOBIUM GLANDULOSUM var. OCCIDENTALE (Trel.) Fern. Map 16.

Epilobium adenocaulon Haussk. var. *occidentale* Trel.
Epilobium occidentale (Trel.) Rydb.

Stems 1–8 dm high, simple or commonly branched. *Leaves elongate-lanceolate,* sharply serrulate, 2–6 cm long, 3–13 mm wide. Petals 3–5 mm long. Mature capsules 3.5–6 cm long.

Infrequent in the colder northern regions of the state in damp ground grazed woods, clearing in woods, ledges, and burnt-over land. Flowering from late June to early September, and fruiting from early July through September.

6d. EPILOBIUM GLANDULOSUM var. ADENOCAULON (Haussk.) Fern. Map 16.

Epilobium adenocaulon Haussk. var. *adenocaulon.*

Stems 1–10 dm high, simple to much branched. *Leaves narrowly ovate to ovate-lanceolate,* 1.5–8.5 (–10) cm long, 4–25 (–30) mm wide. Petals 2.6–6 mm long. Mature capsules 3–8.5 cm long (fig. 4).

Throughout Wisconsin, though more common in the northern parts, in swamps, bogs, marshes, moist woods, wet sedge meadows, and abandoned fields, along river banks, lake margins, springs, roadside ditches, and on moist gabbro, limestone, and sandstone cliffs. Flowering from mid-June through September, with a peak in late July (generally about 2½ weeks before *Epilobium coloratum,* with which it may hybridize), and fruiting from late June to mid-October.

7. EPILOBIUM x WISCONSINENSE Ugent, *in* Rhodora. 1963. Map 17.

(*E. coloratum* Biehler x *E. glandulosum* var. *adenocaulon* [Haussk.] Fern.; HOLOTYPE: Polk Co.: edge of road in wet swamp, not common, West Sweden tp. sec. 36, *Johnson s.n.* [WIS]).

Stems loosely bushy-branched, spreading glandular pubescent as well as minutely pilose, the sides as well as the angles pubescent. Larger leaves 3–6.5 cm long, 8–21 mm wide, narrowly lanceolate, acuminate, closely and irregularly serrulate, on petioles 1–3 mm long. Flowers solitary in the upper leaf axils; buds rounded, or with divergent sepal-tips, often somewhat intermediate. Calyx 3–4.2 mm long. Petals purple or lilac, 3.5–6 mm long. Mature capsules 1–3.5 (–4.5) cm long. *Seeds mainly aborted* (fig. 5), the mature ones 1–1.2 mm long, 0.2–0.5 mm wide, *striate-papillose, the coma brown or tawny* (white in immature capsules).

Southern and northwestern Wisconsin, very sporadic in disturbed sedge-goldenrod peat marshes, spring-saturated sedge meadows, and along wet swampy roadsides, river banks, and railroad tracks. Flowering from early July to early September, and fruiting from mid-August to early September.

WISCONSIN: *sine loc.* [ca. 1860?] *Hale s.n.* (WIS). Dunn Co.: railroad tracks, Menomonie, *Bachman & Patrick 7–10* (WIS). Grant Co.: Potosi, *Davis s.n.* (WIS); along streams, Boscobel, *Sylvester 13590* (MIL). Jefferson Co.: disturbed sedge-goldenrod peat marsh, Sullivan tp. sec. 13, *Burger 152* (WIS). Lafayette Co.: Fayette, *Cheney s.n.* (WIS). Polk Co.: St. Croix Falls, *Baird s.n.* (WIS); near river bank, 8 mi. N. St. Croix Falls, *Benner 363* (MINN); edge of road in wet swamp, not common, West Sweden tp. sec. 36, *Johnson s.n.* (WIS). Walworth Co.: spring-saturated sedge meadow, Delavan, *Wadmond 17439* (MINN, WIS).

This hybrid resembles *Epilobium coloratum* in the sharply and irregularly serrulate leaves, the bushy-branched inflorescence (lower branches longer and less crowded than usual), the papillose nature of the seeds, and the often brown or tawny coma (fig. 4). The pubescence and striate character of the seeds are features definitely associated with *Epilobium glandulosum.* Some of the morphological inter-relationships of these plants are shown graphically in fig. 2A. The shortness and slenderness of the hybrid capsules is no doubt due to the abnormally high amount of seed abortion, which on different plants may vary from 27% to 95% (Fig. 3).

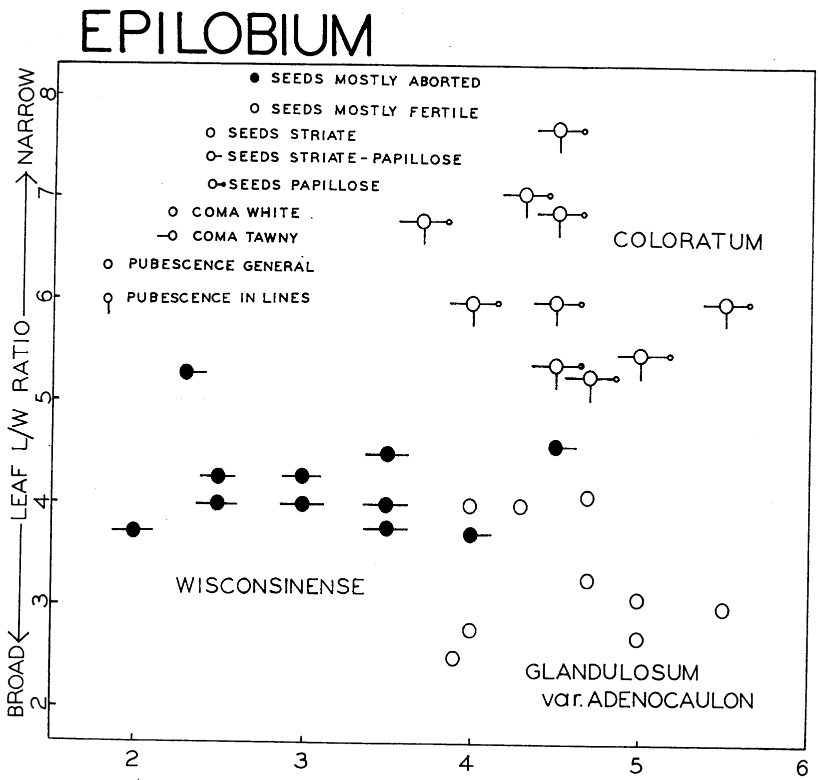


FIG. 2A.

Epilobium glandulosum var. *adenocaulon* is frequently associated with *E. coloratum,* and not uncommonly plants of both taxa have been collected together and mounted on the same herbarium sheet. When comparing the phenology of these plants, one can readily observe that when *Epilobium coloratum* is in flower, *E. glandulosum* var. *adenocaulon* is in fruit. As can be seen from the compiled flowering dates (Maps 14 and 18; Fig. 2B), var. *adenocaulon* flowers about 2½ weeks earlier. This seasonal isolation factor may be important in keeping these taxa relatively distinct. It should be noted that hybrids occur in a region where the ranges of both parental

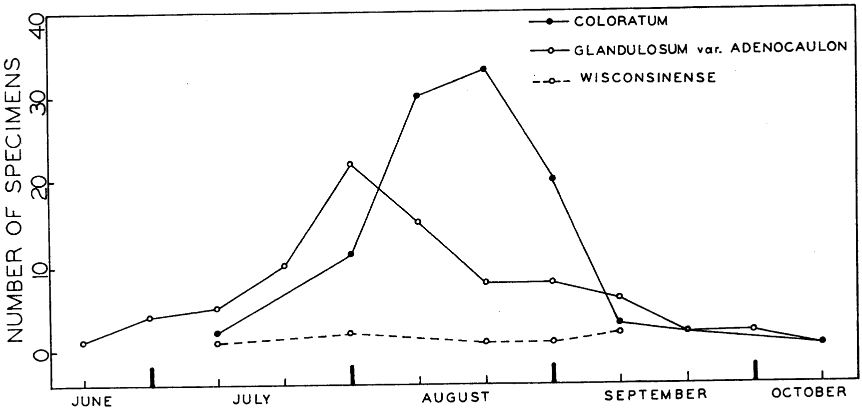


FIG. 2B.

species overlap: *Epilobium glandulosum* var. *adenocaulon* has a wide northern distribution, ranging from Alaska to Newfoundland, south to Delaware and *Northern Illinois,* and extending at higher elevations along the Rocky Mountains to Colorado; while *Epilobium coloratum,* a species with Eastern and Southeastern affinities, extends from Georgia to Kansas north to Minnesota, and across *Northern Wisconsin* to Southern Quebec.

Specimen	Capsule	Number of Seeds		% Abortion
		Aborted	Mature	
Hale, *sine loc.*	1 2 3	49 83 55	10 14 7	85
Bachman & Patrick Dunn Co.	1 2 3	110 84 98	7 5 6	94
Burger, Jefferson Co.	1 2 3	18 20 16	35 45 60	27
Johnson, Polk Co.	1	74	4	94
Benner, Polk Co.	1	92	4	95
	TOTAL	719	197	78

Figure 3. Seed abortion in *Epilobium x Wisconsinense.*

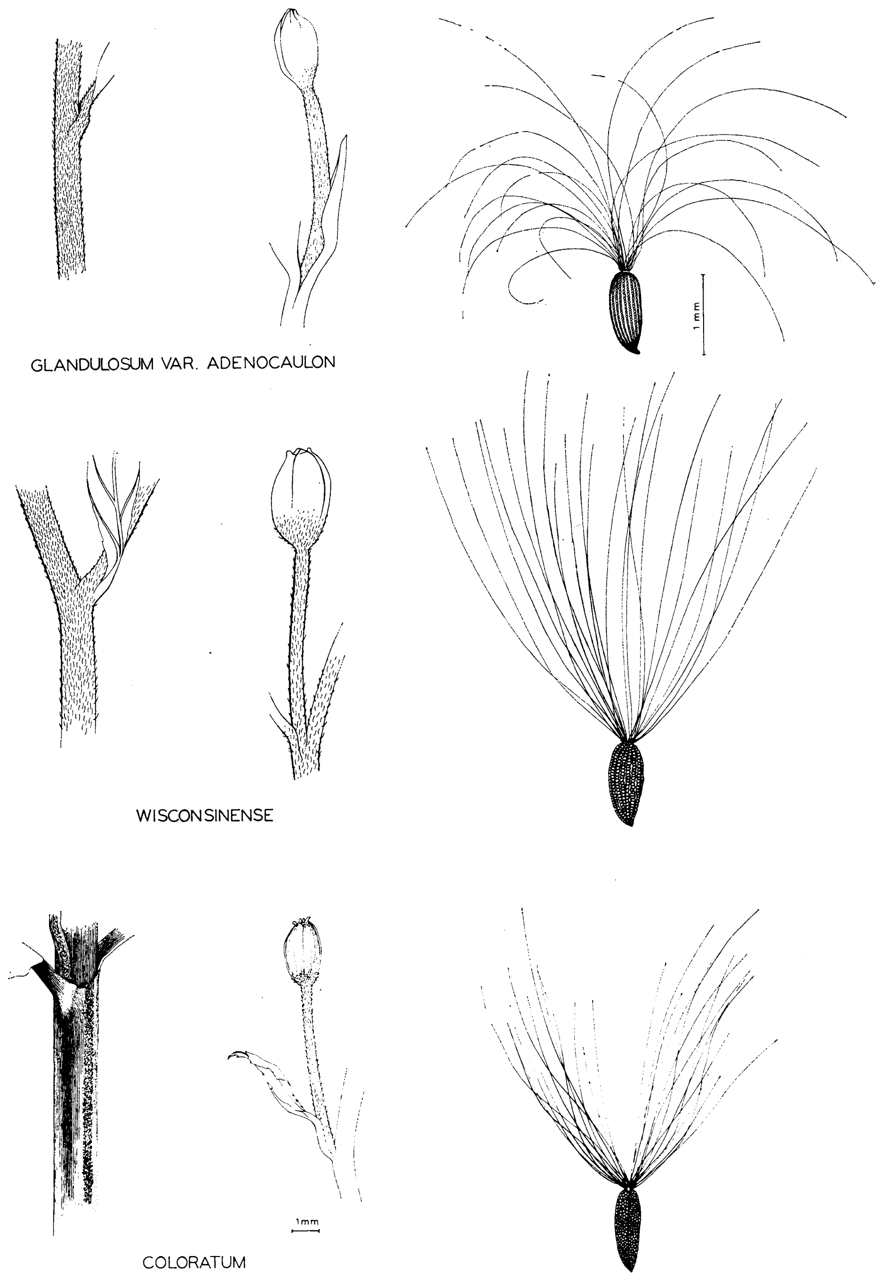


FIG. 4 STEMS, BUDS, AND SEEDS OF SOME WISCONSIN EPILOBIUMS


E. COLORATUM
SEEDS ALL NORMAL
1mm
CAPSULE
ABORTED AND NORMAL SEEDS
EPILOBIUM WISCONSINENSE
ILLUSTRATION OF TYPE SPECIMEN

FIG. 5

Epilobium coloratum and *E. glandulosum* var. *adenocaulon* are both known to hybridize with other species. The following hybrids are reported in the Index Kewensis and the Gray Herbarium Card Index: *Epilobium coloratum* X *Epilobium lineare* Muhl.; *Epilobium coloratum* X *Epilobium commutatum* Haussk.; and *Epilobium adenocaulon* Haussk. (*E. glandulosum* var. *adenocaulon* [Haussk.] Fern.) X *Epilobium canadense* Levl.

8. EPILOBIUM COLORATUM Biehler. Purple-Leaved Willow-Herb. Map 18.

Erect perennial 2–10 dm high, bushy-branched at summit or stems simple in small plants, *minutely pubescent above with incurved hairs (often in lines)*, glabrous below. Leaves elongate-lanceolate, acuminate, closely and irregularly serrulate, the cauline 3–18 cm long, 1–3 cm wide, distinctly short petioled. Flowers axillary, *buds with divergent sepal-tips* (Plate I, fig. 3) petals pink to lilac, 3–5 mm long. Capsules finely pubescent; *seeds papillose, beakless, the coma brown (whitish only in immature capsules!)*

Throughout Wisconsin, though most common in the southern parts, in wet ground along river banks, lakes, springs, ponds, sandy beaches, on damp sandstone cliffs, often in bogs, swamps, moist sedge meadows, marshes, damp willow thickets, wet woods, roadside and railroad ditches. Flowering from early July to early September, with a peak in mid-August (generally about 2½ weeks after *Epilobium glandulosum*, with which it may hybridize), and fruiting from mid-August through late October.

3. OENOTHERA L. EVENING-PRIMROSE.

[Munz, P. A., Studies in *Onagraceae:* A revision of the subgenera *Salpingia* and *Calylophis*. Am. Jour. Bot. 16:707–715. 1929; the subgenus *Anogra*. Am. Jour. Bot. 18:309–327. 1931; the subgenus *Kneiffia*. Bull. Torr. Bot. Club 64:287–306. 1937; the subgenus *Raimannia*. Amer. Jour. Bot. 22:645–663.

Cleland, R. D., Chromosome structure in *Oenothera* and its effect on the evolution of the genus. Cytologia (Supplement Vol.) : Proc. Internat. Gen. Symp. 1956:5–19; The evolution of the North American *Oenotheras* of the *"Biennis"* group. Planta 51:378–398. 1958.]

Annual or biennial, rarely perennial, erect herbs, with alternate leaves and *yellow (white or pink)* flowers solitary in the upper leaf axils or forming terminal racemes. *Hypanthium-tube prolonged beyond the ovary, deciduous,* its 4 lobes reflexed at anthesis. Petals 4; stamens 8; ovary 4-celled. Capsule dehiscent, many seeded.

KEY TO SPECIES

A. Capsules cylindric to 4-angled, never prominently winged; stamens equal and plants annual or biennial (except no. 8).

B. Hypanthium-tube prolonged more than 1 cm beyond the ovary; stamens equal; annual or biennial herbs from a basal rosette.

C. Stem pubescent, variously colored; flowers yellow, sometimes aging reddish; seeds in 2 rows in each locule.

D. Capsules 3–8 mm thick, 1.5–4 cm long at maturity, slightly tapering from a thickish base, straight or slightly curved; seeds angled, horizontal in the locules (Subgenus *Onagra*).

E. Sepal-tips of unopened bud strictly terminal (figs. 6A, 6C), closely parallel and forming a tube, or the tips converging (character sometimes poorly preserved in pressed specimens); leaves lanceolate to ovate-lanceolate; petals 9–30 mm long.

F. Calyx glabrous to more or less villous or hirsute, not densely canescent (fig. 6A); leaves broad, thin, crinkled, bright green, mostly with short erect hairs ------------- 1. O. BIENNIS. (see also 2. O. ERYTHROSEPALA).

FF. Calyx densely canescent-strigose (fig. 6C); leaves narrow, thick, grayish-green with a dense pubescence of closely appressed short stiff hairs ------------------ 3. O. STRIGOSA.

EE. Sepal-tips of unopened bud subterminal, the bud apex therefore exposed (fig. 6B); leaves narrowly lanceolate to oblong-lanceolate; petals 6–18 mm long; stems commonly simple and less than 1 m high ------------------ 4. O. PARVIFLORA.

DD. Capsules 1–3 mm thick, 1–3.5 cm long at maturity, cylindrical, straight or commonly curving inwards; seeds not sharply angled, ascending in the locules (Subgenus *Raimannia*).

H. Leaves subentire to remotely denticulate; flowers in a terminal raceme, forming a distinct spike in fruit; capsules 1–2 cm long, 1–3 mm thick, often strongly curving inwards -------------------------------------- 5. O. RHOMBIPETALA.

HH. Leaves deeply lobed; flowers solitary in the axils of the upper foliage leaves, not forming a distinct spike in fruit; capsules 2–3.5 cm long, 2–3 33 thick, straight or slightly curving ---------------------------------- 6. O. LACINIATA.

CC. Stem glabrous, the silvery-white bark exfoliating toward the base; flowers white, turning pink (in pressed specimens often a dingy yellow); seeds in one row in each locule (Subgenus *Anogra*) --7. O. NUTTALLII.

BB. Hypanthium-tube prolonged less than 1 cm beyond the ovary; stamens alternately unequal; plants perennial; leaves sharply serrulate; flowers sessile in the axils of the upper foliage leaves, not forming a distinct spike in fruit (Subgenus *Calylophis*) ----------------8. O. SERRULATA.

AA. Capsules clavate to obovoid, with well defined wings; stamens alternately unequal; plants perennial (Subgenus *Kneiffia*).

I. Petals 4–9 mm long; hypanthium-tube 4–8 mm long, stems strigose-puberulent; leaves subentire ----- 9. O. PERENNIS.

II. Petals 13–30 mm long; hypanthium-tube 13–25 mm long; stems spreading-hirsute, the hairs 1–2 mm long; leaves denticulate --------------------------- 10. O. PILOSELLA.

SUBGENUS ONAGRA LUDWIG

Because of the peculiar genetic situation in this subgenus, with innumerable true breeding and self-pollinating lines resulting in numerous locally distributed geographic races or "biotypes" (which then occasionally hybridize), delimitation of species has long been a hopeless and confusing matter. The fact that scores of "mutants" or local biotypes have been published as true "species," not only obscured the recognition of evolutionary trends but also made it impossible to establish a useful taxonomy for the group as a whole (cf. Gates, 1957, 1958). The present study takes into account the extensive cytogenetical work of Cleland who considers the subgenus *Onagra* to be composed of relatively few species, each of which, in itself, is of hybrid origin and consists of many races. Concerning the origin of the various species, Cleland (personal communication, 1961) says: "There is a great deal of variation within the major groups that I have found to exist. This is owing, in the first place, to the fact that, when two populations, each possessing internal diversity, met and crossed, many crosses took place, many hybrids were formed and these were somewhat diverse in individual characteristics. In the second place, new "races" have come into existence from that day to this, by crossing between existent "races," thus multiplying the number of races and increasing the diversity . . . there are multitudinous races, often with considerable distinctions, but there are only a few major end-points of the evolutionary process. By calling everything . . . that differs slightly from what has been seen before a new species, completely masks the true picture in *Oenothera*. . . . It is essential to understand, of course, that the *Oenothera* population consists of innumerable true-breeding and self-pollinating lines and hence is compartmentalized by the presence of innumerable reproductive barriers."

1. OENOTHERA BIENNIS L. Bastard Evening-primrose. Map 19.

Erect biennial, the stems stout, 7–21 dm tall, simple or branching, commonly villous or hirsute. *Leaves bright green, rather thin, crinkled,* lanceolate to ovate-lanceolate, 3–20 cm long, 5–48 mm wide, acute, dentate, short-petioled or sessile, *glabrate to sparsely pubescent with short erect hairs.* Flowers in terminal racemes, the bracts often markedly different from the leaves and shorter than to slightly longer than the capsules. *Calyx glabrous to sparsely villous or hirsute, the sepal-tips terminal and parallel, closely adjoining and forming a tube* (fig. 6A). Hypanthium-tube 18–35 mm long. Petals obovate, 9–27 mm long. Capsule 15–40 mm long, glabrate to hirsute. 2n=14 (Cleland, 1958).

The following two races, recognized by Cleland (1956), are proposed as subspecies by Munz (see discussion):

A. Floral bracts subovate ------------------ 1a. "BIENNIS I"
AA. Floral bracts narrow-lanceolate --------- 1b. "BIENNIS II"

1a. O. BIENNIS L., "BIENNIS I" race of Cleland (1956). Map 21.

Mainly in southern and western Wisconsin, though sporadic, on roadsides, railroad embankments, river banks and sandbars, lake shores, moist meadows, and woods. Flowering from early June to early September, and fruiting from early August to late September.

Cleland (1958:378–398), in his extensive cytogenetic study of the *Onagras,* found the *biennis* complex to be composed of 3 genetically distinct groups native to the eastern United States. In Wisconsin and throughout the Middle West (extending to the Atlantic Ocean in the Southeast) occurs the race known as *biennis I.* A genetically different population called *biennis II* occurs in the northeastern U. S. and Quebec, and extends west to Wisconsin. The *biennis III* race is confined to North Carolina, Virginia, Pennsylvania, and western New York, and its range overlaps both *biennis I* and *biennis II.* Concerning *biennis I,* Cleland (1958:380) says: "The various lines show considerable diversity, but all races are mesophytic in character, with thin, broad, crinkly, relatively hairless leaves, and a tendency toward delicate, brittle stems."

Dr. Philip A. Munz has kindly examined our collections of *Oenothera biennis* and has been able to determine the majority of them as to race or subspecies. Although the *biennis I* race is of sporadic occurrence in Wisconsin, especially in the southern and western counties, it is quite common in Illinois, Minnesota, North Dakota, Michigan, Indiana, Missouri, Arkansas, and Oklahoma. Munz notes that the *biennis I* race has subovate floral bracts, in contrast to the narrow-lanceolate bracts of *biennis II*, and is about to publish formal subspecies names for these two taxa (personal communication, 1961).

1b. O. BIENNIS L., "BIENNIS II" race of Cleland (1956). Map 20.

O. biennis L., var. *nutans* (Atkinson & Bartlett) Wieg.
O. biennis L., var. *pycnocarpa* (Atkinson & Bartlett) Wieg.

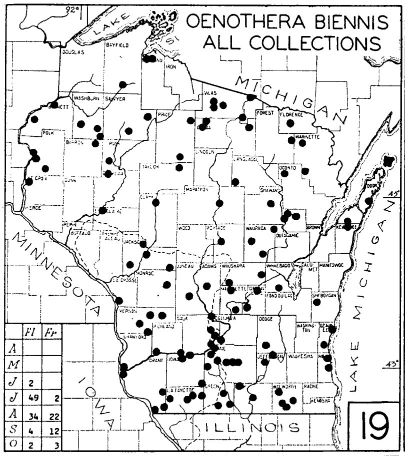
Throughout Wisconsin in a great variety of open, especially disturbed habitats, frequently along roadsides, railroad tracks, abandoned or cultivated fields, lake shores, river banks, marshes, sedge meadows, prairies, and open woods. Flowering from late June through October, with a peak in late July, and fruiting from late July to early October.

An abnormal plant from Shawano Co. has nearly linear petals only 33 mm wide (*Goessel 4826*, 1916 [MIL]). Such forms have been referred to in the past as *Oenothera cruciata* Nuttall. Concerning this abnormality, Munz (personal communication, 1961) says "*O. cruciata* has in my opinion no taxonomic status. The cruciate character occurs in all the species mentioned above and behaves like a single gene with imperfect dominance. It is conspicuous, but apparently of no more significance than differences in many other characters. For example, see Bartlett in Amer. Jour. Bot. 1:238. What he calls *cruciata* is in *parviflora;* so is *venosa;* so is *atrovirens;* so is *ostreae* of Sturtevant. *Stenomeres* is in . . . ["the Biennis I" race of Cleland]. I have seen cruciate forms in *depressa* [*O. strigosa*] likewise." For statements pertaining to the genetic behavior of the cruciate character consult Renner (1958), and Gates (1936).

2. X OENOTHERA ERYTHROSEPALA Borbás Map 22.

[Munz, P. A., 1949. The Oenothera Hookeri Group. El Aliso 2:38.]
Oenothera erythrosepala Borb., Magyar Bot. Lapok 2:245, 1903.
Oenothera lamarckiana of de Vries, Die Mutationstheorie 1:152–378, 1901; Comptes Rendus 121:124, 1900; not Séringe, in DC., Prodr. 3:47, 1828.

Biennial. Stems erect, simple or branching, rather stout, up to 1 m tall, villous-strigose, and commonly reddish-purple. Leaves lanceolate to ovate-lanceolate, 6–15 cm long, 15–40 mm wide, acute,


OENOTHERA BIENNIS
ALL COLLECTIONS
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IOWA
ILLINOIS
Fl Fr
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M
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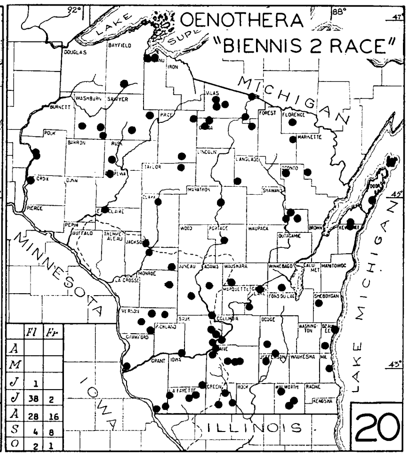
A 34 22
S 4 12
O 2 3
19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IOWA
ILLINOIS
Fl Fr
A
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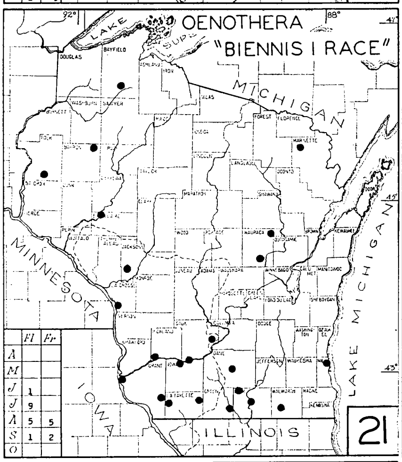
A 28 16
S 4 8
O 2 1
20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"BIENNIS I RACE"
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IOWA
ILLINOIS
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A
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J 1
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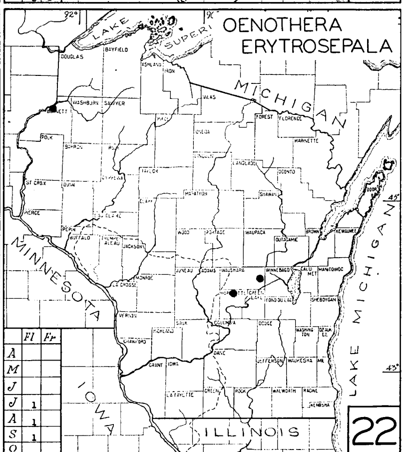
A 5 5
S 1 2
O
21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ERYTROSEPALA
LAKE MICHIGAN
MINNESOTA
IOWA
ILLINOIS
Fl Fr
A
M
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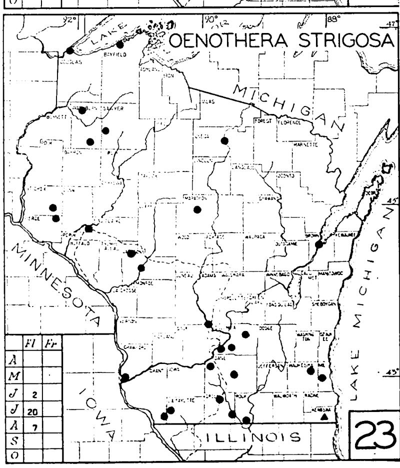
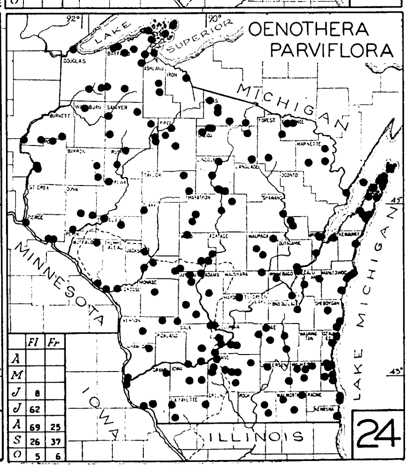
J 1
A 1
S 1
O
22

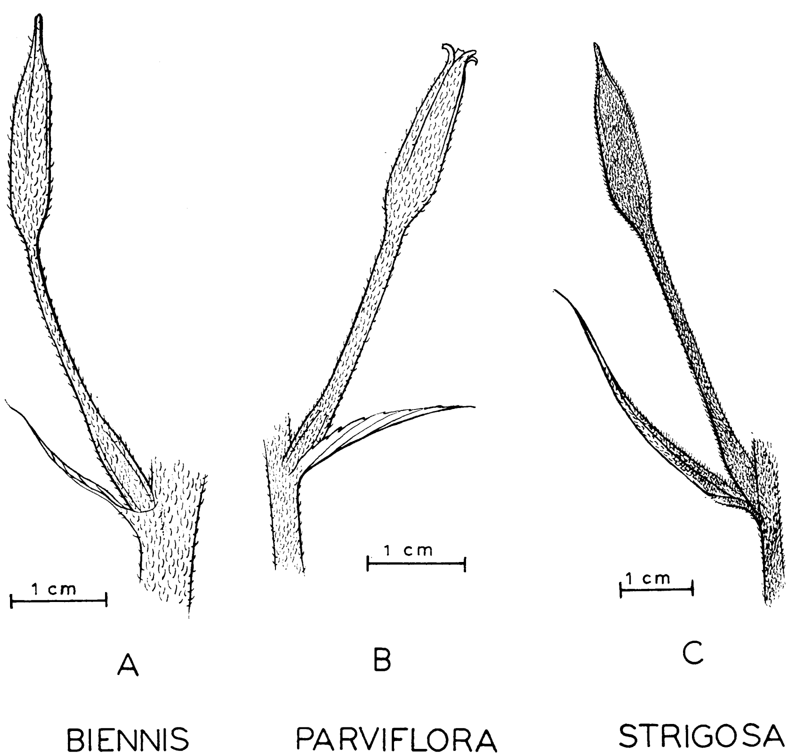

OENOTHERA STRIGOSA
LAKE MICHIGAN
MINNESOTA
IOWA
ILLINOIS
Fl Fr
A
M
J 2
J 20
A 7
S
O
23


OENOTHERA
PARVIFLORA
LAKE SUPERIOR
MICHIGAN
LAKE MICHIGAN
MINNESOTA
IOWA
ILLINOIS
Fl Fr
A
M
J 8
J 62
A 69 25
S 26 37
O 5 6
24

dentate, passing without evident interruption into the foliaceous bracts. *Calyx reddish-purple* (drying pale green), more or less villous, the sepal-tips terminal and parallel, closely adjoining and forming a tube. Hypanthium-tube glandular, 30–40 mm long. Petals yellow, often tinged with red, subrotund-obovate, *20–30 mm long.* Capsule oblong-ovate, enlarged below, sparsely pilose and glandular, 25–35 mm long.

Differing from *O. biennis* L. in the mostly larger showy flowers and the reddish-purple sepals (a character observable only on living plants). Apparently escaping from cultivation. Our three collections, determined by P. A. Munz, are as follows: Burnett Co.: Danbury, Aug. 26 [fl], 1916, *Baird s.n.* [WIS]. Marquette Co.: alluvial soil along trout stream, township of Newton, 8 mi. n.e. of Westfield, July 29–30 [fl], 1933, *Wadmond 3275* [MINN]. Waushara Co.: marsh and now dry grassland, along Willow Creek, T19N; R12E; Sec. 22, Sept. 30, 1956 [fl], *Hagene s.n.* [WIS].

FIG. 6 OENOTHERA



3. OENOTHERA STRIGOSA (Rydb.) Mackenzie & Bush Map 23.

Erect biennial, 5–9 dm high. Stem stout, simple or branched, sparsely pubescent below, canescent to strigose-villous above, the hairs mostly appressed. *Leaves* 4–17 cm long, 6–40 mm wide, oblong-lanceolate to lanceolate, acute, remotely denticulate, *grayish-green with a dense pubescence of closely appressed short stiff hairs. Calyx densely canescent-strigose, the sepal-tips terminal and parallel, closely adjoining and forming a tube* (fig. 6C). Hypanthium-tube commonly strigose-villous, 2–34 mm long. Petals yellow, obovate, 10–22 mm long. Capsule 17–40 mm long, often finely pubescent with appressed hairs. 2n=14 (Cleland, 1958)

Throughout Wisconsin, though sporadic and rather rare, on roadsides, railroad ballast, abandoned fields, and dry lime prairies. Flowering from late June to mid-August.

An abnormal form from Kenosha Co. (*Russel s.n.*, 1908 [MIL]) has nearly linear petals only 3 mm wide. The nature of this "cruciate" mutant is discussed under the treatment of the *biennis I* race of *O. biennis* L.

Oenothera strigosa extends eastward from the Rocky Mts. and the Great Plains to the Mississippi River and into Wisconsin, where it is at its eastern limit, and northwestward to Oregon and Washington. It is the predominating *Onagra* of the Great Plains. Cleland says: "Phenotypically the strigosas tend to have thick and rather narrow leaves, strigose hairs, a greyish-green color and thick woody stems." (1956:13). "These plants have . . . balanced lethals and moderately small self-pollinated flowers. They are xerophytic in character, but the various lines or races show a great diversity in foliage characters, in the abundance of anthocyanin pigmentation, etc." (1958:380).

4. OENOTHERA PARVIFLORA L. Small-Flowered Evening-Primrose. Map 24.

Stems simple or rarely branching, 1.4–13 (–20) dm high, glabrate to strigose-puberulent. *Leaves narrowly lanceolate to almost linear* or to ovate-lanceolate, 2–15 cm long, 3–35 mm wide, acute, denticulate, glabrate to strigose, passing without obvious change into the bracts of the fruiting spike. Calyx glabrate to strigose-villous, *the sepal-tips subterminal, buds therefore open at apex.* (fig. 6B). Hypanthium-tube 20–35 mm long. Petals yellow, obovate, 6–18 mm long. Capsule 1.5–4 cm long, 2n=14 (Cleland, 1958).

Common throughout Wisconsin in sandy or gravelly soil, often along lake shores, river banks, roadsides, railroad tracks, and cliffs, frequently in abandoned or cultivated fields, pastures, sedge meadows, and prairies. Flowering from early June to mid-October, with an extended peak lasting from mid-July through August, in latter August and September the predominant *Onagra* in flower, and fruiting from early August to mid-October.

An abnormal plant has nearly linear petals only 3 mm wide (Manitowoc Co.: Two Rivers, *Burch s.n.*, 1885 [WIS]). The nature of this "cruciate" mutant is discussed under the treatment of the *biennis I* race of *O. biennis* L.

Oenothera parviflora extends from New England into eastern Quebec, and along the Great Lakes into Wisconsin. Cleland (1956: 14) divides the *parvifloras* into two distinct groups, their appearance depending upon the particular set of genes carried by the maternal gamete, or alpha complex. Due to the "ring" formation of chromosomes at meiosis (peculiar to the subgenus *Onagra*), only two kinds of gametes are ordinarily formed, and a given set of genes is transmitted intact from generation to generation. The maternal set of genes is termed the "alpha complex," the paternal the "beta complex." The following excerpt from Cleland's paper (1956:14) particularly applies to our Wisconsin plants.

"[The *parvifloras*] share with the subgenus *Raimannia* certain characters not possessed in noticeable degree by other groups of *Euoenothera* [*Onagra*], namely, subterminal sepal-tips and a peculiar type of stem tip structure, the tips bending downward and then, at the very tip, upward again. These characters together with a tendency toward smallness, narrowness and hairlessness of the leaves are borne by the beta complexes. The alpha complexes are of two types—in some races they carry genes for a *biennis*-like phenotype, in others, genes for a *strigosa*-like phenotype. There are therefore two distinct categories of parvifloras—those with leanings toward *biennis,* and those which bear a resemblance to *strigosa.* In all cases, however, the beta complex impresses upon the plant its extreme narrowness of leaf so that there is no danger of confusing any of the parvifloras with *biennis* or *strigosa.*"

In Wisconsin *parvifloras* with *biennis-like* and *strigosa-like* phenotypes occur, the latter more rarely.

SUBGENUS RAIMANNIA (ROSE) MUNZ

5. OENOTHERA RHOMBIPETALA Nutt. Rhombic Evening-Primrose. Map 25.

Erect biennial, 2–13 dm tall. Cauline leaves narrowly oblong-lanceolate to lance-ovate, 2–9 cm long, 3–13 mm wide, subentire to remotely denticulate, acute, passing up the stem into leafy lanceolate bracts. Flowers numerous, crowded in a terminal spike. *Buds* *narrowly cylindric, densely strigose.* Hypanthium-tube sparsely strigose, 15–35 mm long. Petals yellow, rhombic-obovate, 10–22 mm long. *Capsules often strongly curved,* 1–2 cm long, 1–3 mm thick.

Southwestern Wisconsin, particularly common in the Central Wisconsin, Wisconsin River, and Black River sand areas, in sandy prairies and open Jack Pine-Oak woods, frequently in abandoned sandy fields, sand barrens, "goat" prairies, river terraces, lake shores, roadsides, and railroad ballast. Commonly associated with *Koeleria cristata, Monarda punctata, Euphorbia corollata, Liatris aspera, Lespedeza capitata, Ambrosia psilostachya, Cenchrus pauciflorus, Arabis lyrata, Helianthus occidentalis, Bouteloua curtipendula, B. hirsuta, Opuntia compressa,* and *Selaginella rupestris.* Flowering from early July through early October, and fruiting from late July to early October.

6. OENOTHERA LACINIATA Hill. var. LACINIATA. Cut-Leaved Evening Primrose. Map 26.

Low annual with villous or hirsute stems 1–3 dm tall, simple to several stemmed and branching. *Leaves* oblanceolate to oblong-lanceolate, *sinuate-pinnatifid,* 2–6 cm long. Flowers solitary and sessile in the axils of upper leaves. Calyx-lobes 5–12 mm long. Petals yellow to whitish, drying red, 5–18 mm long.

Rare in Wisconsin, adventive from further south, growing in railroad ballast, sandy farmyards, roadsides, and fallow gardens, and along the "lake front" at Manitowoc. Flowering from late June to early September.

Oenothera laciniata Hill. var. *grandiflora* (Wats.) Robinson., with calyx-lobes 20–30 mm long and petals 20–35 mm long, a southwestern form, has been collected once in Plymouth (Sheboygan Co., on railroad ballast, *Goessl s.n.,* 1903 [WIS]). This report is questionable.

SUBGENUS ANOGRA (SPACH) JEPSON

7. OENOTHERA NUTTALLII Sweet. White-Stemmed Evening Primrose. Map 27.

Perennial with creeping underground rootstocks. *Stems* erect, *glabrous,* 2–9 dm high, *the white bark exfoliating toward the base.* Leaves linear to linear-oblong, acute, nearly entire, glabrous above, strigose beneath, 2–12 cm long, 2–7 mm wide. *Flowers showy white, turning pink,* with disagreeable odor; buds nodding. Calyx-lobes glandular pubescent. Hypanthium-tube 2–3 cm long. Petals obovate, 1–2 cm long. Capsules glandular, 1–2.5 cm long, *the seeds in one row in each locule.*

Rare and scattered in Wisconsin along railroad tracks, though occasionally forming large colonies, adventive from the Northern Great Plains. Flowering from late June to early September, and fruiting from early August to early September.

SUBGENUS CALYLOPHIS (SPACH) MUNZ

8. OENOTHERA SERRULATA Nutt. Toothed-Leaved Evening Primrose. Map 28.

Perennial. *Stems thin, often woody,* 2–5 dm tall, simple to much branched from the base, glabrous below, the upper portion canescent. *Leaves* linear to linear-lanceolate, 1–6 cm long, *commonly sharply serrulate,* sessile or tapering to a short petiole. Flowers solitary, sessile in the axils of the upper leaves. *Hypanthium-tube 4–8 mm long,* roundly 4-angled, funnelform. Petals yellow, obovate, 5–10 mm long. Stamens alternately unequal. Capsule 1–3 cm long, roundly 4-angled, straight or slightly curved.

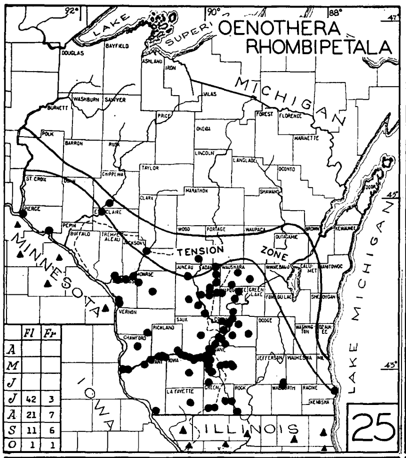
Native in western-most Wisconsin, in dry steep "goat" prairies, open sandy Juniper glades, on sandy prairies, or on sand terraces, along or near the Mississippi River bluffs; near Mondovi (Buffalo Co., *Iltis & Noamesi 8078* [WIS]) in a mesic railroad prairie on deep sandy soil, with *Andropogon gerardi, Hieracium longipilum, Lithospermum croceum, Leptoloma cognatum, Solidago rigida, S. speciosa, Potentilla arguta, Stipa spartea, Helianthus* and *Liatris* spp., *Aster ericoides,* and *A. azureus;* elsewhere adventive mainly along railroad tracks. Flowering from mid-June to early September, and fruiting from July to mid-October.

SUBGENUS KNEIFFIA (SPACH) MUNZ

9. OENOTHERA PERENNIS L. Sundrops Map 29.

Slender perennial with erect stems 1–4 (–7) dm tall, simple or few branched above, *strigose-puberulent.* Leaves linear-lanceolate to oblanceolate, 1–6 cm long, entire or remotely denticulate. Inflorescence a few flowered raceme, glandular-puberulent, the tip nodding in bud. Sepals glandular-puberulent, reflexed in pairs or in 4's at anthesis. Hypanthium-tube 4–8 mm long. Petals yellow, obcordate, 4–9 mm long. Stamens alternately unequal. *Capsule ellipsoid-clavate or -oblong, winged,* including the narrow stipe-like base 8–13 mm long. $2n=28$ (Valcanover, 1927, ex Darlington, 1955).

Widespread in Wisconsin, in wet to mesic prairies, sedge meadows, pastures, sandy or muddy margins of marshes, shallow bogs, streams and rivers, moist cliffs, sandy roadsides, and occasionally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TENSION ZONE
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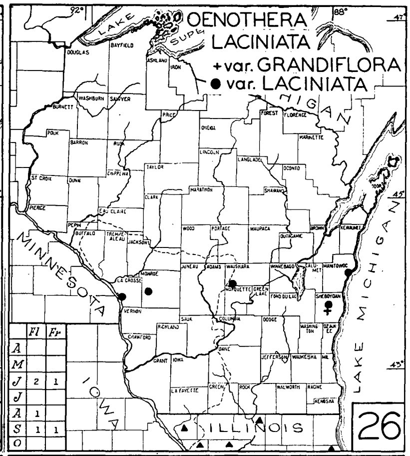
S 11 6
O 1 1
25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+ var. GRANDIFLORA
● var. LACINIATA
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A 1
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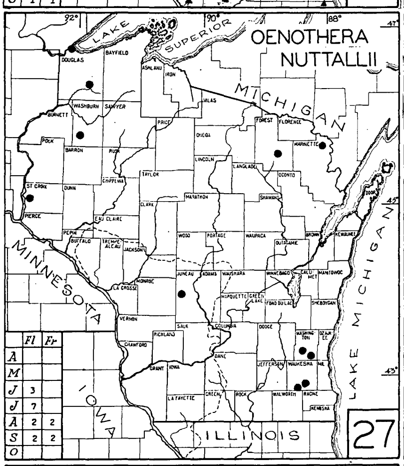
O
26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Fl Fr
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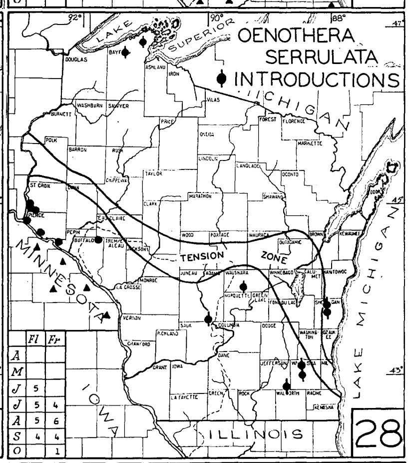
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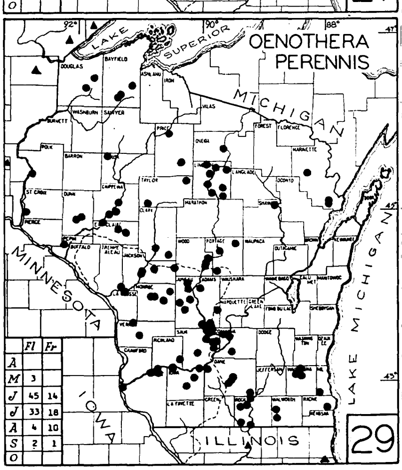
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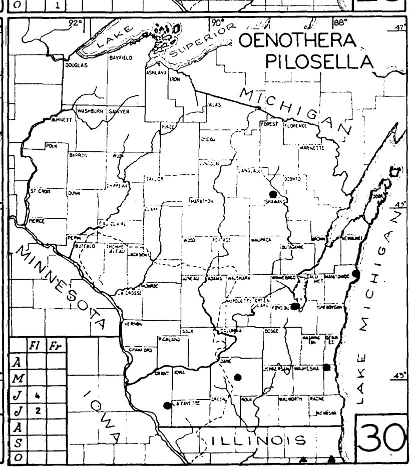
J 33 18
A 4 10
S 2 1
O
29


OENOTHERA PILOSELLA
Fl Fr
A
M
J 4
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S
O
30

in open Oak-Hickory woods and along railroad tracks. Flowering from late May to mid-September, with a peak in late June, and fruiting from mid-June to September.

10. OENOTHERA PILOSELLA Raf. Meadow Sundrops Map 30.

Perennial. Stems erect, 2–6 dm high, *with spreading hirsute hairs 1–2 mm long.* Leaves lanceolate to almost ovate, 2–7 cm long, obtuse, minutely and irregularly denticulate, more or less hirsute. Hypanthium-tube 13–20 mm long. Petals obcordate, yellow, 2–3 cm long. Stamens alternately unequal. *Capsule* sessile, *linear-clavate, winged,* hirsute, 1–2 cm long.

Commonly cultivated for its showy yellow flowers, and occasionally escaped on roadsides, railroads and old gardens. Flowering from mid-June to mid-July.

4. GAURA L. GAURA

[Munz, P. A., A revision of the genus *Gaura.* Bull. Torr. Bot. Club 65:105–122. 1938.]

Herbs with alternate, sessile leaves, *and small white, pink or red flowers* in terminal spikes. *Hypanthium-tube conspicuously prolonged beyond the summit of the ovary, deciduous.* Petals 4; stamens 8; stigma 4-lobed, surrounded by a ring. *Fruit indehiscent, hard and nut-like, 1–4 seeded.*

KEY TO SPECIES

A. Ovary and spindle-shaped fruit pubescent with spreading hairs; basal portion of fruit 4-angled; plants not ordinarily branched from the base ---------------------- 1. G. BIENNIS.

AA. Ovary and pear-shaped fruit pubescent with appressed or incurved hairs; basal portion of fruit nearly round; plants often branched from the base -------------- 2. G. COCCINEA.

1. GAURA BIENNIS L. Biennial Gaura. Map 31.

Stems branched, 9–11 dm high or more, spreading villous as well as short-pubescent. Leaves oblong-lanceolate to lance-ovate, acute at both ends, remotely denticulate, 3–11 cm long. Flowers in slender glandular pubescent spikes; opening in evening. Sepals often red, reflexed in pairs at anthesis. Petals white, turning pink or red, about 5 mm long. *Fruit with spreading hairs, 4-angled, acute at both ends,* 6–8 mm long. $2n=14$ (Bhaduri, 1942, ex Darlington, 1955).

Southernmost Wisconsin probably native from Grant to Walworth County, in mesic to moist prairies, rarely in open woods; in the counties north of the five lowest adventive (?) with all but one collection either from railroad tracks or roadsides; near Monticello (Green Co.; *Iltis & Greene 6747* [WIS]) growing in a rich deep black soil prairie, between R. R. tracks and road, with scattered Willows, Dogwoods, Bur Oak, *Potentilla arguta, Eryngium yuccifolium, Ratibida pinnata, Hypericum sphaerocarpum,* and *Galium* spp. Flowering from mid-July through September, and fruiting from August through September.

2. GAURA COCCINEA Nutt. Scarlet Gaura. Map 32.

Perennial. Stems 2–4 dm high, canescent-strigose, often branched from the base. Leaves oblong-lanceolate to nearly linear, entire or remotely denticulate, finely and closely pubescent, mostly sessile, 1–3 cm long. Spikes simple, nodding at tips. Sepals gray-green, often pink, reflexed separately at anthesis. Petals white to pink, aging red, 3–6 mm long. *Capsule pubescent with appressed or incurved hairs, pear-shaped, tapering from near the base, the body proper 4-angled, basal portion nearly round.* 2n=14 (Johansen, 1929, ex Darlington, 1955).

Native of the southwestern U.S., a rare adventive in Wisconsin along railroad tracks. Dane Co.: railroad, Yahara, N.E. of Madison, *Thomson & Dailey s.n.,* 1955 (WIS); Madison, *Denniston s.n.,* 1916 (WIS). Outagamie Co.: R.R. ballast, Appleton, *Goessl s.n.,* 1915 (MIL, WIS). Waukesha Co.: Railroad track, Hartland, *Cull 880* (WIS); garden, Waukesha, *Finger s.n.,* 1908 (MIL). Flowering from June through July.

5. CIRCAEA L. ENCHANTER'S NIGHTSHADE

Perennial herbs with opposite, dentate, petioled leaves and small white (pink) perfect flowers in terminal and lateral racemes. Petals 2; stamens 2, alternate with the petals; ovary 1–2 celled. Hypanthium-tube slightly prolonged beyond the ovary. *Fruit indehiscent, 1–2-seeded,* small and bur-like, *bristly with hooked hairs,* readily sticking to clothing and animals like stick-tights.

KEY TO SPECIES

A. Fruit with ridges separated by deep furrows, 3–5 mm thick (inc. bristles), 2-celled; buds prior to anthesis 2.5–4.5 mm long; leaves rounded or barely subcordate at base, shallowly (rarely sharply) sinuate-denticulate; stem firm, 2–10 dm high; rhizome slender. ---------------------1. C. QUADRISULCATA.

AA. Fruit smooth, 1–2.5 mm thick (inc. bristles), 1 or unequally 2-celled; buds prior to anthesis 1–3.5 mm long; leaves truncate, cordate, or rarely only rounded to base, sharply denticulate; stem weak, 0.5–5 dm high.

B. Buds 2–3.5 mm long; fruit unequally 2-celled (semi-sterile), 1.2–2.5 mm thick; larger leaves 4–11 cm long, stems 2–5 dm high; rhizome slender ------2. C. "CANADENSIS."

BB. Buds 1–2 mm long; fruit 1-celled, 0.6–1.5 mm thick; larger leaves 1–6 (–8) cm long; stems 0.5–3 dm high; rhizome tuberously thickened --------------------3. C. ALPINA.

1. CIRCAEA QUADRISULCATA (Maxim.) French & Sav. var. CANADENSIS (L.) Hara. Southern Enchanter's Nightshade. Map 33.

Stems firm, 2–10 dm high, from a slender rhizome. Leaves dark green, rather firm, oblong-ovate, the larger 5–13 cm long, 2–7 cm wide, *shallowy (rarely sharply) sinuate-denticulate, rounded or barely subcordate at base. Buds* prior to anthesis *2.5–4.5 mm long.* Stigma shallowy 2-lobed. *Fruit 2-celled, deeply grooved, 3–5 mm thick* including the stiff hooked bristles. Fruiting pedicels 3–12 mm long, strongly reflexed.

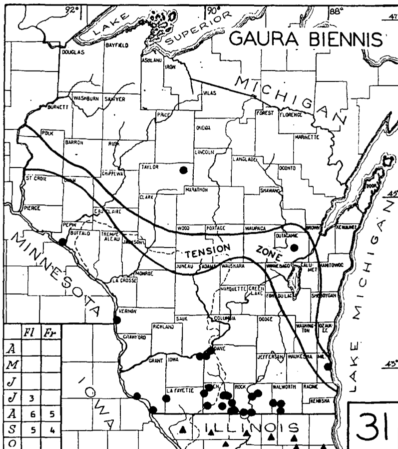
Throughout the state except in the northern-most counties, in a great variety of mesic to moist wooded habitats, especially in mixed Sugar Maple-Basswood forests, often with Bitternut, Yellow Birch, Hemlock, and Balsam Fir, frequently found in Beech-Sugar Maple, White Pine-Oak-Red Maple, and Oak-Hickory woods; as well as thickets, wooded ravines, and roadsides. Flowering from mid-June through August, and fruiting from mid-July through September.

2. CIRCAEA "CANADENSIS Hill."[2] Map 34.

Stems rather weak, 2–5 dm high, from a slender rhizome. Leaves light green, thin, ovate or oblong-ovate, the larger 4-11 cm long, 4–7 cm wide, *sharply undulate-denticulate, rounded to subcordate at base. Buds* prior to anthesis *2–3.5 mm long.* Stigma deeply 2-cleft. *Fruits unequally 2-celled* (mostly sterile), *smooth, 1–2.5 mm thick* including the soft bristles. Pedicels 3–4 mm long, spreading or slightly reflexed.

Rare in Wisconsin, with all our specimens without habitat data: Ashland Co.: Ashland, 1896, *Cheney 4722* (WIS, MIL). Bayfield Co.: Fish Creek Valley, 1932, *Bobb 770* (WIS). Douglas Co.: opposite Fond du Lac, 1897, *Cheney 7906* (WIS). Rusk Co.: Strickland, 1938, *Fassett 22044* (WIS). Flowering in July.

[2] This hybrid has recently been studied by Dr. Peter Raven (Stanford University), who, in a forthcoming publication, will rename it in honor of Prof. M. L. Fernald.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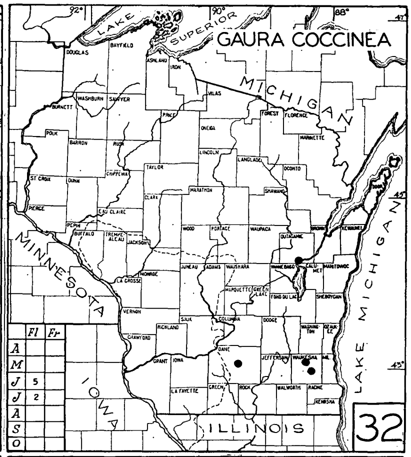
LAKE SUPERIOR
MICHIGAN
TENSION ZONE
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A
M
J
J 3
A 6 5
S 5 4
O
31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MICHIGAN
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ILLINOIS
LAKE MICHIGAN
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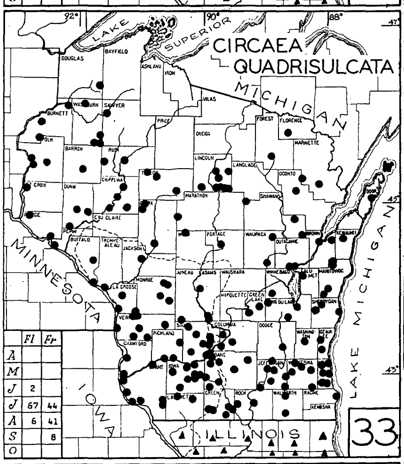
J 2
A
S
O
32


CIRCAEA QUADRISULCATA
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MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A
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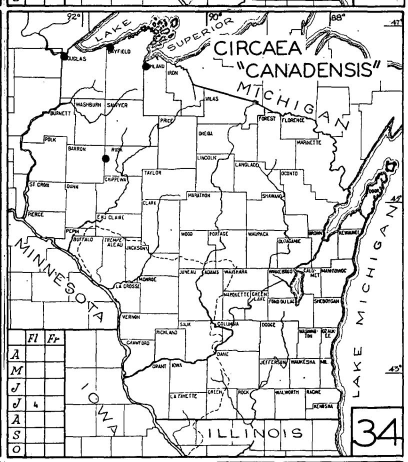
J 2
J 67 44
A 6 41
S 8
O
33


CIRCAEA "CANADENSIS"
LAKE SUPERIOR
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A
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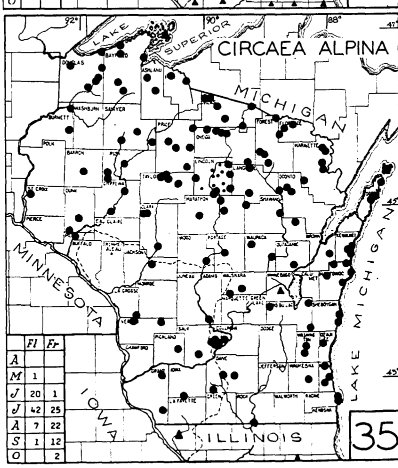
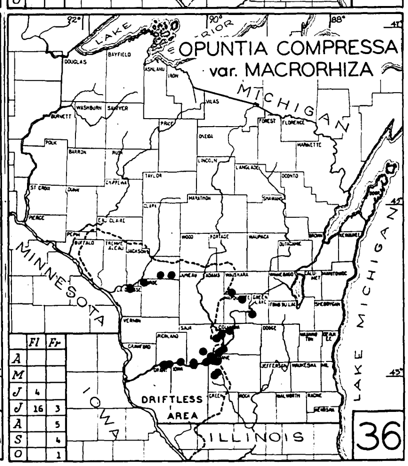
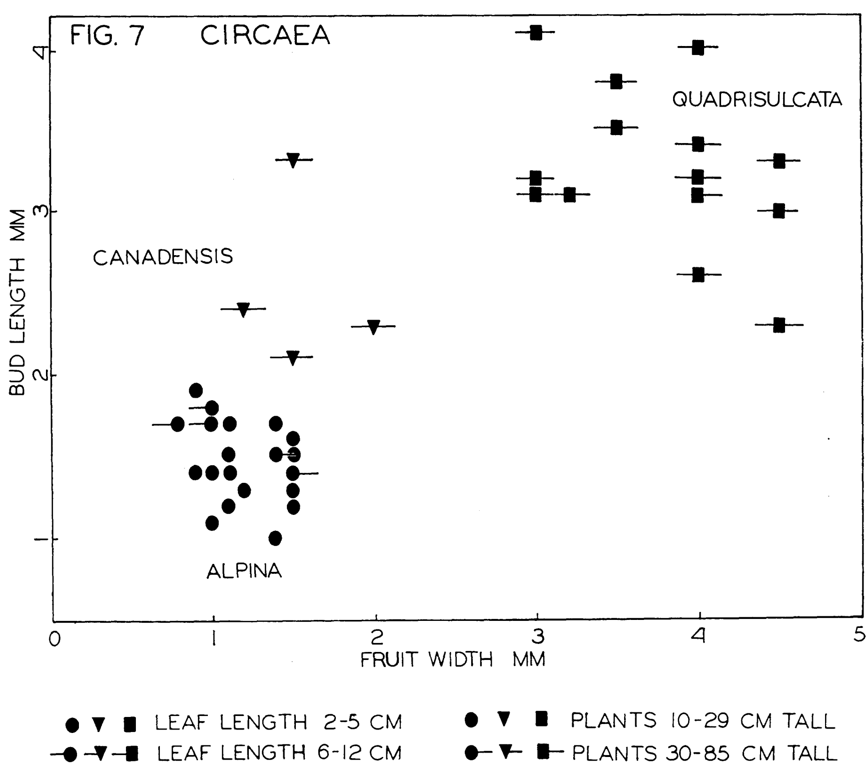
J
J 4
A
S
O
34


CIRCAEA ALPINA
LAKE SUPERIOR
MICHIGAN
MINNESOTA
IOWA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A
M 1
J 20 1
J 42 25
A 7 22
S 1 12
O 2
35


OPUNTIA COMPRESSA var. MACRORHIZA
LAKE SUPERIOR
MICHIGAN
MINNESOTA
IOWA
DRIFTLESS AREA
ILLINOIS
LAKE MICHIGAN
Fl Fr
A
M
J 4
J 16 3
A 5
S 4
O 1
36

The above plants have morphological characters intermediate to those of *Circaea alpina* and *C. quadrisulcata,* especially in height, size of flowers, and fruit thickness. The sharply dentate leaves and rather short racemes resemble those of *Circaea alpina,* while the size and shape of the leaves are like those of *Circaea quadrisulcata.* Similar eastern plants have been known as *Circaea "canadensis* Hill." (Fernald, 1917). There is a European equivalent of this plant, *Circaea intermedia,* which has long been thought of as a hybrid between *Circaea alpina* and *Circaea lutetiana,* the old world vicariad of *C. quadrisulcata* (Hegi, 1908; Hulten, 1958). Rarity of the intermediate plants, plus semi-sterile fruits, are conditions frequently associated with hybridization. Cooperrider (1962), in "The Occurrence and Hybrid Nature of an Enchanter's Nightshade in Ohio," reports that *Circaea "canadensis"* plants had less than 1% fertile pollen, and were growing in deep "hemlock gorges" or ravines together with *C. alpina* and *C. quadrisulcata.* Cooperrider cites the low pollen fertility of these plants, plus their proximity to *C. alpina* and *C. quadrisulcata,* as evidence of their hybrid nature.



The scatter diagram (fig. 7) reveals some of the subtle morphological relationships that exist between the intermediate forms and the good species. It should be noted that *Circaea "canadensis"* in general has been collected in the broad area where the ranges of both *Circaea quadrisulcata* and *C. alpina* overlap: *Circaea alpina,* a species with boreal affinities, ranges from Alaska to Labrador, south to New York, along the Appalachian Mountains to Georgia, northwest to South Dakota and Washington and along the Rocky Mountains to Colorado; while *Circaea quadrisulcata,* a species mainly of the southern deciduous forest, ranges from Nova Scotia to North Dakota, and south to Oklahoma and Georgia; *Circaea "canadensis"*, has been reported from Southeastern Quebec to Minnesota, south to Pennsylvania and the mountains of West Virginia (Fernald, 1950). However, of the 4 Wisconsin collections, 3 are just north of and beyond the range of *Circaea quadrisulcata*!

3. CIRCAEA ALPINA L. Northern Enchanter's Nightshade. Map 35.

Stems weak, 0.5–3 dm high, from a tuberously thickened rhizome. Leaves thin, pale green, ovate or deltoid-ovate, 1–6 (–8) cm long, 1–6 cm wide, *sharply undulate-denticulate, truncate or commonly cordate at base. Buds* prior to anthesis *1–2 mm long.* Stigma deeply 2-cleft. *Fruit 1-celled, smooth, 0.6–1.5 mm thick* including the soft hooked bristles. Pedicels 2–5 mm long, spreading or slightly reflexed. $2n=22$ (Levan & Löve, 1942, ex Darlington, 1955).

In cool moist woods, swamps, ravines, limestone, sandstone, and quartzite ledges, common in mixed Hemlock-Yellow Birch forests, often with Balsam Fir, White Pine, Red Maple, Sugar Maple, Basswood, Slippery Elm, and Iron Wood. Often in cool moist Arbor Vitae woods, then with Yellow Birch, Black Spruce, and Mountain Maple; or Arbor Vitae swamps with Tamarack, Alder, or Yellow Birch. Frequently growing on mossy rocks, decaying logs, and along streams. Associated with *Mitella nuda, Mitella diphylla, Coptis groenlandica, Oxalis montana, Adiantum pedatum,* and occasionally with *Circaea quadrisulcata;* at Wildcat Mt. State Park (Vernon Co.), in crevices on sandstone cliffs along with *Sullivantia renifolia* and *Cryptograma.* Flowering from mid-June to early September, and fruiting from late June to early October, this species about 2 weeks earlier than *C. quadrisulcata,* the two species to some extent seasonally isolated.

HALORAGIDACEAE—WATER MILFOIL FAMILY

Aquatics (ours) with simple, opposite, alternate, or whorled leaves and small 2–4-merous epigynous flowers sessile in the axils of the leaves or bracts. Sepals wanting or minute; petals small or none; *stamens 1–8; ovary* inferior, *3–4-celled* with a single ovule in each cell. Fruit nut-like, indehiscent.

Represented in our area by six species of the genus *Myriophyllum,* which has 4-merous flowers and whorled or alternate, usually pinnatifid leaves, and by *Proserpinaca palustris* L., with 3-merous flowers and alternate leaves. The family has been treated by N. C. Fassett, in the Preliminary Reports on the Flora of Wisconsin 10 (Trans. Wis. Acad. Sci., Arts, and Letters 25:201–203. 1930).

HIPPURIDACEAE—MARE'S TAIL FAMILY

Aquatic plants with simple, sessile, whorled, entire leaves and minute, perfect or pistillate, epigynous flowers sessile in the upper leaf axils. Sepals and petals wanting; *stamen 1; ovary* inferior, *1-celled* and 1-ovuled. Fruit nut-like.

A monotypic family. *Hippuris vulgaris* L., its only member, has been treated with the *Haloragidaceae* by N. C. Fassett (1930).

ORDER CACTALES

Flowers solitary, sessile, regular, perfect, epigynous. Sepals and petals numerous, inserted on the hypanthium. Ovary inferior, 1-celled, ovules numerous. Fruit a dry or juicy berry. Only the following family.

CACTACEAE—CACTUS FAMILY

Characters of the order. Stems fleshy and thickened, jointed, globular, or columnar, often spiny, mostly leafless.

A large family native (with a few questionable exceptions) mainly to the arid and semi-arid regions of tropical and temperate America and consisting of approximately 124 genera and 1200 species.

1. OPUNTIA Mill. Prickly Pear

[Benson, L., A revision of some Arizona *Cactaceae*. Proc. Cal. Acad. Sci. 25:245–268. 1944; Britton, N. L. and Rose, J. N., "The *Cactaceae*". Carnegie Inst. of Wash. Pub. no. 248. 1919.]

Succulent plants with jointed greatly flattened to cylindric stems. Leaves reduced to awl-like fleshy scales, soon deciduous, with clusters of detachable barbed bristles (glochids) and often elongate spines in their axils (areoles).

Key to Species

A. Joints of stem strongly flattened, when full grown 3–23 cm long; spines 1–4 per areole (more numerous in immature joints), or none; fruit juicy when ripe, spineless ---------- ---------------------------------------1. O. COMPRESSA.

AA. Joints of stem turgid, scarcely flattened, when full grown 1–4 cm long; spines 1–7 per areole; fruit dry, often spiny -------- --2. O. FRAGILIS.

1. Opuntia compressa (Salisb.) Macbr. Prickly Pear.

Joints orbicular to oblong, flattened, 3–23 cm long, 2–10 cm broad. Areoles 8–18 mm apart, the glochids yellow or brown. Spines from upper areoles only, or wanting, when present 1–4 per areole, of which one is much the larger, white or gray, 4–43 mm long. Petals yellow, the base often reddish, 2.5–4 cm long. Fruit obovoid or clavate, spinless, juicy, green, aging red or red-purple, 3–8 cm long, edible. 2n=22, 44 (Bowden, 1945, ex Darlington, 1955).

Key to Varieties

A. Stems forming circular mats 1–2 m in diam.; central roots tuberously thickened ----1a. O. COMPRESSA var. MACRORHIZA.

AA. Stems spreading for many meters, not forming distinct circular mats; all roots fibrous ------------------------------- ---------------------1b. O. COMPRESSA var. MICROSPERMA.

1a. Opuntia compressa var. macrorhiza (Engelm.) Benson. Map 36.

Opuntia macrorhiza Engelm.

Stems prostrate, the terminal portions ascending, *forming mats 1–2 m in diameter from a central cluster of tuberous roots,* these sometimes 5 cm in diameter and resembling an elongated potato, the peripheral joints frequently with fibrous roots only.

Var. *macrorhiza,* which extends from Arizona and Texas eastward to Kansas and Missouri, and north through Nebraska, and Minnesota, occurs in Southwestern Wisconsin in sand areas and bluffs mainly along the Wisconsin and Black Rivers, in dry prairies, open Jack Pine-Oak woods, and sand barrens. Commonly associated with *Monarda punctata, Euphorbia corollata, Ambrosia psilos-*

tachya, Liatris aspera, Lespedeza capitata, Asclepias verticillata, Oenothera rhombipetala, Koeleria cristata, Selaginella rupestris, and *Cladonia cristatella.* The joint surface is often infected by the parasitic fungus *Perisporium wrightii* B. & C., which forms large black plaques 1 cm or more in diameter. Flowering from mid-June through July, and fruiting from mid-July through October.

The Spring Rose Beetle, *Strigoderma arboricola* Fab. *(Scarabaeidae)*,[3] has been observed by me at several stations to visit the flowers in great abundance, frequently forcing their way through the numerous overlapping petals of the bud. Often, each flower will have a dozen or more beetles coated with yellow pollen struggling to gain access to the nectaries at the petal bases. The flowers are less frequently visited by honey bees, wasps, and ants.

All of our plants grow either on Upper Cambrian Sandstone ledges, or on sand or sandy soil derived from that parent material. Frequently the sandstone ledges are capped by a layer of Lower Ordovician Dolomite, the alkaline seepage of which permeates and cements the underlying sandstone, causing the soil pH to vary from fairly acidic to mildly basic (Table 1).

TABLE 1. Soil pH, dry samples, Beckman meter. Soil samples taken from earth immediately surrounding roots of *Opuntia compressa* var. *macrorhiza.*

LOCALITY	COUNTY	pH
Gotham	Richland	4.73
Okee	Columbia	5.00
Black Earth	Dane	6.17
Blue River	Grant	6.18
Pine Bluff	Dane	6.49
Spring Green	Sauk	6.55
Budsin Corners	Marquette	6.99
Troy	Sauk	7.40
Lodi Mills	Sauk	7.49
Marxville	Dane	7.55
Cactus Bluff	Sauk	7.61
Mazomanie	Dane	7.73

Benson (personal communication, 1960) finds that var. *macrorhiza,* in general, has much broader seed margins than var. *microsperma.* The seeds of Wisconsin plants, while somewhat broader margined, are not distinctive enough to be of much value in differentiating between varieties.

[3] Identified by Dr. Roy Shenefelt, Dept. of Entomology, University of Wisconsin.

1b. OPUNTIA COMPRESSA var. MICROSPERMA (Engelm.) Benson. Map 37.

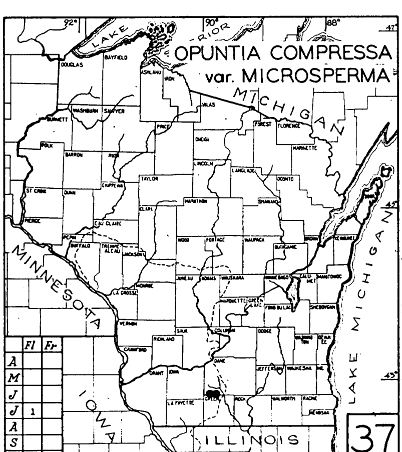
Opuntia humifusa Raf.
Opuntia rafinesquii Gray.

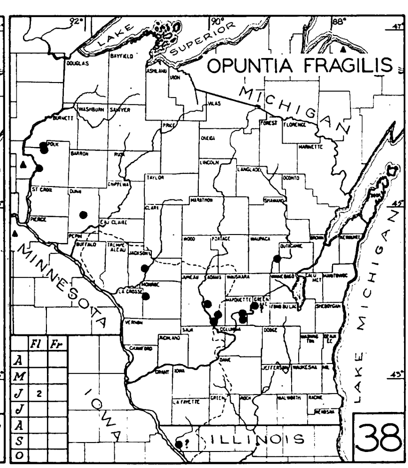
Differing from var. *macrorhiza* by its habit of spreading irregularly over large areas (rarely forming small well-defined mats), *completely fibrous root system,* and somewhat smaller seed margins.

Var. *microsperma,* a wide-ranging Middle-Western form differing from the eastern typical variety only in its more spiny and slightly larger joints and fruits, is apparently very rare in southwestern Wisconsin in dry sand prairies and sandstone ledges. Flowering in early July.

The plant is known from only two localities, both in Dane County. Near Daleyville (*Looman s.n.,* 1960 [WIS]) it occurs on a grazed sandy south-facing slope (pH 6.72) leading up to crumbly ledges of St. Peter sandstone, there thriving on the organically poor soil derived from weathering of the rock, which is encrusted with many lichens, especially *Physcia caena* and *Lecanora rubina.* Near the top ledge, *Opuntia* grows intermixed with spreading mats of *Juniperus horizontalis,* while in the lower grazed slope it is associated with *Oenothera rhombipetala, Rubus* and *Rosa* spp., and scattered *Xanthoxylum americanum.* Near Belleville it has been collected on a crumbling sandstone bluff *(Fassett 3100* [WIS]).

OPTUNIA TORTISPINA Engelm., which extends from South Dakota to Texas and New Mexico, is reported for Wisconsin by Britton and Rose (1:1313, 1919) and other authors, a record evidently based on a misidentified specimen of *Opuntia compressa.* No specimens referable to this species have been seen by the writer.





2. OPUNTIA FRAGILIS (Nutt.) Haw. Brittle Prickly Pear. Map 38.

Stems prostrate or decumbent, forming loose mounds up to 5 dm in diameter and to 2 dm high. *Joints* dark green, *easily detached. usually turgid, orbicular to obovate, 1–4 cm long, 6–22 mm thick.* Areoles crowded, filled with white wool and yellow glochids, nearly all armed with 1–7 spines, 1–22 mm long. Petals yellow, 24–26 mm long. Fruit dry, spiny, inedible. 2n=66 (Bowden, 1945, ex Darlington, 1955).

Opuntia fragilis, extending from British Columbia eastward to Manitoba, and south to Texas and Arizona, is rare though locally abundant in central and northwestern Wisconsin, on thin rocky soil of granite or quartzite outcrops and occasionally in sandy soil or on sandstone ridges; SE of Grantsburg (Burnett Co.; *Schlising 1647* [WIS]) in dark rich soil (pH 4.6) in cracks and crevices of an exposed grazed granite outcrop with scattered *Quercus macrocarpa, Juniperus virginiana, Rhus glabra, Xanthoxylum americanum, Selaginella rupestris, Rhus radicans, Monarda fistulosa, Campanula rotundifolia,* and *Silene antirrhina,* sharing the rock space with many lichens, especially *Parmelia conspersa, Parmelia stenophylla, Cladonia pyxidata;* near New London (Waupaca Co.: *Fuller s.n.,* 1931 [MIL]) abundant on granite outcrop (pH 4): and SW of Adams (Adams Co., *Fuller s.n.,* 1925 [MINN]) in sand barrens with *Selaginella rupestris* and *Polygonella articulata.* Flowering in mid-June.

OPUNTIA POLYACANTHA Haw., which extends from southern Alberta and Saskatchewan to Texas and Arizona, and reportedly to Wisconsin (Gleason 2:570, 1952), has not been seen from Wisconsin, the report probably based on a misidentified specimen of *Opuntia fragilis.* The only specimen that might possibly be included in *O. polycantha* is one Green Lake County specimen, which has tentatively been determined by Benson as *O. fragilis* (on map 38 with a ? mark). Though further field work may resolve this question, it is worth noting that this collection is well within the geographic range of *O. fragilis* in Wisconsin.

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MINERAL DEFICIENCY SYMPTOMS ON TURFGRASS[1]
I. MAJOR AND SECONDARY NUTRIENT ELEMENTS

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It is well documented that the lack of an essential mineral element can cause physiological disease (e.g., chlorosis) in plants. Descriptions of the deficient symptoms in various agronomic and horticultural plants have been reported by numerous investigators, including Bear *et al* (1949), DeTurk (1941), Hewitt (1943, 1944), McMurtrey (1948), and Wallace (1953). However, in none of these publications have the deficiency symptoms for any of the nutrient elements been described using a turfgrass as the indicator plant.

It was the purpose of this study to determine the deficiency symptoms of the major nutrient elements: Nitrogen (N), Phosphorus (P) and Potassium (K) and the secondary nutrient elements: Calcium (Ca), Magnesium (Mg) and Sulfur (S) in three grass species: Kentucky bluegrass (*Poa pratensis,* Merion) Creeping Bentgrass (*Agrostis palustris,* Seaside) and Creeping Red Fescue (*Festuca rubra,* Pennlawn).[2]

Duplicate treatments of each of these grass-nutrient combinations were grown in acid-washed quartz sand under controlled conditions in the greenhouse. A modified Hoagland's solution was used to maintain the plants in a healthy state until each grass was vigorously established. Prior to initiating the differential nutrient treatments, each sand culture (including the controls) was leached under suction with approximately three liters of distilled water to remove any accumulation of soluble salts. The plants were then managed as before except for the withholding of the particular nutrient element under investigation. The harvested tissue from each treatment was saved for chemical analyses.

That the visual symptoms noted in this study were due to a shortage of the major and secondary nutrient elements is evidenced first by the fact that the deficiencies were elicited three times, i.e., twice the deficient nutrient was added to the growth medium and

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[2] A study is also underway to establish the minor element deficiency symptoms in these same grass species.

the grass permitted to recover and secondly by the lower content of the deficient nutrient in the harvested leaves (Table 1). These steps are important because unless verified the possibility exists that the appearance one is diagnosing as a mineral deficiency may in actuality prove to be the result of some disease, lack of sufficient sunshine, too much or too little water, unfavorable temperatures, or some other condition. In all instances the visual symptoms were found to be reproducible.

TABLE 1. MAJOR AND SECONDARY NUTRIENT CONTENT OF VARIOUSLY TREATED TURFGRASS

Treatment	Percent Nutrient Contained in Leaves					
	N	P	K	Ca	Mg	S
			Seaside Bentgrass			
Complete	0.75	0.13	1.25	0.77	0.18	0.19
Deficient	0.40	0.06	0.31	0.27	0.08	0.08
			Merion Bluegrass			
Complete	0.65	0.10	1.05	0.82	0.18	0.15
Deficient	0.38	0.04	0.19	0.05	0.05	0.06
			Pennlawn Fescue			
Complete	0.78	0.09	1.23	0.65	0.14	0.12
Deficient	0.35	0.04	0.25	0.19	0.05	0.04

As in other studies of this kind, it was noted that the mineral deficiency symptoms varied according to the extent of the shortage and the stage of growth at which the deficiency manifested itself. It was found that unless some amount of the nutrient in question was added initially, the small seeded bent- and bluegrass died from starvation either too small to clearly exhibit the deficiency symptoms (this was especially seen in those plants lacking N, P, K) or else without showing the same signs that characterize the deficiency in the more mature stage of growth.

An example of the latter can best be illustrated in grass receiving no additional Ca. In these plants the blades of adjacent leaves stuck to one another in a manner somewhat resembling that in corn as described by DeTurk (1941). The roots were extremely stunted, black and very gelatinous. In no case were these signs observed in Ca deficient plants that were permitted to become established prior to withholding the Ca from the growth medium. That the shortage of Ca in these older plants was critical is demonstrated in the fact that one of the duplicates in the bluegrass series failed to recover after the deficiency was elicited for the second time.

Finally it should be emphasized that while the criteria establishing the essentiality of the nutrient elements have been well outlined by the plant physiologists (Arnon, 1950), describing the visual symptoms of the nutrient deficiencies still remains a matter of individual judgment and, as such, the following descriptions should perhaps best be prefaced by the old admonition: Say not, this is so! But say, so it seems to me to be as I now see the thing I think I see.

Nitrogen Deficiency

Seaside Bentgrass. Plants are thin and erect, with little if any tillering. The leaves are short and small, developing a pale green color in the early stages of the deficiency. As the starvation progresses the older leaves take on a yellow hue until the entire blade is a yellowish-green color. This chlorotic condition is followed by a tanned or fired effect that appears at the tips of the older leaves. The manner in which the firing progresses down the leaf is similar to that seen in oat plants, in a more or less horizontal fashion, as opposed to the v-shaped pattern that characterizes the firing seen in corn.

Merion Bluegrass. Similar to that described above except that there is less copper tone to the firing than is seen in the Seaside bentgrass.

Pennlawn Fescue. Similar to that noted in Seaside bentgrass.

Phosphorus Deficiency

Seaside Bentgrass. The first sign of P deficiency in Seaside bentgrass, as indeed in nearly all plants, is the appearance of a dark green coloration in the leaves. Associated with this is a restriction in growth and while the plants tend to be spindly the shoots are not as short and thin as that seen in plants lacking N. If the deficiency persists, the leaves take on a dull bluish-green color, with purple discolorations appearing along the entire margin of the blade and in the main veins near the base. Gradually these colors give way to reddish-bronze tints which first appear near the leaf tips and progress down the blade. At its climax the entire leaf appears scorched and the leaf tip withered.

Merion Bluegrass. While the initial symptoms of P deficiency resemble that seen in Seaside bentgrass, namely the dark green coloring of the leaves accompanied by restrictions in growth, the foliage of Merion bluegrass does not pass through the dull blue-green to purplish stages that normally characterize the advanced conditions of P starvation in other grasses, including the cereals.

In the case of this grass, the dark green color of the leaves gives way to an intense tanned condition. The latter appears first at the tips of the older leaves and progresses slowly down the blade.

It is at this stage that P and N deficiencies in Merion bluegrass are most similar in appearance. There are, however, several ways of distinguishing these two deficiency symptoms: first, the tanning effect in the case of no P is more intense than that seen in N starvation and secondly, a comparison of the color of the grasses at the base of the blades offers another clue in differentiating the respective causes. In the case of no N, the color of the blade below the firing is a very pale green to yellowish-green, whereas for the same plant part in the case of no P the color is dark green.

Pennlawn Fescue. Similar to that described for Seaside bentgrass.

POTASSIUM DEFICIENCY

Seaside Bentgrass. In the early stages of development, K deficiency in Seaside bentgrass is generally characterized by one or more of the following symptoms: the soft feel and drooping appearance of the leaves, with many blades horizontally inclined; a tendency toward excessive tillering; moderate chlorosis of the intervenal areas in the older leaves; rolling and withering of the leaf tips which retain blotches of green coloring. In the more advanced stages the chlorotic area extends to the midvein which still remains green, while the leaf margins are scorched and the tips severely withered.

Merion Bluegrass. Similar to that noted in Seaside bentgrass except for the early loss of chlorophyll in the leaf tips and the delayed appearance of tip firing and marginal scorching of the blades (note the absence of the latter symptoms in spite of the severe chlorotic condition of the leaf that extends almost to the base of the folded blade).

Pennlawn Fescue. Similar to that noted in Merion bluegrass.

CALCIUM DEFICIENCY

Seaside Bentgrass. As noted earlier, the symptoms of Ca deficiency in young plants are quite different from those observed in older plants. The first diagnostic sign that characterizes the shortage of Ca in established Seaside bentgrass is the appearance of reddish-brown discoloration in the intervenal tissue along the margin of the blade in the upper (newer) leaves. If allowed to progress, this condition gradually extends inward to the midvein and the


SEASIDE BENT GRASS
All Elements
No Nitrogen
No Phosphorus
No Potassium
No Calcium
No Magnesium
No Sulfur
All Elements
MERION BLUE GRASS
All Elements
No Nitrogen
No Phosphorus
No Potassium
No Calcium
No Magnesium
No Sulfur
All Elements
PENNLAWN RED FESCUE
All Elements
No Nitrogen
No Phosphorus
No Potassium
No Calcium
No Magnesium
Each group of unhealthy leaves show progressive stages of deficiency symptoms
All Elements

colors fade to lighter shades of red, predominately rose red. Terminally the leaf takes on a fired and withered appearance.

Merion Bluegrass. Similar to that observed in Seaside bentgrass.

Pennlawn Fescue. Similar to that observed in Seaside bentgrass.

Magnesium Deficiency

Seaside Bentgrass. The general appearance of Seaside bentgrass lacking Mg closely resembles that seen in Ca starvation and to the casual observer they may appear to be identical. However, a careful examination of the symptoms (together with a chemical test of the soil and/or plant tissue to confirm the visual findings) will generally yield the proper diagnosis. In contrast to Ca deficiency symptoms, those of Mg usually appear first in the lower (older) leaves and the initial discoloring is more cherry red. Also, in approximately 30 to 50 per cent of the affected leaves the coloring is blotchy, giving rise to a banded appearance that was never observed in the Ca deficient plants.

Merion Bluegrass. Similar to that noted in Seaside bentgrass.

Pennlawn Fescue. Similar to that noted in Seaside bent grass.

Sulfur Deficiency

Seaside Bentgrass. As with Ca and Mg, the deficiency symptoms of S in well established turf are late to develop and as a consequence have only a slight effect on growth. However, in appearance the signs of S starvation more closely resemble those seen in plants lacking N or K than in those deficient in either Ca or Mg.

The initial symptoms of S deficiency in Seaside bentgrass is the general paling of the leaves. If the chlorotic condition is allowed to progress, the blades take on a pale yellow-green cast. Accompanying this is the appearance of a faint scorching at the tip of the blade that advances toward the leaf base in a thin line along each margin. Gradually the border enlarges until finally the entire leaf blade becomes fired and withered.

Merion Bluegrass: In Merion bluegrass the shortage of S manifests itself in two distinct ways: first, as the chlorotic condition develops the veins, especially the midvein, remain green, similar to that seen in cotton, giving the leaf a pale striped appearance. Eventually, however, even the midvein loses its color and the entire blade fires. The second characteristic sign of S deficiency noted repeatedly in Merion bluegrass is the enhanced susceptibility of these plants to powdery mildew.

Pennlawn Fescue. Similar to the described for Seaside bentgrass.

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STUDIES ON THE IRON, MANGANESE, SULFATE AND SILICA BALANCES AND DISTRIBUTIONS FOR LAKE MENDOTA, MADISON, WISCONSIN*

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The purpose of this paper is to present some results of unpublished investigations on Lake Mendota. The data presented are taken primarily from reports to the University of Wisconsin's Lakes Investigation Committee and from theses on file in the University of Wisconsin Library.

Since 1948, the University of Wisconsin's Lakes Investigation Committee has sponsored, directed and coordinated investigations on the fertilization of lakes and streams. One phase of these investigations was directed toward finding the amounts of plant nutrients entering Lake Mendota, Madison, Wisconsin. In addition, studies were conducted on the distribution of these compounds in the Lake. This paper summarizes some of the unpublished results of these investigations on the amounts of iron that enter this lake, how iron is distributed in the water and sediments, and the amounts of iron that leave the lake. In addition, data are presented for manganese, sulfate, and silica distributions and balances.

LOCATION AND DESCRIPTION

Lake Mendota is a hard water eutrophic lake located on the northwestern limits of the city of Madison, Wisconsin. The lake has a surface area of 15.2 square miles and average depth of 40 feet with a maximum depth of 84 feet, a volume 15 x 10^9 cubic feet (Domogalla 1926). The lake has a cumulative drainage area of 265 square miles. The runoff from this watershed enters the lake through ten tributaries and leaves the lake principally by the Yahara River. The watershed is devoted principally to farming with the tributaries passing sluggishly through marshes before entering the lake.

The lake occupies a pre-glacial valley system excavated by streams in sand stones and sandy dolomites of upper cambrian age (Hanson 1951, 1952). It has a theoretical detention time of five years based on the mean annual tributary flow of 3 x 10^9 cubic feet (Belter and Calabresa, 1950).

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WATER BALANCE AND SAMPLING STATIONS

In July 1948, stream gaging and sampling stations were established on the ten tributaries to Lake Mendota and on the Yahara River at the outlet of the lake. These stations are shown in Figure 1.

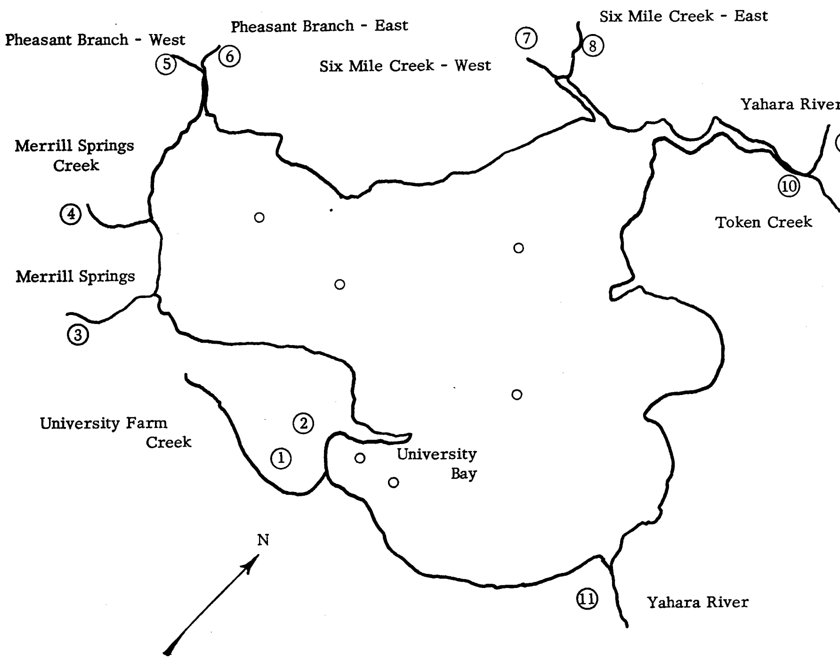

FIGURE 1. Map of Lake Mendota showing sampling stations.

A water balance for Lake Mendota for the year October 1, 1948 to October 1, 1949 is presented in Table 1 (Belter and Calabresa, 1950).

CHEMICAL ANALYSIS

Grab samples were collected at each sampling station once every three weeks. The chemical analysis performed on these samples included determination of pH, alkalinity, dissolved oxygen, biochemical oxygen demand, nonfilterable and total phosphorous, ammonia, organic nitrogen, nitrite, nitrate, sulfate, silica, manganese, and iron. These analyses were performed according to the procedures in Standard Methods (1946). This paper is limited to a presentation of the results of the analysis of iron, manganese, sulfate, and silica.

TABLE 1. WATER BALANCE OF LAKE MENDOTA—OCTOBER 1, 1948–OCTOBER 1, 1949

	MEAN ANNUAL DISCHARGE
INFLOW	
a. Measured Tributaries—Sta. 1–10 (192.27 sq. miles of drainage basin)	78.4 cfs.
b. Unmeasured Tributary Area (31.87 sq. miles of drainage basin, by computation)	13.0 cfs.
c. Precipitation on lake surface (31.65 inches)	38.7 cfs.
Total Inflow (4,100,000,000 cubic feet)	130.1 cfs.
OUTFLOW	
a. Storage	3.5 cfs.
b. Evaporation (51.17 inches, by computation)	58.2 cfs.
c. Outflow, Station 11—Yahara River	70.0 cfs.
d. University—Water Supply	1.5 cfs.
Total Outflow (4,200,000,000 cubic feet)	133.2 cfs.

Unaccounted for 133.2–130.1–3.1 cvs. = 2.33% of outflow. Possibly due to unmeasured inflow from sub-surface springs, or experimental errors. (after Rohlich and Lea, 1959.)

Table 2 presents the relative annual contributions of each of the tributaries. These computed values were based on the assumption that the concentration of the compound remained constant at the mean value between the sampling periods. The mean concentration value for a sampling period was used to convert the concentrations to pounds of compound per day based on the recorded discharge of each tributary.

TABLE 2. SUMMARY OF DATA—OCTOBER 1, 1948–OCTOBER 1, 1949

STATION	PER CENT				
	Flow	Fe	Mn	SO_4	SiO_2
1	0.9	0.9	0.9	0.9	0.6
2	0.7	1.5	0.6	2.4	0.9
3	0.9	0.1	0.4	0.5	0.9
4	0.9	0.2	0.5	0.6	0.9
5	3.2	5.1	5.1	24.7	3.0
6	6.4	3.8	6.4	4.9	6.2
7	1.5	1.1	1.7	1.4	1.4
8	20.1	34.2	27.5	9.5	20.5
9	31.4	22.2	28.0	31.9	30.5
10	34.0	25.5	28.9	23.2	35.1

(Belter and Calabresa, 1950)

Table 3 presents a summary of the iron, manganese, sulfate, and silica apparent balances based on inflow-outflow for Lake Mendota for the period October 1, 1948 to October 1, 1949.

Examination of this table shows that 20,640 pounds of iron entered the lake during this water year with approximately twice as much iron entering the lake during winter flows as compared to summer flows. During the same year, however, only 3,955 pounds of iron left the lake via the Yahara River Outlet. These data show an 80 per cent iron retention in the lake, or that iron was carried out of the lake by some other means.

The data for manganese show that a fairly good balance was obtained with a difference of inflow-outflow or less than 50 pounds for the year. During this same period 18 per cent of the sulfate and 90 per cent of the silica was apparently retained in the lake.

TABLE 3. IRON, MANGANESE, SULFATE, AND SILICA APPARENT BALANCE—LAKE MENDOTA

	WINTER PERIOD OCT. 1, 1948– MAY 1, 1949	SUMMER PERIOD MAY 1, 1949– OCT. 1, 1949	YEAR PERIOD OCT. 1, 1948– OCT. 1, 1949
IRON			
Station 1–10....	14,480 lbs.	6,160 lbs.	20,640 lbs.
Station 11......	2,350 lbs.	1,605 lbs.	3,955 lbs.
Retained in Lake (apparent)	12,130 lbs. = 84%	4,555 lbs. + 74%	16,685 lbs. = 81%
MANGANESE			
Station 1–10....	17,750 lbs.	5,927 lbs.	23,677 lbs.
Station 11......	16,150 lbs.	7,576 lbs.	23,726 lbs.
Retained in Lake (apparent)	1,600 lbs. = 9%	—1,649 lbs. = 28% (loss)	—49 lbs. = 0.2%
SULFATES			
Station 1–10....	1,281,870 lbs.	471,390 lbs.	1,753,260 lbs.
Station 11......	949,650 lbs.	481,950 lbs.	1,431,600 lbs.
Retained in Lake (apparent)	332,200 lbs. = 26%	—10,560 lbs. = 2% (loss)	321,550 lbs. = 18%
SILICA			
Station 1–10....	935,880 lbs.	144,430 lbs.	1,080,310 lbs.
Station 11......	76,530 lbs.	28,590 lbs.	105,120 lbs.
Retained in Lake (apparent)	859,305 lbs. = 92%	115,840 lbs. = 80%	975,190 lbs. = 90%

Stations 1–10 inlet, 11 outlet, (after Rohlich and Lea, 1949)

Emelity and Hanson (1948) present data on the flux of these compounds at the Yahara River outlet station 11 for a period that coincides in part with the previously reported data of Belter and Calabresa (1950). These data are presented in Table 4 for the period July 1, 1948 to April 1, 1949 and grouped according to periods when the flow was reasonably constant. They are based, however, on a grab sample taken every week.

Examination of this table shows that the iron flux has a range of 0.6 to 69 pds/day. Also, that during certain three week periods, particularly in Spring, large changes took place in the amounts of these compounds leaving the lake.

It is of interest to compare these data of Emelity and Hanson (1949)—one sample every week—with that of Belter and Calabresa (1949)—one sample every three weeks—for the winter period October 1, 1948 to May 1, 1949. Belter and Calabresa (1950) reported for this period 2,350 pounds of iron and 16,150 pounds of

TABLE 4. AMOUNTS OF IRON, MANGANESE, SULFATE AND SILICA LEAVING LAKE MENDOTA

DATE	FLOW, x10^{-6}	FE	MN	SO_4	SIO_2
	pounds/day				
1948					
July 1–22	145	1.5	14	1,704	116
July 22–Aug. 7	125	1.2	19	988	7
Aug. 7–Sept. 5	98	0.6	5	1,000	216
Sept. 5–Oct. 2	59	1.5	8	220	225
Oct. 2–Oct. 22	59	15	9	666	42
Oct. 22–Nov. 12	59	5.2	6	546	27
Nov. 12–Dec. 3	59	1.2	8	738	35
Dec. 3–Dec. 31	59	2.2	5	613	54
1949					
Jan. 1–Feb. 8	94	1.4	14	1,053	93
Feb. 8–March 3	498	15	75	5,087	549
March 3–March 18	1,261	6.3	202	13,877	1,123
March 18–March 25	1,101	69	7	16,521	694
March 25–April 11	1,138	57	102	10,816	683
April 11–May 1	942	24	47	11,116	942

(Emelity and Hanson 1949)

manganese leaving the lake with an 84 per cent iron and 9 per cent manganese apparent retention. These same computations based on the data of Emelity and Hanson (1949) show 2,950 pounds of iron with 79 per cent retention and 10,470 pounds of manganese—60 per cent retention during this winter period. The sulfate leaving the lake was 946,229 pounds—26 per cent retention. This same agreement was obtained in the silica data with 72,092 pounds passing the Yahara river sampling point based on a one week sampling period—93 per cent retained as compared to 92 per cent retention based on the three week sampling period. Therefore, the only major discrepancy between the two sets of data occurs with manganese.

It should be pointed out that the comparison of the two sets of data is based on samples taken from the outlet of the lake and that the variability of these data may not be as large as the data from the Lake Mendota tributaries.

The transport of these elements past the Yahara River outlet of Lake Mendota is presented in Table 5 for 1949 and 1950. These data were obtained by Haggerty (1950).

TABLE 5. TRANSPORT OF ELEMENTS—YAHARA RIVER OUTLET—1949–1950

	Flow gal/day x 10^6	Average Transport			
		Fe	Mn	SO_4	SiO_2
		mean pounds per day			
1949					
Autumn Circulation..... (Oct. 13–Dec. 31)	17.6	10.9	10.4	1,262	49
Winter................	92.8	62.5	108	8,850	84.5
1950					
Spring Circulation....... (Mar. 24–April 17)	225	159	1,525	22,800	188
Summer................	38.4	15.4	39.1	2,720	159

The data clearly show the importance of the high spring flows and lake circulation on the flux of elements past the Yahara River outlet of the lake.

Data were available for a comparison of the transport of these elements over several years. Table 6 presents these data.

The concentration data for this period are presented in Table 7. Examination of Table 6 shows that for any one season the year to year variation in the amount of an element carried out of the lake by the Yahara River is highly variable even though Table 7 shows that concentrations are essentially constant from year to year for one season. The cause of this variability cannot be explained without further data. However, these data do show that a balance based on one year's inflow-outflow record should not be used to predict the long-term accumulation of an element in the lake.

TABLE 6. SEASONAL TRANSPORT OF ELEMENTS YAHARA RIVER OUTLET OF LAKE MENDOTA

SEASON	YEAR	FE	MN	SO_4	SiO_2
		mean pounds/day			
Summer	1948	1	19	1,230	113
Fall	1948	5	7	556	77
Winter	1949	8	48	3,070	321
Spring	1949	38	89	13,082	860
Summer	1949	10	54	2,449	150
Fall	1949	11	10	1,262	49
Winter	1950	62	108	8,850	84
Spring	1950	159	1,525	22,800	188
Summer	1950	15	39	2,720	159
Fall	1950	20	....	3,297	60

These data were obtained by Emelity and Hanson (1949, 1950), Fuller (1949), Haggerty (1950), Darrow and Jackson (1949), Levihn (1951).

Based on the seasonal variations in the transport of these elements in the outlet of Lake Mendota, it may be expected that the concentration of these elements should show similar variations in the lake. From July 1948 through May 1949, Belter and Calabresa (1950) and Emelity and Hanson (1950) performed analyses on the element content of Lake Mendota. Sampling stations were established at various locations in the lake. These stations are shown in Figure 1 as circles on the map of the lake. Samples were taken once every three weeks at each of these stations; at the surface, at the thermocline or at a depth of 10 meters, and at one half meter from the bottom.

Examination of these data with respect to horizontal location did not reveal any significant trends. However, when the data are pooled for all horizontal sampling sites for any particular depth and season, significant variations do occur. These data are presented in Table 8. Examination of the table shows that the standard deviations are rather large and, in general for iron and manganese, are of the magnitude of the mean. These data show, as would be expected, low surface iron concentrations during the summer; while in the fall, winter, and spring, the lake is fairly well mixed. Without additional information the low values (0.02) near the bottom during the spring are not explainable. If these data are compared in Table 7 on the mean concentrations in the Yahara River outlet, it is apparent that it is difficult to predict Yahara River Concentrations based on Lake Mendota concentrations.

TABLE 7. MEAN CONCENTRATIONS OF ELEMENTS IN THE YAHARA RIVER OUTLET OF LAKE MENDOTA

mg/1

SEASON	YEAR	NO. OF OBSER'S	FE Mean	FE Std. Dev.	MN Mean	MN Std. Dev.	SO_4 Mean	SO_4 Std. Dev.	SIO_2 Mean	SIO_2 St.d Dev.
Summer	1948	4	0.02	0.02	0.1	0.08	8.4	5.4	1.8	2.2
Fall	1948	4	0.1	0.1	0.1	0.2	10.8	6.5	0.7	0.4
Winter	1948	14	0.06	0.1	0.1	0.06	11.6	4.5	0.9	0.3
Spring	1949	14	0.05	0.05	0.2	0.05	8.1	4.3	0.4	0.3
Summer	1949	19	0.06	0.1	0.1	0.4	8.8	2.8	0.4	0.3
Fall	1949	11	0.07	0.07	0.08	0.06	8.5	3.4	0.3	0.1
Winter	1950	13	0.07	0.1	0.3	0.6	11.3	1.7	0.1	0.1
Spring	1950	11	0.06	0.08	0.08	0.07	12.1	4.4	0.8	0.5
Summer	1950	13	0.05	0.04	0.08	0.04	8.8	5.0	0.4	0.3
Fall	1950	13	0.07	0.01	0.07	0.09	12.0	4.0	0.2	0.1

Table 8 shows that this lake has considerably greater concentrations of manganese as compared to iron concentrations. The seasonal and vertical distribution of manganese is as would be expected.

The sulfate data displays a typical picture of a relatively unreactive compound in the lake with concentrations increasing during the winter during periods of ice cover and decreasing during spring melting and runoff.

The silica data are interesting in that the summer and winter periods display minimums in vertical periods at the 10 meter station.

Other Studies on the Iron and Manganese Cycle. Dugdale (1956) reported in a study of the emergent crops of diptera found, that during the spring and fall of 1954, the net weight of emergent larva was:

Spring	203 metric tons
Fall	632 metric tons
for a total	835 metric tons of emergent insects leaving

Lake Mendota. In comparison, it is interesting to see that the estimated annual crop of perch taken from the lake is 140 metric tons.

Nees (1954) from a knowledge of the amounts of insects leaving the lake and the iron and manganese content of these insects, estimated that the annual loss of iron and manganese due to insects was 1.9 metric tons and 0.15 metric tons, respectively. Therefore, the amounts of iron transported by insects out of Lake Mendota in 1954 was of the same order of magnitude as the amount of iron transported out of the lake by the Yahara River outlet. Nees also estimated that about 5 per cent of the net apparent gain in iron, Table 3, is lost via removal of fish. Therefore, the iron balance for Lake Mendota may be computed from 1948–1949 data on amounts of iron that enter this lake as: loss via Yahara River Outlet, 15%, 1948–1949; loss via Emergent Insects, 15%, 1954; loss via Fish, 5%; Total 35%; net annual retention of iron; approximately 65%.

Bottom Sediments. The previously presented data show that approximately 50–60 per cent of the annual inflow of iron is retained in the lake. Therefore, it is of interest to examine the iron content of the bottom sediments. Hanson (1951, 1952), in a report to the University of Wisconsin Committee on Lakes and Stream Investigation, re-examined and summarized the previous work (Twenhofel 1933) on the bottom sediments of Lake Mendota. Parts of the report are presented here as background information.

The near-shore sediments consist of sand and gravel. The deeper portions of the lake are covered by a black sludge, 1–14 inches thick, which is underlain by a lighter-colored siliceous marl. The sludge is composed of a mixture of precipitated calcium carbonate, organic matter and clastic grains, silica, with smaller amounts of

TABLE 8. CONCENTRATION OF IRON, MANGANESE, SULFATE, AND SILICA IN LAKE MENDOTA—1948–1949

	concentration mg/l							
	SUMMER 1948		FALL 1948		WINTER 1949		SPRING 1949	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
IRON								
Surface	0.009	0.01	0.02	0.01	0.05	0.06	0.04	0.04
Therocline or 10 meters	0.007	0.02	0.01	0.01	0.08	0.01	0.03	0.02
0.5 meters from bottom	0.13	0.18	0.1	0.009	0.04	0.08	0.02	0.02
MANGANESE								
Surface	0.10	0.03	0.15	0.05	0.11	0.08	0.12	0.13
Thermocline or 10 meters	0.11	0.05	0.12	0.05	0.10	0.04	0.10	0.04
0.5 meters from botton	0.5	0.34	0.12	0.12	0.33	0.42	0.12	0.06
SULFATE								
Surface	10.2	1.1	10.7	1.8	13.9	7.0	9.6	2.7
Thermocline or 10 meters	10.6	3.4	10.8	4.0	15.7	8.3	8.9	2.8
0.5 meters from bottom	9.8	4.0	10.9	4.1	16.8	8.6	9.6	4.5
SILICA								
Surface	1.1	0.25	0.7	0.3	1.3	0.8	0.4	0.2
Thermocline or 10 meters	0.6	0.4	0.8	0.3	0.9	0.3	0.3	0.2
0.5 meters from bottom	3.4	2.1	0.7	0.3	1.5	0.9	1.5	2.7
NUMBER OF OBSERVATIONS								
Surface	24		21		16		28	
Thermocline or 10 meters	12		9		9		11	
0.5 meters from bottom	11		9		9		9	

magnesium carbonate and alumina. It is highly flocuated and is moved on the lake bottom by wind-generated currents strong enough to destroy any evidence of cylic deposition. The underlying marl, and the organic matter decreases from an average of over 20 per cent in the sludge to 11 per cent in the marl.

Judson and Murray (1956) and Murray (1956) studied in greater detail the sediments in Lake Mendota They concluded that the sedimentation in Lake Mendota has changed abruptly in the recent past. This change is recorded in cores by a buff marl overlain by 1–14 inches of black sludge. They observed that the interface between the two types of sediment is very sharp. The change in sedimentation is ascribed to increased deposition of clastic materials in the lake as the result of drainage from farm lands and urban areas. The black color of the sludge results from the presence of ferrous sulfides deposited under conditions of oxygen deficiency and not from the organic content of the sludge as previously supposed.

Their analyses have shown a hydrocarbon content of the sludge and marl of 120 to 225 ppm with 10–12 per cent organic matter based on three reported analyses.

Iron Content of Bottom Sediments. Kaneshige (1952) and Levihn (1951) collected samples of the bottom sediments with an Eckman dredge and analysed them for the non-filterable and total phosphorous, ammonia, total organic nitrogen, nitrite, nitrate, and total iron of the period, winter 1950 to the summer 1952. The results of their investigations are presented in Figure 2. This figure shows a plot of the isoiron contours for the summer 1951. These contours were established by sampling at 67 different sampling sites. In general, the high concentrations of iron correspond to the deeper parts of the lake. The variations at the mouth of the Yahara River Inlet to the lake may be attributed to suspended material brought in by the river during high flows. Figure 3 compares the iron content of the bottom sediments for University Bay for the winter 1950 and summer 1951. It is readily apparent upon examination of the figure that marked changes take place from season to season in iron composition of this sludge. These changes can be attributed to movement of the floculate sludge by currents in the lake. Hanson (1952) determined that the floculate sediments had a settling rate equivalent to particles in a grain size range of 1/16 to 1/14 mm. and that based on the current meter measurements of Bryson and Soumi (1952), the lake currents near the bottom are sufficient to transport the sludge. The investigations of Bryson and Soumi (1952) found that current velocities up to 3 meter/min. were quite common in the lake with some up to 13 meters/min. Bryson and Kuhn

(1955) made some measurements of the bottom stress in the lake and found an estimated bottom current velocity of 3–10 cm/sec. during the summer of 1951. From their analyses, Bryson and Soumi (1952) and Bryson and Kuhn (1955) conclude that these currents are due to wind-driven circulation of the epilimnion which results in circulation of the hypolimnion. With respect to circulation within University Bay, Bryson and Ragotzkie (1955) found that the wind-driven water replacement time for the bay varied from about 3 hours to more than 600 hours for wind velocities 3 to 15 miles per hour.

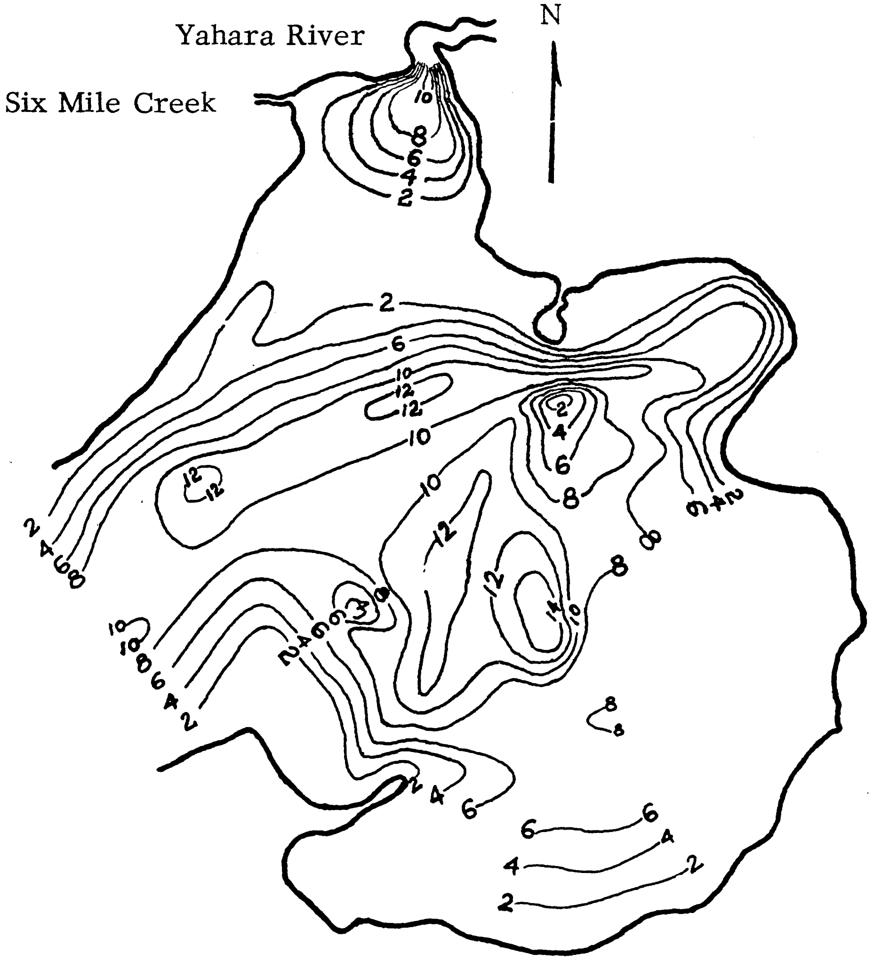

FIGURE 2. Lake Mendota Bottom Muds, Summer 1951. Iron quantities in thousands of P.P.M.

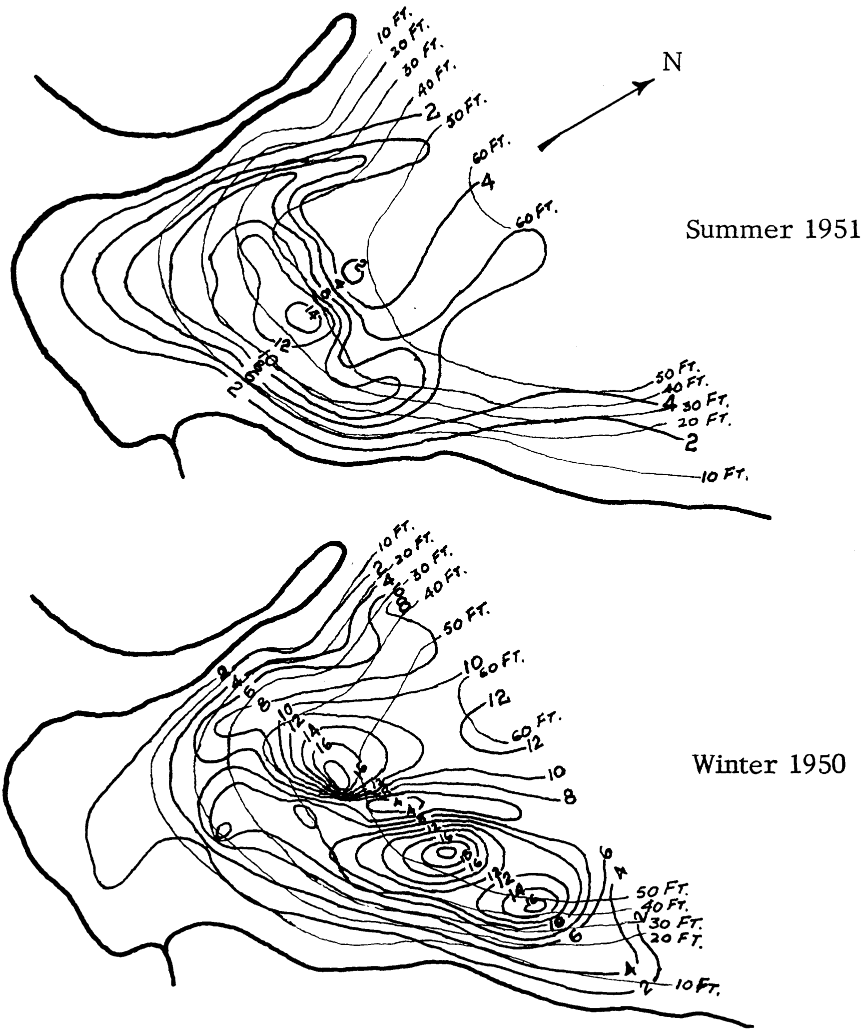

FIGURE 3. University Bay Bottom Muds, 1950–51. Iron quantities in thousands of P.P.M.

In another study by Bryson and Soumi (1951), it was found that following a very rainy period in the summer of 1950, dissolved oxygen temporarily reappeared in the hypolimnion of Lake Mendota. They proposed that this oxygen was introduced by density currents of cold, silt-laden, well-oxygenated run-off water. The highly varying, wind-induced currents and density- turbidity-currents can possibly explain the movement of the bottom sediments and also possibly account for some of the apparent deviation in the data observed in the chemical analysis of the lake water and Yahara River outlet.

Discussion of the Iron Data. The results of the investigation on iron permit a better understanding of the iron cycle for Lake Mendota. These studies have shown that over a one year period approximately 20,000 lbs. of iron entered the lake through the tributaries while only 4,000 lbs. of iron left the lake via the Yahara River outlet. The iron content of the lake water was found to be approximately 0.03 mg/1 with a general pattern of increasing iron concentration with increasing depth.

These investigations have shown that 80–85% of the iron that enters the lake each year settles to the bottom and becomes part of a floculant black sludge. Some 15–20% of the annual inflow iron is carried out via the Yahara River outlet.

Analyses of the bottom sludge have shown that it has a highly variable iron concentration with a range of a few thousand parts per million to 16,000 ppm. A general pattern was observed in which the sludge in the deeper parts of the lake had a greater iron concentration. Considerable evidence exists pertaining to the movement of bottom sludge by wind induced currents. This movement of the sludge eliminates any evidence of cyclic deposition, also causing marked seasonal changes in the iron content of the sludge at any one location.

This iron rich sludge serves as a hatching ground for a large emergent Diptera population. These emergent insects have been shown to play an important role in the iron balance of the lake. Estimates have been made that as much iron leaves the lake by emergent insects as leaves the lake by the Yahara River outlet.

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SOCIAL SCIENCES

"BRICK" POMEROY AND THE DEMOCRATIC PROCESSES: A STUDY IN CIVIL WAR POLITICS*

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Marcus Mills Pomeroy drifted to La Crosse in April, 1860, to invest his small capital and his extraordinary talents in a Democratic newspaper which needed an editor and a purpose. He brought with him some newspaper know-how, the sobriquet "Brick," and a devotion to Stephen A. Douglas. He purchased a one-third interest in the La Crosse *Union and Democrat.* Soon "Brick" Pomeroy, champion of Douglas doctrines, feuded with one of the other partners who liked President James Buchanan's views. The feud led to a sheriff's sale, stock transactions, and the birth of the La Crosse *Democrat,* debt-encumbered and with Pomeroy as sole proprietor and editor.[1]

Pomeroy lost no time in gaining the attention of friends and foes. He was witty and fearless, vindictive and vain. He wrote in such a readable and interesting style that "even his enemies could not resist buying his newspaper."[2] He knew the role of the press in shaping public opinion, and he tried to convince his subscribers that they should hate President Buchanan as intensely as he. Irritated by Buchanan's "weak-kneed" policy and "vacillating tactics," Pomeroy waged a campaign of abuse against the President. "What a weak and imbecile old fool Jim Buchanan is," he editorialized. "Buchanan," added Pomeroy, "is a traitor to his Country—a traitor to his party—a traitor to his word." He suggested to his readers that they add a postscript to their prayers: "Save our Country, but damn our President."[3]

Pomeroy's strong language seemed to be due more to his hatred of Buchanan than to his desire to see the federal government coerce South Carolina. In fact, Pomeroy justified his anti-coercion views by quoting Horace Greeley's statement about allowing the erring

* Paper read at the 92nd annual meeting of the Wisconsin Academy of Sciences, Arts, and Letters.

1 Marcus Mills Pomeroy, *Journey of Life; Reminiscences and Recollections of "Brick" Pomeroy* (New York, 1890) is the best single source for Pomeroy's early life. Mrs. Mary E. Tucker combines fact and fiction indiscriminately in her *Life of Mark M. Pomeroy . . .* (London, 1868).

2 Benjamin F. Bryant, *Memoirs of La Crosse County* (Madison, 1907), 116.

3 La Crosse *Democrat,* Dec. 24, 1860, quoted in Charles Seymour, "The Press," in *History of La Crosse County, Wisconsin* (Western Historical Company, Chicago, 1881), 550.

sisters "to go in peace." "We are opposed," he editorialized, "to forcing a State to remain where she is determined not to." He viewed coercion as "a pretty thing to talk about," but impractical, impossible, and froth with danger.[4]

Like Douglas and most Democrats, Pomeroy hoped that compromise would ease the crisis and reunite the quarrelsome sections. Compromise was an historic American process. The Constitution had been evolved out of a series of compromises. Furthermore, compromise had resolved national crises in 1820, 1832–3, and 1850. When the compromise efforts in Congress and at the National Peace Convention came to naught in 1861, Democrats blamed Republicans for adhering to their no-slavery-in-the-territories principle—no matter what the consequences. There was a genuine fear, among some of Douglas' followers, that an inter-sectional struggle might bring an end to the American experiment in democracy. European civil wars had ended in dictatorships, and there was some fear that a Napoleon or Cromwell might emerge in America.[5]

After Fort Sumter fell, Pomeroy wrote and talked like a zealous patriot. He penned an editorial polemic entitled "The Stars and Stripes Forever." He wanted the insult to the flag avenged and he wanted the rebellion speedily crushed. He endorsed the sentiments of a fellow-Democrat, Stephen D. Carpenter of the Madison *Wisconsin Patriot:* "Let blood flow until the past is atoned, and a long future secured to peace, prosperity, happiness, and honor."[6] Pomeroy even tried to organize a company of volunteers, the "Wisconsin Tigers," to do business in "Marion's style."[7] But Pomeroy had neither the friends, funds, nor influence to make his dream of military glory come true.

His patriotic binge endured for several months. The Union debacle at First Bull Run served as a spirituous stimulant. When some opponents of the war raised their voices in La Crosse, Pomeroy promised vigilante action to quash the talk of "treason."[8] He did not advocate civil action nor educational means to convert the recalcitrants, but threatened to use extra-legal measures as patriotism stirred his spirit.

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[4] La Crosse *Democrat,* Jan. 11, 14, 1861.

[5] Democratic interest in compromise is revealed in such works as: Mary Scrugham, *The Peaceable Americans of 1860–1861* (New York, 1921); Robert Gunderson, *Old Gentlemen's Convention; The Washington Peace Conference of 1861* (Madison, 1961); and George Fort Milton, "Stephen A. Douglas' Efforts for Peace," *Journal of Southern History,* I (August, 1935), 261–75. Kenneth Stampp, *And the War Came: the North and the Secession Crisis* (Baton Rouge, 1950), offers an explanation of why coercion replaced compromise. Robert Schwab, "Wisconsin and Compromise on the Eve of Civil War" (M. A. thesis, Marquette U., 1957), reveals that Wisconsin helped defeat compromise efforts.

[6] Madison *Wisconsin Patriot,* May 4, 1861.

[7] La Crosse *Democrat,* April 26, May 2, 1861.

[8] *Ibid.,* Aug. 19, 1861.

Time tempered Pomeroy's patriotic passions, aided somewhat by political opportunism and the prophecies of the abolitionists. The approach of the fall elections of 1861 gave Democratic editors like "Brick" Pomeroy a chance to substitute partyism for patriotism. The "howls of the abolitionists," who wanted the war turned into an antislavery crusade, also chilled the patriotic passions of Democrats. Pomeroy, ever bold and blunt, put his protests into print:

> There is not today half the enthusiasm in the country there was two months since. . . . A chill has already set in. . . . We are willing to fight till death for the common good of a common people, but will not be forced into a fight to free the slaves. The real traitors in the North are the abolitionists, and they are the ones who will do more to put off the day of peace than all the soldiers of the South.[8]

Republican party strategists, meanwhile, launched the Union Party movement to take advantage of the tidal wave of patriotism. "Brick" Pomeroy, unwittingly, got tangled in the Union Party net. He endorsed a non-partisan slate in the county elections and gradually retreated from supporting bipartisanship on the state level. By September he had reached the conclusion that even in wartime it was desirable to keep the two-party system functioning. He also reached the conclusion that the Union Party movement was really "a Republican swindle"—a political feast in which the Republicans took the loaves and gave the Democrats the crumbs.[9] The Union Party stratagem paid dividends to the Republican sponsors—they elected their candidate, Louis P. Harvey, over Benjamin Ferguson, nominee of the straight-line Democrats. Pomeroy claimed to have learned a valuable lesson. He pledged never to be caught again in a game "where the Republican cat was well concealed under the Union meal."[10]

Pomeroy, erratic on many counts, hewed a steady line in opposing abolitionists and abolitionism. He learned to hate those who favored freeing the slaves and he turned his sarcasm and intemperance upon them full force. He detested Sherman M. Booth, Wisconsin's best-known abolitionist, and applied a string of epithets to him. "He is to respectable people," Pomeroy wrote one day, "what a blooming pole cat would be in a ballroom."[11] Pomeroy also condemned General John C. Frémont for trying to free the slaves of rebels within his military district. Pomeroy did not defend slavery as a desirable institution, but he argued that constitutional guarantees were binding upon the people North and South. He believed that it was unconstitutional for Congress or political generals to tamper with

[9] *Ibid.,* Sept. 6, 20, Oct. 4, 11, 1861.

[10] Sheboygan *Journal,* Oct. 7, 1861; Madison *Wisconsin Patriot,* May 10, 1862; La Crosse *Democrat,* Nov. 15, 22, 1861; Pomeroy, *Journey of Life,* 122.

[11] La Crosse *Democrat,* Sept. 27, 1861.

slavery where it existed. Pomeroy's antipathy toward abolition became more intense with each passing month—it would help to transform him into a violent critic of the Lincoln Administration.

Pomeroy's aversion to abolition also helped him to become a critic of New England. That section of the country was the home of William Lloyd Garrison and Wendell Phillips, the two best-known abolitionists. New England fanaticism had helped drive the South out of the Union. It wanted the Morrill Tariff which was anathema to Western farmers. Pomeroy believed that New England mouthed pious platitudes while stuffing its pockets with money. It furnished fewer soldiers and it pursued a policy which would make the Great West the slave and servant of New England. Pomeroy spoke the language of a Western sectionalist—it was good politics to condemn New England in many sections of the Midwest.[12] One of Pomeroy's fellow Democrats and fellow-editors sarcastically suggested that Republicans could best support a mistaken president by "drinking lots of coffee at thirty and thirty-five cents a pound."[13]

Pomeroy did not hew to a narrow partisan line during the fall campaign of 1862. He considered the Democratic party "Address" of September 3, 1862, too narrowly partisan and too critical of the war. He refused to publish the "Address," the handiwork of Edward G. Ryan of Milwaukee, in his newspaper. He also brought Matthew H. Carpenter, a self-styled "War Democrat" who was both a personal and professional rival of Ryan's, to La Crosse to talk to a "Union rally."[14] He even gave support to the Union Party movement which he had denounced a year earlier—partisan Democrats thought Pomeroy sought a spot on the state Union slate. On the other hand, he denounced Lincoln's preliminary proclamation of emancipation (September 23, 1862) as "indiscreet," unnecessary, and unconstitutional. He believed it "would be powerful in producing evil results." He accused Lincoln of giving way to abolitionist pressure and perverting a war to save the Union into one to free the slaves.[15]

The election returns revealed a strong Democratic trend and emboldened Pomeroy. He blasted President Lincoln's removal of General McClellan, condemned presidential suspension of the writ of habeas corpus, and criticized arbitrary arrests made during the fall of 1862. To Pomeroy it seemed that the President had scrapped the Constitution, had assumed the role of despot, and had "bungled" and "experimented" too much.[16] He even regretted his support of

[12] *Ibid.*, Feb. 7, 1862.

[13] Sheboygan *Journal*, Feb. 18, 1862.

[14] La Crosse *Democrat*, Sept. 8, Oct. 7, 1862.

[15] *Ibid.*, Nov. 18, 25, 1862, Jan. 6, 1863.

[16] *Ibid.*

the Union Party movement. He told Republicans that they had abused the Union Party principle. "In the past," "Brick" Pomeroy wrote, "they [the Republicans] were not willing to divide their victories—in the future we will not share their defeats."[17]

After the election post-mortems were over, Pomeroy took a three-week trip to St. Louis to see how the war was going in that sector. His Quaker blood curdled at what he saw and he recorded his impressions for his readers. Hospital ships were described as "boat-loads of pain and agony." War produced "mangled bodies," sorrow, and death. War contractors and army quartermasters made money "by the cord."[18] Pomeroy lost some of his enthusiasm for the war.

His three-week tour of the St. Louis sector was followed by a two-month visit to Helena, headquarters of the Army of the Southwest. He held a first lieutenant's commission signed by Governor Edward G. Salomon, but it was little more than a newsman's pass. He was "assigned" to no regiment, company, detachment, or duty and on the margin the Governor wrote: "By request of M. M. Pomeroy no pay chargeable against the State under this commission."[19] Pomeroy sought the commission so he could stay at the headquarters of General Willis A. Gorman, a friend from Minnesota. He occasionally accompanied army units pursuing guerrillas, hunting for cotton on outlying plantations, or sloshing through Arkansas mud. In time General Gorman was assigned elsewhere and General Benjamin S. Prentiss took over command of the Army of the Southwest. Pomeroy wrote exposés of army life for the Chicago *Times*, the Milwaukee *News*, and his own La Crosse *Democrat*. Each week's epistles became more critical of the war, the Lincoln Administration, and the army's Arkansas activities. He called the war "a murderous crusade for cotton and niggers," he plumped for peace, and he insulted his host.[20] General Prentiss, in turn, banished the La Crosse newsman from his sector, threatening to arrest him as a spy if he returned.[21]

Pomeroy returned to the editorial offices of the La Crosse *Democrat*, hating General Prentiss and disillusioned with the war. He wanted political compromise substituted for military coercion. War was a "frightful" thing. "Its glories," he wrote, "are those of death and grief—its pomp and vanities, those of crazed ambition; of sorrow and ruin."[22]

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[17] *Ibid.*, Nov. 11, 1862.

[18] *Ibid.*, Dec .9, 16, 23, 1862.

[19] Pomeroy, *Journey of Life*, 182–83.

[20] La Crosse *Democrat*, Feb. 27, March 3, 1863.

[21] "General Orders, No. 19," March 24, 1863, District of Arkansas, Volume XLIV, Records of the War Department, The National Archives.

[22] La Crosse *Democrat*, April 18, 1863.

Pomeroy became a bitter critic of the Lincoln Administration in the months that followed. He condemned the Conscription Act of March 3, 1863, as a measure which would crush "the sovereign power of the States" and make Lincoln the "permanent ruler of the nation." "The late Conscription act," he editorialized, " . . . is one that elevates Abraham Lincoln to the position of MILITARY DICTATOR . . ." He believed federal conscription violated American principles and tradition. Furthermore, the provision which excused from service those who paid $300 in commutation money, favored the rich at the expense of the poor.[23]

Pomeroy viewed the arrest of Clement L. Vallandigham of Ohio by General Ambrose E. Burnside as an extension of presidential tyranny. He also deplored General Burnside's suppression of the Chicago *Times* as proof that Lincoln was a despot—Burnside was his "western satrap." The President was "intoxicated and entranced by the whirl of the mighty events around him." Pomeroy called Lincoln "a tyrant," and Vallandigham and Storey (editor of the Chicago *Times*) "martyrs" to free speech and free press. It seemed, to Pomeroy, that a despotism was enveloping the government and that civil liberties retreated as Lincoln & Company ruled the land.[24] When President Lincoln set aside August 5, 1863, as a day of fasting and prayer, the editor of the La Crosse *Democrat* composed a "prayer" which he recommended to his readers: "Remove by death the present Administration from power and give us in their place Statesmen instead of clowns and jokers—honest men instead of speculators—military ability instead of conceit and arrogent assumption."[25]

Democratic critics of Lincoln made a distinction between the government and the Administration. They insisted they were loyal to the first, critical of the second. They spoke of the government and the Constitution in the same breath. They viewed themselves as the defenders of the Constitution and of civil rights against the usurpations of a "mistaken Administration." They emphasized the primacy of the Constitution, arguing that "when the Administration violates the Constitution, loyalty to the Administration may become disloyalty to the Union."[26] "We revere the Constitution," wrote Pomeroy, "but we have no faith in those administering it."[27]

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[23] *Ibid.,* Feb. 17, April 14, 1863.

[24] *Ibid.,* June 2, 9, 16, 1863.

[25] *Ibid.,* July 28, Aug. 12, 1863.

[26] "Address to the People by the Democracy of Wisconsin, Adopted in State Convention in Milwaukee, September 3, 1862" (Milwaukee, 1862), 11.

[27] La Crosse *Democrat,* Aug. 25, 1863.

Later Pomeroy stated his mistrust of the Lincoln Administration more boldly and bluntly:

> Abraham Lincoln is the traitor. It is he who has warred against the Constitution. We have not. It is policy—his Administration which has prolonged the war. We have not. It is his proclamations—not our editorials—which have disgusted the country. . . . Abraham Lincoln was elected President by the People; he has been President for the Republican party. He has broken his oath—lent himself to corruptionists and fanatics. . . .[28]

Pomeroy received, in full measure, criticism of the same kind which he dispensed so generously in the columns of the La Crosse *Democrat*. Some Republicans boldly denounced him as a "Copperhead," a "secessionist," and a traitor whose newspaper was "a mouthpiece for damnable treason."[29] The La Crosse *Democratic Journal* condemned "the treasonable doctrines of those who sympathize with the rebellion."[30] Indignant La Crosse patriots threatened Pomeroy with bodily harm and mob action. Members of the Third Minnesota Regiment, while passing through La Crosse, attempted to "clean out the *Democrat* office" via mob action, but prompt action by Mayor Pettibone kept things in hand. Soldiers, writing from the war front, threatened to "get" Pomeroy when they returned home.[31] Patriotic businessmen quit advertising in Pomeroy's paper and some subscribers told the intrepid editor to cross their names off the mailing list. The circulation of Pomeroy's *Democrat* dropped to 360 copies—publishing the paper became a money-losing venture.[32] Members of the Union League, partiotic arm of the Republican Party, even organized a social boycott.

Pomeroy walked the streets of La Crosse defiantly and unafraid—like a true curmudgeon. He returned taunt for taunt. When they called him a "Copperhead," he retorted "Blowsnake!" He carried a gun when he went out at night. He advised his Democratic friends how to react to threats of arson:

> Matches are cheap. If fanatics and fools seek mob law and anarchy, by all means let them have it. Burn down and destroy theirs as they have or may yours. By dark or by daylight—by fire or by powder—feed those who may injure you the dish they prepare. On no account inaugurate violence or excitement, but for every dime of your property destroyed by political opponents, destroy a dollar's worth in return.[33]

Later, when defiant patriots again talked and threatened, Pomeroy repeated his warnings. He would fight fire with fire: "When this

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28 *Ibid.*, Oct. 27, 1863.

29 Milwaukee *Sentinel*, April 1, 1863.

30 La Crosse *Democratic Journal*, July 8, 1863.

31 La Crosse *Democrat*, October 3, 1864.

32 *History of La Crosse County, Wisconsin*, 546.

33 La Crosse *Democrat*, Feb. 19, 1864.

office is destroyed, a hundred buildings in this city will keep it company. Matches are cheap and retaliation sweet. If anyone wants a little riot, they shall have a big one—one to last them forever."[34] "When they ignite the match," he again admonished his fellow Democrats, "let us apply the torch."[35]

Pomeroy and his fellow Democrats insisted that the government could not expect loyalty from its citizens if it failed to give them protection. One prominent Midwestern Democrat, arbitrarily arrested in the fall of 1862, stated that thesis:

> Allegence [*sic*] is that fidelity or obedience which a citizen owes to the *Government. . . . But it is reciprocal.* The Government owes to the citizen or subject *protection.* Without protection, no allegence [*sic*] can be due. Such is the nature of the contract—our allegence [*sic*] is due, where our protection is secured.[36]

President Lincoln countered by contending that critics of the Administration wanted protection from the Constitution which their policy was helping to destroy. He defended arbitrary measures "as indispensible to the public safety." He insisted that the carping critics damaged the country rather than the Administration.[37] There seemed to be a no-man's land between loyalty and treason as defined by the Constitution.

When Pomeroy learned that Lincoln was seeking re-nomination in early 1864, the bumptious editor cut the cords of restraint. His shower of epithets showed that he had discarded moderation for madness. "May Almighty God forbid," he wrote angrily, "that we are to have two terms of the rottenest, most stinking, ruin-working small pox ever conceived by fiends or mortals in the shape of two terms of Abe Lincoln's administration."[38]

As the election campaign of 1864 gained momentum, Pomeroy became more abusive and more intemperate. Entangled in his own web of hate, he spewed forth frothy editorials. He wrote of "widows in black" who were "living monuments of Lincoln's imbecility." He called Lincoln "clown," "buffoon," "teller of smutty jokes," "orphan maker," and "the poorest apology for a chief magistrate the world ever saw." He suggested to Republicans that they "Shout for Abraham—for taxes—for Fort Lafayette—for the draft—for usurped power—for suspension of sacred writs—for a nigger millennium—for worthless currency—for a ruined nation—and for desolate

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[34] *Ibid.,* April 2, 1864.

[35] *Ibid.,* Oct. 10, 1864.

[36] "Dissertation upon Constitutional Rights" (mss.), n.d., in Madison Y. Johnson Papers, Chicago Historical Society.

[37] Letter, Lincoln to Erastus Corning *et al,* June 12, 1863, Robert Todd Lincoln Papers, Library of Congress.

[38] La Crosse *Democrat,* July 5, 1864.

cities." He contended that Lincoln was "hell's viceagent on earth," the "fanatical tool of fanatics," "flat boat tyrant," and "the lurer drunk with madness." He claimed that the people wanted peace in a land filled with "fear and mourning."[39] In the August 23, 1864, issue of the La Crosse *Democrat,* Pomeroy placed a picture of Lincoln on the front page and above it put the caption: "The Widow Maker of the 19th Century and Republican candidate for President." That day's editorial rantings reached an all-time low:

> The man who votes for Lincoln now is a traitor and murderer. He who, pretending to war for, wars against the constitution of our country is a traitor, and Lincoln is one of these men. . . . And if he is elected to misgovern for another four years, we trust some bold hand will pierce his heart with dagger point for the public good.[40]

The intemperate editor even suggested an epitaph for Lincoln's tomb-stone:

> Beneath this turf the Widow Maker lies,
> Little is everything; except in size.[41]

The adamant editor conducted a negative campaign. He seldom said what McClellan (Democratic candidate for the presidency) and the Democratic Party stood for. He just abused Lincoln and tried to scare voters from casting their ballots for the incumbent. He appealed to the spirit of Negrophobia and to Western sectionalism —antipathy to New England. He sought votes in the field of war weariness and he spoke the language of the defeatists. "It can never be done," he editorialized. "The south can never be subjugated"[42]

Consistently he revealed that hating Lincoln had become an obsession. He tabbed Lincoln "a usurper who wears a No. 5 hat and No. 14 boots." He insisted that President Lincoln had ignored his oath of office, spit upon the Constitution, and "woven the chains of slavery about the people." "Lincoln," wrote the self-styled curmudgeon, "has been a worse tyrant and more inhuman butcher than has existed since the days of Nero. He has listened to the counsels of fools; and millions of mourners weep over the result of his incompetency."[43] Pomeroy even turned his wrath against the provost marshal in La Crosse—the representative of the "slaughtering machinery." Pomeroy wrote that the provost marshal was "unfit for duty," a "captain in the widow maker's service."[44]

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[39] *Ibid.,* Aug. 2, 9, 16, 24, 1864.

[40] *Ibid.,* Aug. 23, 1864.

[41] *Ibid.* Pomeroy reprinted the epitaph from the Appleton *Crescent,* but he did not state from what paper he clipped it.

[42] *Ibid.,* Sept. 5, 19, Oct. 10, 17, 1864.

[43] *Ibid.,* Oct. 17, 1864.

[44] *Ibid.,* Oct. 10, 1864.

Pomeroy's putrid propaganda failed to halt the Republican tide which swept Lincoln back into office. The editor, then, appeared dispirited and disconsolate. He wrote that he regretted Lincoln's election "more than words could tell." He blamed fraud and intimidation for Lincoln's re-election, and he refused to accept the verdict in good grace. "For the first time in the history of our country," he rationalized, "a corrupt and ambitious President has abused his office by making it a source of terror and fraud to influence political opponents."[45] He suggested that those who voted for "Lincoln and the war" should volunteer for army duty. "Election being over," he noted, "we look to those who voted for Lincoln and the continuance of the war, to go to the front."[46] He spoke the language of the appeasers, predicting that the Union was "lost forever" and stating that the South could "never be subjugated." He supposed that the Northwest might break away from the East, establishing its own confederacy. He wrote that more "thieving generals" would fill their pocketbooks and that more widows and orphans would be "created." The sullen scribe added a prophecy: "There is no hope for the Union now."[47]

When the editor of the Republican newspaper in La Crosse wrote that Pomeroy talked boldly and sought attention but would not dare assassinate Lincoln, the saucy editor retorted: ". . . if Old Abe ever comes into our office to tell one of his stories, or crosses our path, we'll go for him with a culvereen [*sic*] of corn cider. Dare not assassinate Lincoln! We'd shoot him quick as any man."[48]

When Lincoln met death at an assassin hand there were some who pointed a finger of guilt at Pomeroy, suggesting he was involved in the conspiracy. Some spread rumors of his impending arrest and they quoted from Pomeroy's most vicious editorials.[49]

The editor of the La Crosse *Democrat* shed crocodile tears when he decked his newspaper in mourning grab—he turned the column rules—and reported that the country had lost a statesman. Several months later Pomeroy supposed that "God generously permitted an agent to make a martyr of the late president . . ."[50] He followed with remarks even more villifying. "We deprecate assassination," he wrote, "yet we feel to thank God for calling Lincoln home, wherever that may be." Then the defiant Democrat suggested that the act of assassination "gave the country a statesman for a President" and "halted the advance of usurpation most effectively."[51]

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[45] *Ibid.*, Nov. 9, 1864.
[46] *Ibid.*, Nov. 14, 1864.
[47] *Ibid.*, Nov. 21, 1864.
[48] *Ibid.*
[49] Milwaukee *Sentinel*, May 8, 1865; La Crosse *Democrat*, May 8, 1865.
[50] La Crosse *Democrat*, June 19, July 3, 1865.
[51] *Ibid.*, Oct. 2, 1865.

Having drunk deeply from the cup of self-righteousness, Pomeroy believed that time would vindicate him and would treat Lincoln harshly. "They may denounce me," he wrote of his contemporaries, "but their children will not, for they shall know the truth.[52] Pomeroy's cross-town rival gave posterity an evaluation which found its way into history: "He out-jeffed Jeff Davis in treasonable utterances and out-deviled the Devil in deviltry."[53]

Little did Marcus Mills Pomeroy realize that a century later historians would classify him as a carping critic, a man who preached the doctrine of a free press and ignored the responsibilities such a principle imposed upon editors. He claimed that democratic processes must function, even in times of civil war, yet his practices and preachments did more to endanger the processes than to preserve them.

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[52] Quoted in Tucker. *Life of Mark M. Pomeroy,* 91.

[53] Charles Seymour, "The Press," *History of La Crosse County, Wisconsin,* 545.

THE WISCONSIN IDEA AND SOCIAL CHANGE*

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The Wisconsin Idea

The Wisconsin Idea known as "the boundaries of the campus are the boundaries of the state" is a comprehensive concept. Yet, in stating that a University of the people must be taken to the people, its originator, President Van Hise, identified only one of the areas of concern for enlightenment. Simultaneously, the University of Wisconsin became one of the great graduate schools of the nation and the world. This dual development needs to be kept in mind when considering what became known as the Wisconsin Idea. Many of the state universities around the turn of the century concentrated on services to the people of their states since their financial support depended upon the legislators of these states. In Wisconsin, however, as in the ivy covered private institutions of the East, great stress was also placed upon academic excellence and scholarly research. Therefore one immediate objective of scholarship practiced at Wisconsin was involvement with significant public concerns.

As teacher, researcher, and extension lecturer, the professor's concern with the public interest was intimately intertwined with his academic investigation in his subject area. This integrated approach without sacrifice of vigorous research methodology was possible in the days before specialization and fragmentation. Today, public service is associated merely as extension education.

Under Van Hise, a group of scholars influenced by German Universities with stress on scholarship and participation in decisions of public policy came to Wisconsin. These scholars under the leadership of this great president appreciated the importance of making all the resources of the University available beyond the college walls.[1]

In Wisconsin, Agricultural extension and general University extension became enriched by this broader dimension of the Wisconsin Idea. Around the turn of the century, the spirit of co-operation between the two domes, the Capitol and old Bascom Hall, at each end

* Paper read at the 92nd annual meeting of the Academy, May 5, 1962.

[1] Cf. Dr. William Cohnstaedt, "Die Universitaet von Wiskonsin," *Frankfurter Zeitung*, Frankfurt-am-Main, Germany, September, 1909; "The great inner and outer modernization of the German professor in both personality and attitude toward life in recent years became surprisingly evident on this side of the Atlantic. The German professor is more 'Americanized' than the American."

of State Street, promoted public service. This emphasis required an off campus extension faculty to supplement the resident scholar who also served as extension lecturer. The later development of an Agricultural Agent in each county was a mere expansion of this concern to be of service. For a longer period of time Agriculture Extension rather than general extension, was able to preserve a closer identification of public service linked with vigorous resident scholarship. Specialization within agricultural subject fields enabled continued public contacts while a separation became sooner inevitable in the humanities and the social sciences. Political and institutional conditions within the College of Agriculture enabled a longer period of direct co-operation between research scholar and public. Even today the role of the College of Agriculture within the University is unique among the University's family of schools.

Social Change in Wisconsin

A Population of Consumers. The majority of the citizens of Wisconsin, once predominantly engaged in farming, are now defined as urban residents by the 1960 census. The services offered to the farming population, the distribution, processing and transporting of farm products and supplies are no longer the predominant services among the state's activities. Consumers irrespective of occupation or residence, dominate the economic scene and demand the major portion of the state's resources. Of course this shift from a producer to a consumer economy in Wisconsin is not unique for it is similar to the national trend.

Technology and Production. Many social changes are directly attributable to the expansion of our industrialized society with its technological improvements and steady increase in mechanization. The change in farming methods due to mechanization is well known. Fabulous improvements in technology now enable a small number of agricultural producers to satisfy the total national food demand creating severe economic, social, and not least of all, political problems.

Metropolitanization. The most complex of all the changes can be traced to the current trend of metropolitanization. Starting as a small tendency concerned with concentration of peoples in cities, it presently is a major problem, both economically and culturally. An additional change, a counter movement of the urban population results in the dispersion of large numbers throughout the adjoining country-side of the central cities. An entirely new pattern of human habitation has come into being with the emerging suburbs. Older, established suburbs, like the city proper, had characteristics of internal organization and community cohesion which are not found in many of these new subdivision developments. In these recently developed areas innumerable physical and material problems now clamor and press for solution. However, the necessary knowledge and information upon which to base social and political decisions are not yet available.

Communication Breakdown as Social Change

Today's society requires scientific knowledge for the basis of intelligent decision making. The presence of a multitude of experts, all specialists in their respective areas of professional training, would seem to assure the availability of all needed scientifically arrived knowledge. Yet, in a democratic society it is assumed essential that all people make the decisions affecting their own way of life. However, the delegation of decision making has now denied many the opportunities for critical thinking. Also, narrow routines which channel men's lives today do not enable comprehsion of the "whole" of society.

In an urban society social contacts are no longer geographically oriented. Place of work and residence are usually in two separate areas of the city, while the man who controls one's employment lives in still a third part of the community. The latter may be more significant to the employee's total life than the neighbor next door. Similarly, friends with whom one shares in common special and significant interests may live in ever widening circles throughout the metropolitan area. The geographic neighborhood seldom represents a meaningful environment, that is to say, becomes significant in the life of families, until their relationships outside this restricted area become meaningful and comprehensible. Successful Neighborhood Councils are found only when the people concerned are adjusted to their larger economic and political environment. The immediate geographic community cannot be "developed" until there is this functional adjustment.

The loss of territoriality, that is the shift of social ties from the geographic neighborhood, and the change of significance of the local community does not necessarily mean the malfunctioning of a pluralistic society. If people were to participate in a plurality of special interest organizations in which they presently hold membership, alternative ties and social relationships would replace those found in a more community-oriented older society. There are sociologists who consider social organization in the existing mass society possible without the presence of community organization.[2] However this may be, the development of a mass society means a

[2] James S. Coleman, "Community Disorganization," *Contemporary Social Problems*, Robert K. Merton and R. A. Nisbet, New York: Harcourt, 1961, p. 591.

withdrawal from responsibility of citizenship. What brings about such withdrawal? The breakdown of communication accompanying "withdrawal" results from the difficulty citizens have in identifying personal or community problems. For instance, the wide-spread abstention from participation in the making of decisions affecting public affairs usually takes place initially as apathetic non-participation in the citizens' associations of special interest groups. Time does not permit an analysis of the causes for the much lamented and little understood reasons for "lack of participation." It is a theoretical presupposition of this discussion that there are lags and maladjustments in the social structure of our contemporary society. To make issues, values, and practices in the community visible to those who need to be concerned is the problem of a mass society. The structure of a social organization needs to provide occasion to those variously located in that structure to perceive the norms obtaining in the organization. Also, it needs to provide relative ease in perceiving the "character of role-performance" by those who run the organization.

The Urban Agent

A clearer perception of the interrelatedness of social structure with institutional requirements of the culture is needed. An inadequate analysis of the existing social structure may account for some of the shortcomings of currently practiced community development, here and abroad. The prevailing practice of "accepting" the local culture and then attempting to get change introduced by "innovators" or "change-agents" leaves institutional adjustment to a "laissez-faire" condition of unguided change. Local institutions and their persistence have proven a chief stumbling block to lasting, that is, not temporary, acceptance of change.

In an "advanced" society the abundance of experts and the availability of professional services have not prevented the disintegration of urban community processes or the breakdown of communication. This has given rise to a recent search for a new kind of adult educator: the Urban Extension Agent.[3]

The agent would serve as a communication link. The results of urban research findings with respect to community-wide activities and problems would be translated by the urban agent into terms meaningful to the various components of the urban population. While thus serving as "implementor," the agent might simultaneously bring the needs of this urban population into focus for the researcher if the two were brought into a relationship, such as a university-based Urban Extension Service.

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[3] Martin L. Cohnstaedt, "Exploring a Model of an Urban Extension Agent," *Adult Leadership*, February, 1962.

The function of the urban extension agent is to clarify, assist and to enable people to function more adequately in a complex, specialized, technically oriented society, of which their community and their neighborhood are parts. With this aid citizens may gain understanding of the forces impinging upon them and an awareness of a fuller life. Fundamental to the work of the urban agent is the assumption that public and private services available will be drawn upon more meaningfully when their potential users have greater clarity and understanding concerning those services.

The agent serves as a communicator between the community and all professions, enabling urban residents to make more effective use of the services offered by professions and organized agencies. With the emerging sense of community, individual citizen will join together to provide for common unmet needs.

The Future

For a people dedicated to democracy there are a number of encouraging trends. Recently a distinguished group of adult educators from throughout the nation, under the chairmanship of Dean Adolfson of Wisconsin, prepared a statement on *Today's Critical Needs and University Extension.* Their document states that University Extension has become an intimate and essential aspect of the total enterprise of the modern public university. As a philosophy, they contend university extension sees the campus as a community of scholars making itself as useful as possible to the total society from which the institution draws its inspiration and support. Due to the high degree of specialization essential for exploring the frontiers of knowledge this philosophy may clash with prevailing pressures of academic life. Advancement in many professions is at the cutting edge of knowledge. This dilemma to be resolved by the universities demands courage and insight. In their statement of critical needs, the adult educators identify the function of university extension in much the same manner as the function of the Urban Agent; University extension seeks to identify public problems and public needs, to interpret these concerns to the university, to focus university skills and resources upon them, and thence to translate university insights into educational progress throughout a state or region. This statement implies that a city can be a more powerful teacher than formal classrooms. Many approaches to urban problems ignore this and become managerial. Much can be lost when educators seek to manipulate people and resources to solve urban problems. When that occurs little attention is paid to human values, whether people understand their problems or participate in seeking a solution.

The Wisconsin Idea was begun by scholars exploring their subject matter within the framework of public policy and the needs of the residents of Wisconsin. Following social change one must go forward avoiding unimaginative revival. Therefore, in our day of extreme specialization it is not possible to expect the contemporary scholar to imitate an earlier generation, however distinguished and successful. However, it may be worth while to identify institutional conditions which prevailed when state-wide university education achieved its fame and made a place for itself. In Wisconsin, few would question the position the University's College of Agriculture has had in the development of the state and the respect and affection earned by it for the state university. It may not be unreasonable to propose that in our day of urbanization the University's urban college, the University of Wisconsin–Milwaukee, may achieve such an enviable place in the minds of the people of the state and the entire nation. In order to learn from the past and to guide widely the future, it should be remembered that the College of Agriculture performed its service not as an independent unit. The Agricultural College was merely one integral unit drawing systematically on all the other resources a great University had to offer. Within the family of colleges on the University campus it had a much closer relationship to the state and its practical problems than the other schools. While it engaged in both pure and applied research in some fields of knowledge it did not aim to duplicate activities and facilities in other parts of the University. The College of Agriculture was dedicated to the constant improvement and development of its constituents. Thereby political support was gained which was of considerable importance to the entire University. With the rapidly expanding political power due to fairer apportionment the urban voter needs to identify his needs with that of his University.

In the past, first through the organizational support of county agents and later through the fiscal policies of direct farm subsidies the American farmer has been assisted in economic and technological adjustments within an ever changing industrial and corporate economy. At this time in our national history very complex social and economic problems arise from ever increasing state and municipal expenditures, as but one example. The rapidly rising costs of urban living stagger the taxpayer. Let it be said in the future that the University found in its Milwaukee unit an institution serving diverse but ever so practical problems of the people in an urban state.

MIDWESTERN "TOWN-MEETING"—AN EVALUATIVE STUDY OF ORAL DECISION-MAKING IN SHOREWOOD, WISCONSIN*

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I. Scope and Framework of the Study

Authors of contemporary textbooks concerned with oral decision-making display marked unanimity. It would not be too much to say that their key assumptions have become articles of faith in American collegiate classrooms. Although generally stated and held, the principles of oral communication in a democratic society are seldom challenged. Even less often is an attempt made to compare speech axioms with oral practice.

The schism between theory and practice is surprising when the first assumption is considered. This primary assumption postulates an *oral communication continuum* for the processes of oral decision-making in a democratic framework.[1] Leaning heavily on the "reflective thinking pattern" proposed by social philosopher John Dewey, the continuum recognizes that "the scientific method cannot be applied, *in toto,* in the solution of public problems."[2] Rather it is the employment of a series of speech activities or functions relying on scientific procedures which should be used "to maintain a free society."[3] As Baird reminds us, we "live under a government of public opinion . . . a government by talk."[4] The threefold oral communication continuum involves (1) *investigation* of public problems through *discussion,* (2) *systematic clash* on specific issues or proposals through *debate,* and (3) *individual advocacy* of solutions or actions through *persuasion.*

A second assumption concerning oral decision-making is less a matter of what processes are followed by those in a democratic government that it is a prescription of *how* the "functions of inquiry and persuasion" can best be served.[5] A conventional list of

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* Portions of this study were jointly presented by the authors at the 92nd annual meeting of the Wisconsin Academy of Sciences, Arts and Letters.

[1] Waldo W. Braden and Earnest Brandenburg, *Oral Decision-Making* (New York, 1955), pp. 8–15.

[2] Henry L. Ewbank, Sr. and J. Jeffrey Auer, *Discussion and Debate* (New York, 1947), p. 20.

[3] William A. Behl, *Discussion and Debate* (New York, 1953), p. 3; Ewbank and Auer, *Discussion and Debate,* 1951 edition, pp. 31–34.

[4] A. Craig Baird, *Argumentation, Discussion, and Debate* (New York, 1950), p. 4.

[5] William S. Howell and Donald K. Smith, *Discussion* (New York, 1956), p. 263.

elements or characteristics of "government by talk" would include (1) reliance upon human intelligence and good will, (2) willingness to suspend judgment during the initial phase of inquiry (3) ability to deliberate cooperatively, (4) equal opportunity for participation in all phases of the communication continuum, (5) respect for minority opinions, and (6) acceptance of majority rule determined by voting rather than decree or default.[6]

Method and Data of the Study. This study reports the results of a descriptive evaluation of oral communication practices of the village board of Shorewood, Wisconsin. The writers have compared the theoretical assumptions discussed above with the actual oral decision-making processes of the governing body of Shorewood. In arriving at the conclusions and recommendations stated at the end of this report, the authors have used three major categories of information: official *publications* (including the *Village Code,* agendas and minutes of board meetings, press reports, public notices, studies sponsored by the board, and state statutes); structured, tape recorded *interviews* with Village Manager Robert Duncan and Violet Dewey, a local newspaper reporter; and critical *observations* of nine regular board meeings from August 7 through December 18, 1961.

II. Historical Background and Overview of Village Government

One way to understand the present is to view it in terms of the past. An examination of local government in Shorewood, Wisconsin, therefore, may be better understood if such government is viewed historically.[7] Because many of the early settlers in Shorewood were refugees from political persecution in Europe, the desire for self government was strong among them. When the city of Milwaukee was established in 1846, Shorewoodites joined with other eastsiders in forming the town of Milwaukee. Home rule began in the Shorewood area, then, one hundred and sixteen years ago.

The township form of government must have suited the citizens well for it continued in effect until the end of the century. Perhaps this form of government would still be in effect today had it not been for the presence in Shorewood of a large amusement park known in 1900 as Coney Island.

At the turn of the century, Shorewood was a small rural hamlet with only 345 inhabitants. It was a community whose population had remained almost the same as long as anyone could remember. Although there were four miles of paved street in Shorewood, mud

[6] Four of these six elements of democracy are ably treated in Braden and Brandenburg, *Oral Decision-Making,* pp. 4–8.

[7] The following historical sketch is based upon material found in the first two volumes of the four volume *Research History of Shorewood,* ed. by Ernest G. Henkel (Works Project Administration, 1937–38).

made the main road virtually impassable from spring until late fall. Local citizens recognized the fact that improved streets would attract new residents. The problem was how to finance such improvements. Licensing fees from Coney Island offered a credible solution.

Consequently in March of 1900, a small group of progressive-minded citizens petitioned the court for the formation of a new village to be known as East Milwaukee. To the men of Shorewood, it made no sense that park revenues should be spent on improvements elsewhere. Naturally Milwaukeans did not relinquish this source of revenue without a fight. For five months, city attorneys contested the corporation petition. But in August of 1900, the battle came to an end; East Milwaukee became a legal entity.

Village status brought with it a number of advantages. Coney Island revenue was at once appropriated for local improvements—first streets, and later street lights, water, parks, etc. Village government brought with it also opportunity for hungry office seekers. Whereas the former township government had only six elected officers in 1900, the new Village of East Milwaukee found need for twice that number. As one observer commented, "though these jobs were not highly remunerative, the work in most cases was not to [sic] onerous." Village government also brought with it the power to license taverns. Three such establishments already existed in the Shorewood area. No more need be allowed if the village did not desire it. Prohibiting further taverns would please local innkeepers who wanted things kept pretty much as they were.

Three specific forces appear to have influenced the early development of government in Shorewood. The desire to regulate ones own affairs manifested itself in the formation of the village; thus an earlier tradition of *home rule* was continued. *Progressivism* was evident in the community's emphasis upon local improvements, an emphasis which would in time change Shorewood from a rural outpost of farmers of limited means to a prosperous middle class suburb. Preservation of a *village image* became increasingly important as both suburb and city grew.[8]

Perhaps it is not too surprising to find these same three forces at work in the years since the turn of the century. Home rule was to meet two major tests during this period. In the village election of 1928, an entire slate of annexation-minded candidates for the village board was defeated. And in 1934, a county-wide referendum on

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[8] The village founders rigidly adhered to the provisions of Wisconsin law in establishing their new form of government. Cf. the Shorewood *Village Code—The General Ordinances of the Village of Shorewood,* rev. ed. (published by authority of the Village of Shorewood, Shorewood, Wisconsin, 1957) and *Revised Statutes of the State of Wisconsin, 1878* (Madison, Wisconsin), pp. 291–95.

the consolidation of metropolitan governments was voted down in Shorewood by a vote of nearly three to one.[9]

Civic progressivism emerged from time to time in several different ways. In 1917, for example, officials succeeded in getting the village name changed from East Milwaukee to Shorewood, thereby increasing the sense of local identity while at the same time establishing a more descriptive and attractive-sounding name. In 1928, an important new office was created in Shorewood, that of village manager. This position brought efficiency and order to the government of the swiftly growing community. Most recently, the village board employed a firm of professional consultants to plot the future of Shorewood.[10] Once more an emphasis upon progressive planning was apparent.

Preservation of the village form of government has usually been more prominent in village thinking, however, than either home rule or civic progressivism. When it appeared to the village board in 1932 that the village manager had too much to say in the hiring and firing of employees, the manager's powers were sharply curtailed.[11] In 1939, the Shorewood "image" was described in these terms: "because its development has been recent and frankly suburban, the village has no factories and wants none, limits its business area to a small shopping district, and self-consciously devotes its civic energies to making itself a pleasant place in which residents may live and spend their leisure."[12] This description would be equally appropriate in 1962.

Perhaps the most dramatic example of conservativism in Shorewood was the action taken recently by the village board regarding the consultants' report on the future of Shorewood. When it became apparent that the consultants foresaw grave economic problems ahead for the village, the board insisted on editing the preliminary report before its release to the press.[13]

Home rule, civic progressivism, the conservative preservation of a village image—these are the forces which have been influential in Shorewood village government since the turn of the century.

III. Oral Decision-Making in Shorewood, Wisconsin

Physical Setting for Board Meetings. Regular meetings of the Shorewood village board are usually convened in the courtroom on the second floor of the village hall. When only a few citizens are present for participation or observation, meetings are moved to

[9] *Shorewood* (American Guide Series: compiled and written by the Federal Writers' Project of Wisconsin, 1939), pp. 63–4.
[10] *Shorewood Herald,* January 19, 1961, p. 16. See also "Proposals for Tomorrow: Digest of a Preliminary Plan for Shorewood, Wisconsin," May 9, 1962.
[11] *Research History,* II, n. p.
[12] *Shorewood,* p. 11.
[13] *The Milwaukee Journal,* September 21, 1961, p. 2.

a smaller committee room adjacent to the judicial quarters. When meetings are held in the courtroom, the board members are seated three at a table at right angles to the audience and to the judge's bench behind which are seated the board president and the village clerk. The rectangle of official participants is completed with a table occupied by the village manager, his assistant, and village attorney. These officials face the presiding officer with their backs to the approximately fifty chairs provided in the audience area at the rear of the room.

Elements of decor and placement tend to heighten the status of the board and increase the psychological distance between meeting officials and citizen auditors. The higher elevation of the judicial "stage" and the presence of a wooden railing tend to enhance the atmosphere of aesthetic detachment between the board and visitors. Indeed, many citizens with cause to address the board appear awed as if standing before the bar of justice. Other courtroom appurtenances dramatize the formality of the setting: a large reproduction of a Gilbert Stuart portrait of Washington, a cluster of three small American flags above each door to the rear right and left of the bench, and even the gavel wielded by the board president to punctuate the proceedings.

Roles Taken by Meeting Officials. A. The Village Manager. It is a curious anomaly of village government in Shorewood that the "chief administrative officer of the village"[14] is not legally an ex-officio member of the chief deliberative body but is specifically permitted by law "to participate in all deliberations and actions by his voice but without his vote"[15] as an ex-officio member of all other legal bodies appointed by the board or its president. For it is readily apparent that no single individual exercises as much influence in board meetings as does the village manager. Although technically an administrative functionary whose job is to implement the policies and actions of the board, in practice, the manager has assumed the role of an impartial advocate in the deliberations of the board. The present manager does not attempt to present specific proposals but he does offer recommendations on particular issues when requested to do so by the board. In the majority of these cases, the board accepts the manager's appraisals.[16]

The basis for the manager's considerable impact on board decisions seems to be both quantitative and qualitative. Having prepared the agenda of items to be considered, he is in a strategic position to report the results of his research and evaluation. By virtue

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[14] *Village Code,* Art. 3, Sec. 3–302 (a).

[15] *Ibid., Art.* 3, Sec. 3–302 (c).

[16] Tape recorded interview with Robert Duncan, Shorewood Village Manager, January 17, 1962.

of the broad scope of his knowledge of village affairs in general and in specific problems, the manager occupies a unique position of dominance in board meetings. During the committee of the whole period of a recent typical board meeting, Manager Duncan consumed over half of the entire elapsed time devoted to investigative discussion.[17] During public participation in board meetings, the manager's pre-eminent status as a kind of floor manager and expert witness for consideration of public and private problems is equally evident. For about fifteen minutes before a recent board meeting was convened, the manager circulated among the audience preparing the visiting citizens for participation in the meeting and anticipating possible complications by asking for questions and complaints in advance of the meeting.[18]

B. The President. As chief executive officer of the village, the president presides at all meetings of the board.[19] In addition to his nominal role of ensuring that the ". . . deliberations of this board . . . shall be governed by the manual of parliamentary practice commonly known as 'Roberts' [sic] Rules of Order' . . .,"[20] the presiding officer in practice exercises leadership in promoting consensus on issues and handling public relations during periods of informal consideration.

C. The Clerk. The *Village Code* requires the clerk to record ". . . in chronological order, full minutes of all proceedings . . ."[21] Although the minutes are subject to review and approval by the board, the clerk has sole responsibility for their preparation and does not normally consult with the manager or president in the composition of the content of the minutes.[22]

D. The Village Attorney. By ordinance, the village attorney is ". . . the chief legal advisor to the Village Board and to the Village Manager and shall be responsible for preparing and drafting legal opinions, ordinances, rules and regulations . . ."[23] In practice, he also acts as parliamentarian during formal sessions of the board. The attorney participates in discussion and debate during meetings with comments concerning legal precedents and opinions concerning constitutionality and legality of proposed legislation.

E. The Committees. Members of the board constitute various standing committees: finance and administration; police and fire; streets, plats and buildings; judiciary; and parks. These committees

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[17] Authors' observations, village board meeting of October 16, 1961.
[18] Authors' observations, village board meeting of August 7, 1961.
[19] *Village Code,* Art. 1, Sec. 1–103.
[20] *Ibid.,* Art. 1, Sec. 1–107.
[21] *Ibid.,* Art. 1, Sec. 1–110.
[22] Duncan interview, January 17, 1962.
[23] *Village Code,* Art. 4, Sec. 3–402.

are primarily study groups for further investigation of specific matters referred to them by the board for their consideration. They do not normally initiate proposals for board deliberation and action.[24] Much of the discussion and oral inquiry phase of oral decision-making which might be expected of committees is thus practiced by the entire board sitting as a committee of the whole for informal consideration of matters, *de novo*. In the absence of regularly prescribed meetings or procedures, committees operate somewhat fortuitous upon call or felt need.

Sequence of Acts Followed by the Board. Each board meeting is a public drama in two acts. In the first act, the board meets in an extended committee of the whole session following the historical precedent of the New England town meeting. Time is allocated for the presentation of requests and complaints by citizens and for public consideration of agenda items. The second act is composed of a brief formal business meeting later that same evening. Although no conscious effort to arrive at mutual understanding during the session of the committee of the whole is avowed or admitted, the consistent pattern of subsequent unanimous votes suggests an effort to avoid or minimize controversy. In fact, controversy is taken to imply lack of information and an indication of undesirable internal friction. The net effect of this total deliberative process is to discourage systematic debate on crystalized issues in favor of unorganized discussion.

Recurring Themes in the Dialogue of Board Members. Even a casual examination of recent deliberations by the Shorewood village board will reveal the continued importance of those forces which shaped earlier village development. Concern with community progress, the preservation of a village image, and local autonomy continue to dominate official thinking.

Progressivism, for example, has been apparent recently in a variety of instances. A new organization of business and professional men was formed to supplement the efforts of the Shorewood Neighborhood Improvement Council.[25] A housing code providing minimum housing standards for the village was approved, and recently the village board voted to purchase its first "blighted house" as a prelude to property improvement.[26] Over twelve thousand dollars is being spent to finance a village improvement study by professional consultants. Two winters ago, an editorial appeared in the village newspaper chastising public works crews for snow removal "almost as bad" as Milwaukee's.[27] And recently when a metro-

[24] Duncan interview, January 17, 1962.
[25] *Shorewood Herald*, March 6, 1961, p. 1.
[26] *The Milwaukee Journal*, February 6, 1962, Part II, p. 2.
[27] *Shorewood Herald*, March 16, 1961, p. 4.

politan newspaper predicted a dim economic future for Shorewood, numerous citizens phoned the village hall offering to help in any way possible.[28]

The preservation of a unique village image has also been important locally. Village squad cars have been painted a distinctive cocoa brown and patrolling policemen have been attired in uniforms to match. Vine-covered lamp posts have been replaced by green street signs as a distinctive Shorewood symbol. Several months ago, the Shorewood Men's Club awarded $25.00 to an art student for designing an emblem which would further the idea of Shorewood as "a community with city comforts and rustic beauty."[29] No article in the village newspaper concerning village matters in 1961 has received such detailed treatment as the defense of Shorewood by village officials, following the appearance of *The Milwaukee Journal's* controversial piece on Shorewood's future.[30] The village attorney has opposed the board's purchase of blighted property on the grounds that state law has not yet been tested in this sphere; nevertheless, the neighboring community of Whitefish Bay has been buying up depressed property for several years now.[31] Perhaps the village board's concern with imagery is most dramatically illustrated in the proposal of one member that "the meetings on the Shorewood plan, while still in the discussion stage, be kept closed not with any intention of hiding the facts but in seeing that the *right facts* are presented."[32]

Home rule is also a substantial and continuing force in board and village thinking. In order to be sure that "everyone" would be in on the planning of Shorewood's future, a variety of steps were taken. Several hundred village residents attended a program at the local high school entitled "Shorewood Through a Microscope." Questions from the floor and answers by village officials were recorded and later printed in serial form in the *Shorewood Herald*. A questionnaire dealing with "likes and dislikes" about the village and its services was mailed to every fourth Shorewood resident. President McLean of the village board joined a county unit of municipal executives only after he had assured himself that Shorewood "would not lose its local autonomy and home rule" by this act.[33] On the occasion of Shorewood's joint purchase with neighboring communities of a garbage crusher, Village Manager Duncan was careful to reiterate his dislike of metropolitan services "we don't want."[34]

[28] *Ibid.*, May 11, 1961, p. 12.
[29] *Ibid.*, May 25, 1961, p. 1.
[30] *Ibid.*, May 11, 1961, p. 1.
[31] *Ibid.*, May 18, 1961, p. 1.
[32] *Ibid.*, May 11, 1961, p. 12; italics by the authors.
[33] *Ibid.*, January 12, 1961, p. 1.
[34] *Ibid.*, January 19, 1961, p. 1.

A vivid illustration of the importance of local autonomy occurred about a year ago when members of Shorewood's planning committee (a board appointed non-salaried group) agreed to meet in downtown Milwaukee during the noon hour to suit the convenience of committee members. Under the banner heading "Let's Have Meetings at Home" the *Shorewood Herald* alerted readers to the danger of Shorewood's becoming a "bedroom community."[35] "When meetings are held away from the village, it is almost like closing the door to the public," the editor warned. If members meet in the Shorewood village hall, "the planning committee will be more aware that its planning is for Shorewood and not some other community."

Scenes of Oral Decision-Making. As a representative sampling of the oral decision-making practices of the Shorewood village board, the authors have chosen to analyze three specific problems the board acted upon during the past year.[36] Each problem will be examined to determine what actually happened, to evaluate the effectiveness of the communication techniques used, and to estimate the degree to which board members adhered to democratic communication procedures. The problems chosen for analysis include 1) the purchase of fire insurance for village buildings, 2) the regulation of commercial hours of business for chain stores, and 3) the lease by the Shorewood Women's Club of a public recreational facility.

1. Traditionally, the village of Shorewood has handled the problem of fire insurance in a truly democratic manner. Within the boundaries of the village live twenty-four insurance agents, each of whom was alloted an equal share of village coverage. Since the last appraisal of village properties had been made in 1940, everyone agreed that the village was now seriously under-insured.

In mid-March of 1961, one of the local agents presented a new insurance plan for the board's consideration. A "free" appraisal of existing village properties would be made by this agent in exchange for 40% of all village insurance coverage. The new plan stimulated the board to call a meeting of all local insurance agents.

On May 22, twenty-one of the local Shorewood agents met with the village board to discuss the problem of new insurance policies. Since it was obvious to all that splitting coverage twenty-four ways resulted in minimal commissions, the group agreed that only one or two firms should handle the village policies. The *Shorewood Herald* hailed this decision as a change which would lead to easier bookkeeping and easier management. Here was, according to the editor,

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[35] *Ibid.*, May 11, 1961, p. 4.

[36] Communication practices regarding village business do take place, of course, *outside* of the board's regularly scheduled public meetings. An examination of these nonpublic decision-making practices would involve a separate study.

a split with tradition which "will work to the better interests of the village."[37]

On June 8, one of the village trustees asked to have a state insurance fund representative speak to the village board. The matter of fire insurance was then sent to committee for further study and remained there throughout the summer. On October 2, the board voted to place its entire coverage with the state insurance representative.[38]

In terms of the three recurring themes which had previously dominated Shorewood thinking, the affair went something like this. The *village image* was one of equality; policies were split equally among resident agents. This arrangement needed revision because of an outdated insurance appraisal and a feeling among the agents involved that their policy commissions were too small. *Home rule* would have dictated placing the entire village coverage with one or two local agents, a development the assembled agents in May probably assumed would come about. Yet *progress* in a civic sense involved both an immediate reappraisal and minimum insurance rates. When the state fund representative quoted premium rates only half as high as those cited by local agents,[39] the board's decision was greatly simplified; the village of Shorewood is now insured under the state insurance plan.

An analysis of communication techniques used during the consideration of the insurance problem is most revealing. According to speech theorists, the first step in solving any public problem is to inquire into the nature of the problem by means of group discussion. This the board proceeded to do. In May, village insurance agents (those village residents most immediately concerned with the problem) met in open session with the board.[40] In June, the board asked to hear from a state fund representative—an action which would broaden the basis of the board's review of insurance options.[41] Again the board's action was sensible and appropriate. And in October, the board awarded the policy to the lowest bidder, a traditional course of action for a body representing the public interest to follow. In each of these instances, the village board followed sound communication practice; members consulted those persons most closely involved, brought in an outside expert, and based their ultimate decision on economy.

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[37] *Shorewood Herald,* May 25, 1961, p .4.

[38] *The Milwaukee Journal,* October 3, 1961, Part I, p. 28.

[39] *Ibid.*

[40] *Shorewood Herald,* May 25, 1961, p. 1.

[41] *Ibid.,* June 8, 1961, p. 4A.

As for systematic clash through debate—the second step the communication experts recommend—there was none for practical purposes. At no time during the eight months when insurance coverage was being discussed did a public debate over the issues involved in the board's decision occur. Such a debate between state and private insurance representatives might well have occupied the board's attention during either of the two regularly scheduled September meetings.

If debate was lacking, individual advocacy through persuasion was surely not. The local agent who proposed a new village insurance plan in March was strangely absent when the board finally acted in October. Yet even the most optimistic salesman would hardly assume that a persuasive presentation to the board in March would have sufficient lasting power to bring about the desired result in October, seven months later. Another instance of personal persuasion occurred in early June. The village attorney opposed inviting a state fund representative to speak to the board. Attorney Hubert O. Wolfe maintained that "the state has no business in the insurance field;" according to Wolfe, state insurance constituted unfair competition for private agents.[42] Wolfe said further that because the state loaned out its accumulated funds, it was sometimes unable to pay fire losses without a long delay. The village board ignored its attorney's arguments; board members sent for the state fund agent. Again one wonders if the timing of the advocate was sound. A marshalling of these same arguments just prior to the board's action in October would seem to make more sense and to contain greater promise of success.

A third instance of persuasion, even more ill-conceived than the first two, occurred *after* the board had made its decision to purchase its insurance policies from the state. A letter signed by ten Shorewood insurance agents was sent to the board in which the board was accused of raising the "small pink flag of socialism."[43] Aside from personal pique, the letter served no discernible purpose. The board had already made its decision. Persuasion that might have influenced board members should have come before, not after, the decision was rendered.

To what extent was the board democratic in its procedure? A comparison with the six characteristics of "government by talk" listed at the beginning of this report should reveal the answer. Was there reliance upon intelligence and good will? By the board, yes. The decision to purchase the least expensive insurance with a reputable firm was logical enough. The behavior of the Shorewood insur-

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[42] *Ibid.*

[43] *The Milwaukee Journal,* October 3, 1961, Part I, p. 28.

ance agents is questionable, however. Their use of name-calling and their assertion that the board's action was taken "under the guise of 'it's cheaper' " was neither accurate nor productive of good will.

Was the board willing to suspend judgment during the initial phase of the inquiry? Apparently so, with one exception. Halfway through the period of deliberation, the village attorney attempted to limit consideration of insurance companies to private firms. According to Village Manager Duncan, board members follow the legal opinions of their attorney "95% of the time."[44] The village attorney is therefore an important figure at board meetings although he, like the village manager, has no vote. The fact that the board did not in this instance accept the attorney's recommendation is beside the point; the incident represented an unwillingness to suspend judgment by a village official whose opinions are normally listened to with care.

Did the board deliberate in a cooperative manner? Indeed they did. They invited local insurance agents to meet with them in order to present proposals and advice. The consideration of new insurance policies involved eight months of careful deliberation. Surely none could accuse the board of hasty action or indifference to local resource experts.

Was there equal opportunity for participation in all phases of the communication continuum? Such opportunity was available, though as noted earlier, there was no evidence of debate whatever, and what persuasion did occur, was poorly timed and poorly adapted to the audience for which it was intended.

Was there respect for minority opinions? The board listened to the village attorney argue against sending for a state fund representative. And the village manager was instructed to read aloud the insurance agents' letter of condemnation in a public meeting of the committee of the whole.[45] There was ample opportunity for one and all to be heard.

The board accepted the will of the majority by adopting the state insurance plan by a vote of 4 to 3.[46] In this respect, again, the board acted in a democratic manner.

2. A second action of the Shorewood village board chosen for detailed analysis involves the regulation of commercial hours of business for chain stores. The problem centered upon the purchase of food on Sunday.

On September 28, 1961, the village manager attempted to persuade the two chain stores in Shorewood, the Atlantic and Pacific

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[44] Duncan interview, January 17, 1962.

[45] Authors' observations, village board meeting of October 2, 1961.

[46] Minutes of the regular board meeting, October 2, 1961, p. 3.

Tea Company and Kohl's, to close their doors on the Sabbath.[47] The A. & P. was willing to comply if its rival did. There was no village ordinance on this matter, however, so the village manager was simply requesting voluntary cooperation. The store manager at Kohl's refused to comply since chain store business was brisk in Shorewood on Sundays.

At the board meeting on October 16, Village Trustee J. E. Palmer asked the village attorney to draw up an ordinance which would prohibit Shorewood chain stores from being open on Sunday. Mr. Palmer was well known as the owner of the local "Palmer House Delicatessen," an independent food store customarily open on Sundays and closed on Mondays.

In the ensuing discussion, the village attorney pointed out that village barber shops and automobile showrooms were restricted from Sunday operation by legislation. Attorney Wolfe noted that Wisconsin "blue laws" had been outlawed in 1933; he predicted that the ordinance requested by Palmer would be held discriminatory if challenged in the courts. Wolfe did say that such an ordinance would be permissible if not contested. The aforementioned laws on barber shops and automobile salesrooms were cases in point.

Mr. Palmer insisted that it was "immoral" for chain stores to operate on the Sabbath. He alleged that he was speaking for all small, independent businessmen in the village, and reiterated his demand for a village ordinance.

Trustee Alvin Meyer asked why Shorewood residents who disapproved of chain stores being open did not simply boycott these stores on Sunday. He went on to reason that if one food store were closed, all should be. As a lawyer, Meyer supported the opinion of the village attorney that the proposed ordinance fell into the category of discriminatory legislation.

Mr. Palmer insisted that the ordinance would be constitutional. "Shorewood is built on independent merchants," Palmer said, "we have the right to regulate things in our own village."

Palmer's ordinance was adopted at the next regular board meeting on November 6. Trustee Meyer cast the sole dissenting vote.[48]

Here was a case in which *home rule* and the preservation of the *village image* won out over civic *progressivism*. Palmer's key argument was that the village had the right to regulate its own affairs; passage of this ordinance would clearly demonstrate the principle of home rule in action. A second argument that open chain stores

[47] *The Milwaukee Journal,* November 7, 1961, Part II, p. 1.
[48] *Ibid.*

on Sunday were "immoral" illustrated puritan ideals. Sunday was a day of worship and rest, Mr. Palmer maintained. Shorewood had long viewed itself as a "model village." Any behavior which marred this image was behavior to be abolished. Curiously it seemed to matter little to most board members that the main advocate of this ordinance stood to gain from it by himself remaining open on Sunday.

Presumably the progressive-minded citizen would wish to encourage business in the village wherever possible. Yet the closing of chain stores would clearly restrict the hours during which business could be transacted. Government regulation of free enterprise was the pattern the board was asked to follow in this instance.

An analysis of communication techniques used by board members in the chain store dispute is most instructive. The controversy covered a five week period from late September to early November. On October 2, Trustee Palmer called the board's attention to the problem and asked the village attorney for a written opinion on the legality of an ordinance to restrict hours of business. Attorney Wolfe presented both sides of the picture. He explained that such ordinances were usually declared invalid when challenged in court. If the ordinances went unchallenged, as in the case of those regarding barber shops and automobile showrooms, they would be deemed enforceable. Wolfe refused to register an opinion on the constitutionality of the proposed ordinance, a proper stand in view of his non-voting and non-partisan position on the board.

Board members showed little inclination to discuss the closing hours controversy in a regular meeting until the evening of November 6. At this time, a debate occurred between Trustee Palmer and Trustee Meyer. Palmer maintained that chain store activity on Sunday was immoral, and that in his opinion the proposed ordinance was constitutional. Meyer noted the logical inconsistency in Palmer's position—"if you close one food store, why not close all?" —and assailed the ordinance as "discriminatory, bad legislation, and a very bad precedent." The sides were clearly drawn.

On the surface it might seem that Meyer would have the edge for logic and probability were clearly on his side. Yet the vote later that evening showed that Palmer had won the day for he secured all votes except Meyer's.

The deciding factor was Palmer's use of persuasion, particularly his adaptation to the beliefs of his listeners and his personal strength as a speaker. To begin with, Trustee Palmer was a respected board member. Since board members seldom advocated proposals themselves, Palmer could count on an attentive hearing. Furthermore, Palmer maintained that he was speaking for others; small businessmen, he said, had asked him to sponsor the ordinance;

residents, he said, objected to excessive Sunday traffic at chain stores; churches, he said, objected, too, although he refused to identify any specific religious group. Naturally the board would want to cooperate in a venture allegedly supported by so many residents. Palmer himself appeared to be confident and forceful. His insistence that "we have the right to regulate things in our own village" was a direct plea to those favoring home rule.

The Milwaukee Journal declared that Palmer had "put himself in an untenable position by using his public office to advance his personal business interests."[49] Be that as it may, Palmer got his way for chain stores are now closed on Sunday in Shorewood.

A comparison of the elements of democratic decision-making with this decision of the village board suggests intermittent democracy. The board chose to follow an illogical decision rather than the avenue human intelligence would suggest. On the other hand, the good will of a fellow trustee and of village residents was foremost in the members' thinking. Attorney Wolfe scrupulously avoided value judgments during the initial stages of the decision-making process, but Trustee Palmer could hardly do so. Palmer played two roles at once: that of an impartial representative of the people, and that of an advocate for small business. From the time when the question was first introduced until the eventual passage of the ordinance, Palmer was persuasive; he made every effort to convince others. It may even be that Palmer was asked to represent the independent store-owners because these businessmen felt that he would be more persuasive as a member of the board than any non-member. The village manager sought to deliberate cooperatively with the store managers involved. All factions had an equal opportunity to participate in all phases of the communication process. There was little discussion but ample persuasion and debate. The absence of any chain store representatives from any board meetings may have been due to a concern about local public relations and the potential danger of alienating customers. Minority opinion was never actually clear until the time of the vote on the ordinance. Trustee Meyer accepted the decision of the majority without further comment.

The ideals of democratic decision-making were sometimes achieved and sometimes overlooked in this second illustration of board behavior.

3. The third case of board action chosen for analysis involved the lease of a village park facility by the Shorewood Women's Club.

On August 8, 1961, blueprints for a projected addition to the shelter house at Hubbard Park were approved by the village board. For many years past, the Shorewood Women's Club had been with-

[49] *Ibid.*, November 9, 1961, Part I, p. 22.

out a satisfactory club house. The new addition was designed, in part, to meet this need.

At the next regular board meeting on September 5, the Women's Club lease again came up for discussion. The village manager talked at some length on the connotation of the word "bar."[50] The issues were two: 1) whether or not beer should be served in the new facility; and 2) who would receive concession rights for beverages that were served. Manager Duncan noted that certain Milwaukee parks permitted beer. He said further that the majority of groups requesting use of the Hubbard Park facilities wanted beer. Traditionally the park custodian served beer or "spiked punch" and received the commission therefrom.

The village manager became the focal point for this discussion on alcoholic beverages. All persons participating in the discussion, whether board members or residents, directed their comments to Mr. Duncan. Duncan served as chairman, information-giver, and principal speaker. Comments of board members and residents present were largely confined to praise for the manager's handling of the twenty-eight minute session; "very well explained" and "nice to have an explanation" were typical examples. The Women's Club delegation of eight members frequently talked among themselves but played little role in the discussion to which the board attended.

On September 18, Mrs. Skinner, current president of the Women's Club, asked about the progress of the Club lease.[51] She indicated that her group was anxious to start building the club house addition before the frost set in. Again, everyone deferred to the village manager as spokesman. Mr. Duncan apparently grasped the situation better than anyone else for his presentation was virtually accorded the status of reverence. Again, the Women's Club sent a sizable delegation which took little part in the discussion. The village attorney was instructed to meet with the Women's Club's attorney as soon as an appointment could be arranged.

On October 2, Trustee Abramson, a former president of the Women's Club, revealed a new obstacle in the negotiation of the club house lease. Apparently the ladies desired to employ their own custodian and to serve their own beverages. Mrs. Abramson proposed that the board instruct the village attorney to draw up a further agreement specifically covering the duties and responsibilities of the custodian.[52] The matter of the lease agreement was left in the parks committee for an entire month while the village manager, village attorney and village board members sought to reach agreement with Women's Club officials, officers of the corporate organi-

[50] Authors' observations, village board meeting of September 5, 1961.
[51] Minutes of the regular board meeting, September 18, 1961, p. 1.
[52] *Ibid.*, October 2, 1961, p. 5.

zation of the Women's Club, and the Club's attorney. Construction of the club house was postponed for the duration of this period.

Agreement was finally reached on November 6, thirteen weeks after the board had approved construction plans. There would be no park custodian in attendance when the Women's Club was using the facilities but such a person would be in charge when other groups were present. All concessions would be handled through the park custodian as in the past. A large delegation of ladies again appeared although the Women's Club attorney did all the speaking on their behalf.[53]

The final board action was *progressive* in that a long existing need for a club house was now met. *Home rule* was preserved in terms of village control of a village facility. The *image* of a cooperative, responsive village board was upheld in that board members and villagers reached a compromise agreement, suggested first on September 5.[54]

An examination of communication practices used in this transaction reveals some remarkable shortcomings. Each time the board considered the lease agreement, the village manager did most of the talking. These sessions can better be described as informative speaking and "interviewing the expert" than open and broadly based discussion. Observers in the audience found it difficult to understand why the Women's Club lease appeared on the board's agenda week after week.

There was no evidence of controversy at any of the board meetings. Yet agreement on the lease remained elusive. One problem was the fact that the Club appeared to have no single spokesman since the Club president confined her remarks to brief questions and a plea for a speedy settlement. On October 2, it became clear that at least a dozen people representing the village and the Women's Club had to be contacted, convened, and convinced of a solution. It remains unclear as to why so large a group of active citizens was needed to reach an agreement implicit early in the board's deliberation of the matter. Discussion, debate and persuasion may have occurred on this topic but these processes did not occur during regular board sessions.

Was the decision a democratic one? Largely so. Intelligence would have dictated a much more rapid agreement to be sure. And good will should have paved the way for at least some discussion from the floor by the many interested ladies present. But perhaps the latter feared they might be taking up the board's time unnecessarily.

Mrs. Abramson, who had an obvious interest in the proceedings, refrained from persuasive appeals throughout the inquiry. The vil-

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53 Authors' observations, village board meeting of November 6, 1961.
54 Authors' notes, village board meeting of September 5, 1961.

lage board met with all the parties concerned and did its best to deliberate cooperatively. There appeared to be an equal opportunity for participation in all phases of the communication continuum, even though, as mentioned earlier, little use was made of this opportunity in regular board meetings. The final decision of the board in this matter was a compromise satisfactory to all. Minority opinions were respected and majority rule reigned: the Women's Club received the right to regulate its liquor consumption during its own meetings while the board protected the concession rights of the park custodian.

IV. Conclusions and Recommendations

In an admittedly incomplete study of the oral decision-making practices of the Shorewood village board, the authors have reached a series of tentative conclusions. Each conclusion presented below is accompanied by a specific recommendation for improving communication practices.

1. For over sixty years, the formulation of public policy in Shorewood, Wisconsin has been dominated by the three forces of civic progressiveness, home rule, and the preservation of a "village image." Preoccupation with home rule and a village atmosphere have at times prevented board members from considering proposals on their own merits. A systematic use of the oral communication continuum for all policy matters requiring board decision would eliminate this problem. For example, if a set amount of time were allocated to debate before the board of the key issues involved in a proposal, the board would be better equipped to reach a logical solution.

2. Although no attempt was made in this study to validate the communication continuum recommended by speech theorists, the study clearly shows that this recommended pattern of speech processes is only partially adhered to in Shorewood board meetings. Provision for the use of these three processes regularly in board deliberations would aid the board members by providing them with a systematic method of procedure. Such a requirement would also help the citizens of the village in their understanding of the deliberative process their representatives would follow.

3. The characteristics of democratic decision-making occur intermittently in the deliberations of the Shorewood village board. A conscious effort on the part of board members and village officials to suspend judgment during the inquiry phase of a question should help in this connection. The prerogative of personal advocacy should be denied board members in regular board meetings but encouraged in committee meetings.

4. Any complete estimate of Shorewood decision-making practices must include studies of oral communication outside of regularly scheduled board meetings. Related studies of the communication practices of persons who are influential in the village, neighborhood conversation groups, committee sessions, and even coffee breaks would help to complete the picture of decision-making in Shorewood.

5. The most influential participant in board meetings is the village manager, who is not officially a member of the board. Apparent efficiency should be sacrificed for greater use of the democratic process. The manager might better make materials available to board members for study than report on them himself. For in summarizing such materials, the village manager must abstract from them; his selection of what is important might be substantially at variance with that which might be selected by the village trustees. The authors suspect that board members take limited part in board deliberations because they feel that their knowledge of specific topics is limited.

6. Methods of recording minutes of board meetings are unsystematic and outdated. The use of tape recordings of both the committee of the whole and regular board sessions should help to eliminate recording problems. Such tapes would serve as a valuable historical record if carefully preserved. Further, the authors recommend that consultation between the village clerk and the village manager and/or the village president in the preparation of minutes should be required.

7. Although this study was not primarily concerned with the Shorewood board's committee system, it soon became obvious that the committee system is in need of review. Committees should meet regularly to initiate studies and draft proposals in their own areas. Thus, recommendations to the board for action would represent carefully phrased group thinking rather than hastily composed ideas of individuals.

8. Board meetings are inadequately structured from the standpoint of arousing interest among citizens as participants in village government. The failure to begin sessions on time or to publicize before the meeting the evening's agenda, the judicial atmosphere and the placement of important village officials with their backs to the audience, inaudibility of board members at times and citizen unfamiliarity with the steps of the deliberative process—all of these factors contribute to a spectator rather than a participant interest in village government. Added to these factors is the discouragement of conflict, an element of natural interest which might attract greater attendance. The village board has at its disposal the positive means for correcting these deficiencies.

THE RETREAT OF AGRICULTURE IN MILWAUKEE COUNTY, WISCONSIN

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Milwaukee County, in common with other principal urbanized counties of the Middle West—indeed of the nation—has experienced the impact of the urban sprawl and its accompanying rural retreat. The impact has been hastened in the county, and elsewhere, by the "discovery" of hedgehopping by subdividers; hedgehopping, the placing of subdivisions in the midst of fields, and some distance removed from continuous urban areas, results in the fracturing of farm land, the shattering and even the elimination of the agricultural zones that surround a city, and in the creation of economic pressures upon the farm land remaining in the interstices between and among subdivisions.

Milwaukee County contains 239 square miles (152,960 acres) and more than a million people within its borders. The post-World War II advent of hedgehopping has resulted in subdivisions in all parts of the county. The percentage of the county devoted to agriculture has dropped, in twenty years, from 50 to approximately 10. More than 1,250 farms were eliminated in the first fifteen years after the War. But 237 true "commercial farms" remained in the county in 1961, as disclosed by a special survey. The 440 dairy farms of 1940 were reduced in number to approximately 50 by 1961, only 26 of which still produced milk for the Milwaukee market; a county that at one time had the largest milk production per unit of farm area in the state now gathers some of its milk supply from points as distant as central Wisconsin. The former market gardens have been virtually eliminated; only 35 remained in 1960, relicts of the nearly 300 of the recent past.

Milwaukee County was among the top 100 agricultural counties of the nation in some items a generation ago. Today all of its area lies within the limits of incorporated places—Milwaukee, the twelfth city in size in the United States, Milwaukee's long-established suburbs, new suburbs, and "new cities", these last the former towns (townships) of the county. Thus every resident of the county, farmer as well as urban dweller, is now a city resident and subject to zoning ordinances of an urban type as well as to city taxes and assessments.

This paper is concerned with the rural retreat, not with the urban sprawl or the advancing contiguous urbanized areas. It is concerned, too, with farmer resistance to rural retreat. The wave of German settlers of the 1840's occupied much of the farm land, although some settlement of Eastern Americans and Irish occurred during the 1830's and 1840's. The thrifty and hard-working German settlers cleared and developed the land. Many Milwaukee County farms are or were "century farms", having been in the same family for 100 years or more. Fathers established their sons in farm enterprises, and a love of the land comparable to that of the Pennsylvania Germans developed. Seven out of every eight farmers are landowners; many of the renters are related to the owner by marriage. Thus, the resistance of many individuals to loss of their land has perhaps been more determined than in urban counties elsewhere where a more speculative and mobile agricultural population resides.

This paper is based upon detailed field work undertaken in 1959–61, upon other field work carried on in the county by the writer during several periods beginning with the early 1920's, and upon various statistical and historical records. The subject matter is confined to Milwaukee County. The writer recognizes that the urban impact and zone of rural retreat extends into three neighboring townships (now cities) of Waukesha County (Menomonee, Brookfield, New Berlin) and into one of Ozaukee (Mequon), and that some townships beyond these are experiencing rural retreat. Waukesha County to the west has had a serious loss of farm land and of farms during the decade since 1950, from 3,049 farms to 1,883; 864 dairy farms disappeared, and but 904 total still operate. The county is no longer near the top of the leading dairy counties of the nation. But for historical, statistical, and field purposes the paper is held to a county which has long contained one of the major cities of the nation and yet has been important in agricultural production as well.

Hedgehopping in Milwaukee County

The principal advent of hedgehopping in the United States has occurred since World War II, even though some of the War-built housing was at a distance from contiguous urban areas. Prior to the War the "greenbelt towns", sponsored by the Roosevelt administration, were placed in an outer ring; Greendale, the "greenbelt" community built southwest of Milwaukee was such a town. At the time it was unique enough so that "tourists" gathered to witness the operation of machines, the demolishment of large dairy barns included within the planned area, and the razing of other farm structures. The urban expansion of the present proceeds, in Milwaukee County as elsewhere, by contiguous growth from the existing urban margin, by growth along major highways, by the familiar "additions" to a city near its borders, and by hedgehopping. It is this last that creates additional economic pressure upon the agricultural land near which the subdivision is placed.

Many real estate developers have adopted hedgehopping wholeheartedly. Land at a distance is less expensive. Taxes, at least originally, are lower in the rural territory. The omnipotent automobile of office and factory workers, coupled with paved and maintained roads, have made hedgehopping feasible and possible. Public transportation need not be considered as a locative factor; the resident provides his own transportation. In fact, his work may follow him as factories, research laboratories, shopping centers, and other enterprises move to a peripheral setting. The drilled well, the electric pump, and the septic tank, ubiquitous features of nearly all hedgehopped subdivisions or linear rows of new rural nonfarm homes, likewise permit selection of site without regard to water or sewer lines. Milwaukee newspapers, especially in their Sunday real estate sections, now carry many advertisements of well drillers, and septic-tank cleaners—types of business whose services are not needed in the city proper.

The hedgehopped subdivisions of Milwaukee County lie in a semi-circle around the city. They extend, also, into Waukesha County to the west, the southeastern corner of Washington County to the northwest, and into Mequon of Ozaukee County to the north. They differ in quality, landscape, and type of resident—differences not within the scope of this study. In general those to the north near Lake Michigan are of higher quality. Northward, too, are the small and large estates, some of them of small-farm size, but not operated as farms. The southern subdivisions are principally for the worker. Westward and into Waukesha County there is a mixture, but much high-quality property in the Lake Border Moraine, and many subdivisions catering to the middle class. An original factor in the westward placement, aside from propinquity to the western urban edge very near the county line, was the existence of far lower automobile insurance rates in Waukesha County than in Milwaukee. Thus, no matter what the county unit the impact on farms is existent. Broadly, the present general subdivision zone coincides quite closely with the milkshed of the 1920's. At that time Milwaukee, of all the larger cities of the United States, possessed the smallest milkshed *in area,* a reflection of the intensive dairying of southeastern Wisconsin; the outer limits were only 25 miles from the city center. The farms of Milwaukee County were then the largest producers of milk per unit of farm area in the state.

The detailed pattern of subdivisions is markedly affected by the mile-square grid of the road system. But, from the earliest days diagonal roads led outward from the port of Milwaukee, for the city was one of the principal points of disembarkment for settlers who arrived from the East or from Europe via the Great Lakes. These roads, originally plank roads, still constitute principal arteries along which, or adjacent to which, real estate subdividers have placed many hedgehopped communities. Southward the straight roads on the section lines, particularly two or three, are principal arteries; one of the section-line roads is the United States Highway to Chicago, and carries an Interstate Highway southward for 24 miles from the southern edge of Milwaukee County to the Illinois state line.

The individual subdivision, within the confines of the original road pattern, is commonly hit-or-miss in specific site. A realtor buys a single farm, and "develops" it. A nearby farm, a mile or more away, is purchased by another developer. Various builders and real estate firms compete for locations; advertisement after advertisement appears in the city papers, farm-read papers or journals, the gist of each advertisement being "lots and acreage for subdividing wanted" or "wanted: farmland suitable for subdividing." Speculators purchase or option other farms, hoping to sell at an increased price to a builder, and meanwhile renting the land back to the former owner. In fact the real estate sections of the Milwaukee newspapers frequently contain articles on this practice: " 'Trading Up' Realty Properties Profitable if you Avoid Pitfalls." These, and associated activities, result in the specific location of many hedgehopped subdivisions—all, however, being within the broader framework of the "subdivision zone" of urban-rural landscape.

The competition of real estate subdividers for farm land suitable for development into hedgehopped subdivisions has bid up the price of such land. Not only do the subdividers bid among themselves, but operators of large farms—located on the outer fringe or beyond it —have been purchasing land to enlarge their farms. This is owing to their desire to provide a buffer zone between themselves and the subdivisions, and to permit expansion and further mechanization of their operations and increase of income. The small to medium-sized farmer thus may have alternative opportunities to sell out. In many cases the larger farmers have offered prices that are competitive with those of the subdivider; then the latter may choose to seek land elsewhere, another factor in the hit-or-miss location of many subdivisions. In any case the rising value of the remaining farm land, a shortage item, results in increased taxes, even the tax rate is not increased. Thus further economic pressures develop, ones indirectly owing to suburbinization, and the competition for land.

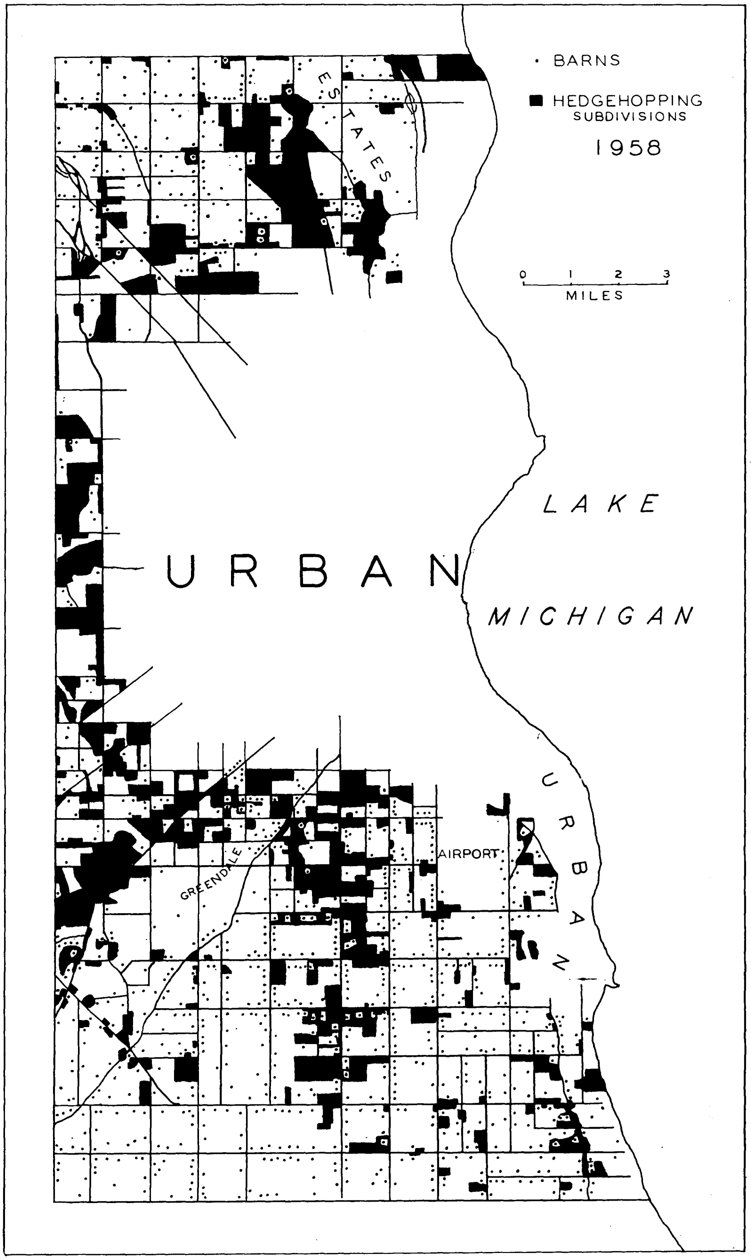

FIGURE 1. The road pattern, location of barns, and the hedgehopping subdivisions in Milwaukee County, 1958.

Subdividers compete with other potential users of land for space. Among these are federal or county agencies purchasing or condemning airport locations, park land, school sites, and institutional sites; churches obtaining land for present or potential use; factories and research centers seeking rural or peripheral locations; country clubs, golf courses, cemeteries, commercial and industrial users; companies building radio or TV towers; dumps, and many others. Each of these users today desires a generous supply of land; in Milwaukee County fringe and rural areas there are 80-acre school sites—one-eighth of a square mile; 40 and 60-acre church sites; 50 to 80-acre sites for towers; paved parking lots of 40 or more acres surrounding shopping centers; and new one-story factory buildings surrounded by extensive parking lots. And, in present and potential Interstate Highways and modern freeways, from one-sixteenth to one-eighth of each square mile through which the road passes is removed from farming or other uses.

The Landscape of the Zone of Rural Retreat

The zone of urban sprawl and hastened rural retreat contains a combination of rural and urban cultural forms. In Milwaukee County the most striking cultural relicts are the large basement dairy barns, nearly 1,000 of which are still standing, inheritances in part from the 2,000 farms of a generation ago, and more particularly from the 1,349 of ten years past. These well-built structures, with field stone (glacial boulders), local Niagara Limestone, or concrete foundations, are too valuable or expensive to demolish as long as some use can be found for them; sheds, cribs, and other out-buildings are removed, however. Many of the barns are 100 to 150 feet long, 40 to 80-feet wide. Some stand in or next to hedge-hopped subdivisions. Some remain next to factories or commercial establishments. Some have been converted to new uses—clubhouse, summer theater, real estate office, headquarters for a contractor. A barn in adjacent New Berlin has been cut down in height and remodelled into a modern ranch-style house. Other barns have been converted into use for storage; some are used for the selling of topsoil, for some of the frugal farmers of German descent gain an income from this before selling space to a subdivider. A relocated market garden may have a large dairy barn upon it, a structure not needed in the new enterprise. Vacant barn after vacant barn stand abandoned on a farm temporarily devoted to the growing of crops alone; the former barnyard is deep in vegetation, and the barn is used, perhaps, only for the overnight storage of an automobile.

Silos are relicts in many locations where the barn has been removed. Some silos still stand in subdivisions. Fields among subdivisions are in effect relicts of a former land use. An occasional abandoned apple orchard is a relict, but on the whole orchards have proved to be especial magnets for subdividers, and orchard acreage was limited in Milwaukee County in any case. Cultivated fields stretch to the back yards of some housing developments; it is not uncommon in the summer to witness a "relict farmer" at work on his tractor on one side of a line fence passing a householder and his power lawnmower on the other side.

Large and substantial frame farm houses, and smaller but well-built yellow-brick farmhouses, each quite usual in the county, remain as relicts. In most cases they have been retained for residences. Where a new subdivision of one story ranch-style houses or hundreds of small and similar box-like frame houses has been constructed, its adjacency to a relic farmhouse of different-style architecture provides a sharp contrast. Equally notable in the scene are the mature trees surrounding the former farm home and the newly-planted "shadeless" small trees of the subdivision.

Dairy cows are becoming relict features in the Milwaukee area. Their numbers, as recorded in the Census, have dropped from more than 7,500 in 1944 to fewer than 2,000 by 1959. Dairy farms have declined in numbers from 603 in 1929, more than 500 in 1939, and 440 in 1944 to only 75 census-reported ones in 1959—and to approximately 50 (only 26 selling milk to Milwaukee) by 1961. In the northern portion of the county only four farmers still maintained a dairy herd during August 1961.

Changes in the Agricultural Zones

The agricultural zones surrounding Milwaukee have been fractured, reversed and turned "inside out," or even eliminated completely by the urban sprawl of the post-World War II period. (1) Market gardens, theoretically closest to a city market are virtually extinct; three dozen remain where there were nearly 300 in the 1930's. In general, they have not been replaced on the present fringe, owing to the hesitancy of making the necessary capital investment because of the certainty of city expansion, and the competition of fresh and frozen vetgetables now produced on truck farms hundreds of miles distant; modern technology and the advent of frozen vegetables, coupled with the housewife's ease of preparation of the latter, have been background factors. There are today only two-and-a-half times the number of vegetable farms in the entire state of Wisconsin that there were market gardens in Milwaukee County alone in 1930. (2) The city milkshed, theoretically in the second zone outward, has been overrun by subdivisions, factories, and fractured by land held for anticipated schools, parks, and other uses. Milk is now transported to Milwaukee from distant counties (Figs. 2 and 3). Even adjacent Waukesha County, which in the past furnished nearly all of the market milk not produced in Milwaukee County, supplied only 19.7 per cent of Milwaukee milk in 1961, and had but 448 farms remaining on the market; during the five years 1954–1959 Waukesha lost 10,000 dairy cows. (3) Field-crop agriculture, the selling of cash crops (mainly small grains and corn now in Milwaukee County), theoretically distant from the city, now appears an activity on the urban fringe. It engages land awaiting "development," on former dairy farms where animals cannot be replaced because of zoning ordinances, by older farmers to ease their daily work-load, by farmers who hesitate to invest in capital equipment for the expansion of other agricultural enterprises, and by farmers renting land which is owned by developers for future subdivisions, by agencies for future park or school use, and other similar land awaiting a future use. The market for the final disposition of these crops is, in many cases, not the Milwaukee market, but one in the reverse direction. (4) The feeding of beef cattle and swine, theoretically not close to an immediate city market, now is an enterprise on certain farms. Former dairymen have shifted to

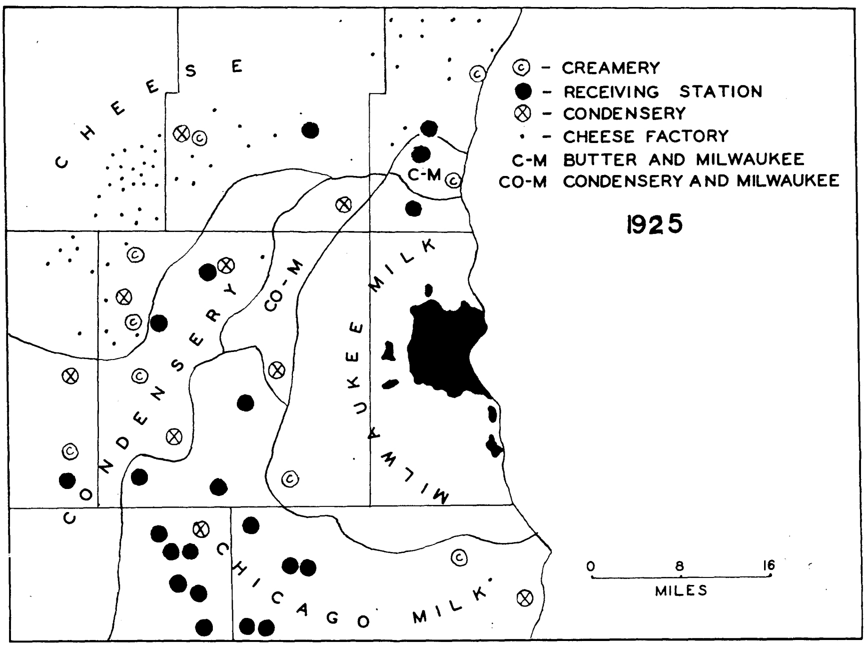

FIGURE 2. Milwaukee milkshed of 1925. The maximum extent of 25 miles from the city reflects the local intensity of dairying.

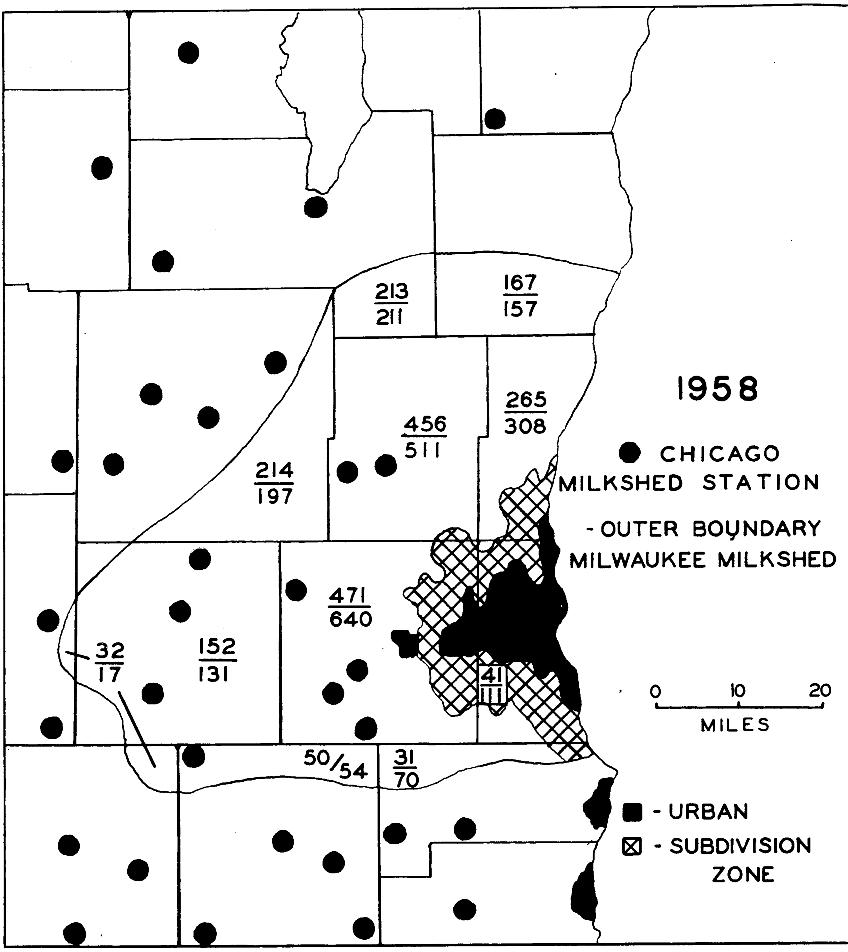

FIGURE 3. Milwaukee milkshed of 1958. The subdivision zone is virtually coincident with the milkshed of 1925 (Fig. 2). The fraction shows the changes in number of farms on the milkshed in two years; the denominator is the number for 1956, the numerator 1958.

beef cattle, in response to labor costs and shortages, the use of their land for crop agriculture during the summer and use of their own labor for feeding animals in the winter, their hesitancy to invest in additional capital equipment for continuance on the fluid milk market, and because the herd can be liquidated quickly if the farm is sold.

Nurseries, greenhouses, growers of ornamental plants, shrubs, and trees and "lawn specialists" have increased in number and importance in urban fringe areas. Their market is the new housing development, an insatiable market considering population growth, the American desire to live in a single house, the prestige factor associated with a landscaped lawn, and the "necessity" factor of a home-owner having his "bare" surroundings seeded and planted.

Other Changes

The activity, if not the function, of the Milwaukee County Agricultural Agent has changed with the times and the urban development. This official now finds a large part of his work (80 per cent) and a large percentage of the questions reaching his office, with the residents of subdivisions or the new rural nonfarm resident. They seek advice on how to grow a lawn on subsoil, for the bulldozer of the subdivider has left the topsoil on the bottom. The activities of the County Weed Commissioner have increased; his problem has been enlarged from concern about weeds on vacant lots to the weed problem on land "awaiting development" and not used for the growing of crops.

The terms *unimproved land and raw land* have assumed new meanings in the Milwaukee setting and elsewhere in urban counties. Today these terms to the subdivider (and no doubt to many urban-reared persons) is land upon which there are no dwellings, factories, man-made parks, or other cultural elements denoting urbanism. "Raw land" is advertised in the newspapers for sale as a building site, the raw (or "undeveloped") land being some of the finest farm land in the nation. Yet one hundred years ago, and even more recently, unimproved land was land that had not been brought into the standards of cultivation of the day. The United States Census recorded improved and unimproved acreage in Milwaukee County through 1860, by which time the county was two-thirds included in farms, on which there were 48,712 *unimproved* acres—land on which there was relict forest or cut-over, was unbroken and unused prairie or oak-opening, was stumpy pasture, marshland, or swamp. By 1870, Milwaukee had 50,000 inhabitants; unimproved acreage in the county was not recorded. In thirty years, 1900, the city of Milwaukee contained 300,000 inhabitants, and its landward edges were semi-circled by more than 2,500 highly-developed farms, whose collective area included more than four-fifths of the county. Only a few woodlots of second-growth hardwood provided any indication of the former dominant landscape-type and fields and pastures occupied the gently rolling to undulating glacial-drift plain.

Thus a little more than a century and a quarter from the 1830's to the present has witnessed marked shifts in the landscape and the geographical scene in the 239 square miles of the county. And the

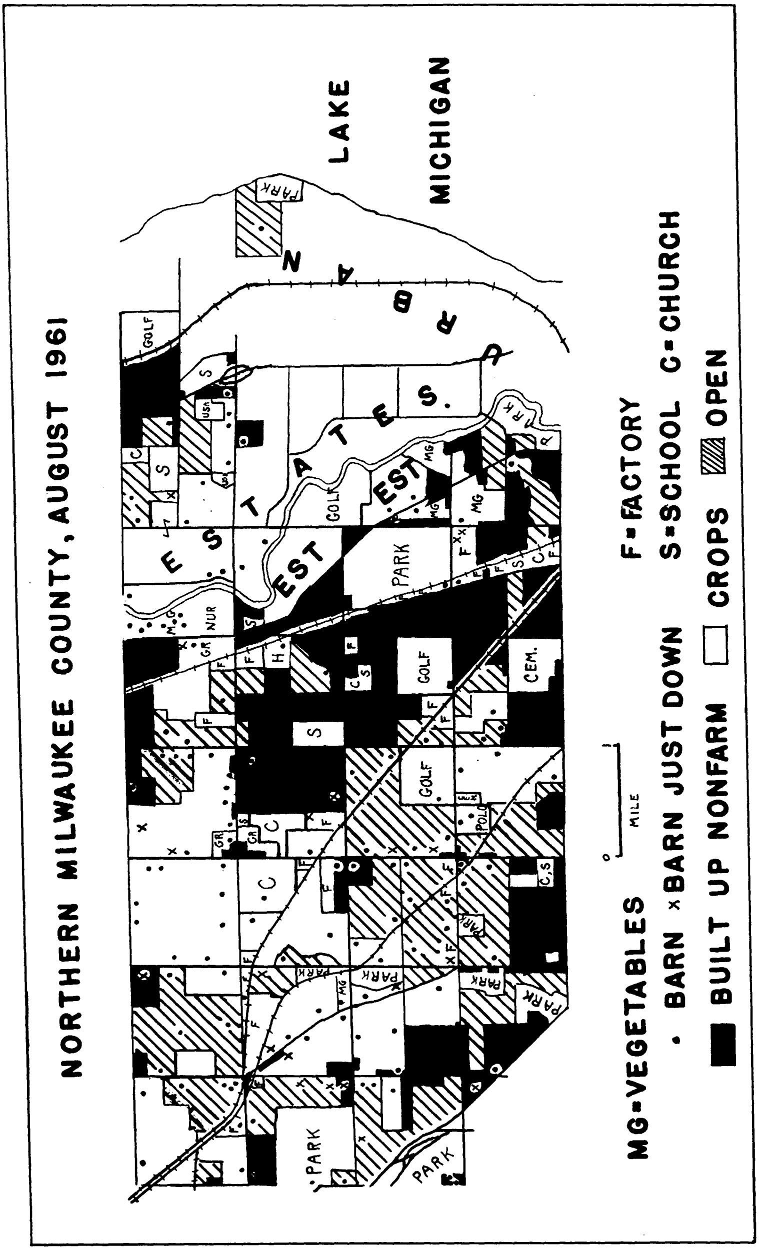

FIGURE 4. Land use in northern tiers of sections in Milwaukee county, 1961. Area shown is from western county line to Lake Michigan. Entire area is in the zone of urban sprawl and rural retreat.

shift in population, not only in this area but in the United States, from predominately rural to principally urban has resulted in marked shifts in the attitude of the majority toward land on the urban fringes of the present. "We must clear the forest and break the prairie to *improve* land" has now become "We must eliminate the farm land (*raw land* to the subdivider) to *improve* the land." The pioneers attacked the forest with axes, to replace it in time with fields and pastures. Their descendants now attack the terrain with bulldozer and concrete to cover it with aspects of urbanism.

Pressures Upon Agricultural Land

The pressures exerted upon farm land in urban counties of the United States are of several origins and types. They involve land uses which are observable in the landscape. The ultimate final decision to sell may be indirect, through the economic pressure of increased taxation of farm land or through a highly favorable price offered. They may be direct in the passage of urban-type zoning ordinances that place the agricultural land in a non-conforming land use; direct when under the "nuisance" application of common law, animals and barnyards may be declared nuisances by the courts should the residents of subdivisions complain and carry a suit successfully through the legal process; or direct through condemnation of a farm for public use such as a park, or municipal airport.

Pressures from Hedgehopping

The presence of a hedgehopped subdivision or a line of rural nonfarm homes creates pressure upon the surrounding farm land, or the farm land remaining in the interstices between subdivisions. The demands of their residents for schools, public garbage collections, other services, and eventually for local water or sewerage systems, local street pavements, fire and police protection, and other services and amenities to which they were accustomed (either in the city, or as young city-reared persons) all lead toward an increase in taxes, of which the farm acreage bears a disproportionate share, considering its size (even though assessed as farm land). The rise in school taxes for new schools is particularly large. Should sewers be provided, the total of sewer-line assessments on the farm property is relatively greater, for the sewer line passes through a longer frontage on the farm property line than on a building lot. Finally, to obtain services or to asure self-rule the residents of the many subdivisions in a township band together and incorporate. All of Milwaukee County now is within incorporated villages or cities; the former towns (townships) have disappeared. The complete incorporation of the county was accomplished during the 1950's, the smaller units competing with Milwaukee to annex territory. Some units moved for self-incorporation for fear that the master city might annex them; in fact, Brown Deer and Milwaukee each annexed the same territory, with a resulting lawsuit. At some point, either before or following incorporation, the tax load on the farm land may reach a point where the farmer is forced to sell to a subdivider. His farm acre is a working acre, and must carry its economic load. An acre-lot, or a fractional-acre lot in a hedgehopped subdivision, does not yield products to help pay the taxes assessed upon it; tax money for it is obtained from the occupier's pay check, whether in the form of wages or salaries. Thus the two adjacent land areas, and the viewpoints of the adjacent farmer and subdivision resident, are reversed. The farm land is devoted to crops or animals, from which enough return per acre must be obtained to pay for the costs of labor upon it, the capital investment, repair of buildings, the charges in taxes, and still yield a profit. The occupier of the house and lot in the subdivision is engaged, in his home at least, principally in the rearing of children.

Other pressures build up on the remaining farm land. Incorporation of a township, or other unit of territory, means concentrated government,—aldermen, city managers or mayors, and other officials. Today it follows that there is planning and zoning of an urban type (rural zoning of farm land has been common in Wisconsin since the early 1930's). The farmer finds his property zoned for a future factory site, shopping center, or some other use. He finds his farm zoned into a non-conforming land use by the planning board, and the zoning ordinance passed eventually by the governing board of the village or city, or by the more-numerous voters resident in the hedgehopped subdivisions. As a non-conforming land user he is zoned out of farming should he cease operations for any reason for a time. In some ordinances his number of animals are set at the time of passage, and he cannot add to them. Thus, added to the pressure of increasing taxes, he is deterred from making capital investments looking to a change in type of operation, modernization of barns or equipment, or replacement of machinery.

Land values have arisen in any case. Between 1954 and 1959 the value of Milwaukee County farm land, as reported by the Census, rose from $684 an acre to $1,049. Even though specific figures are affected by inflation and the purchasing power of the present dollar, both increased value and increased tax rates are operative in providing tax pressure. From this base, the additional school and other taxes, added on with the advent of subdivisions, provide the total pressure upon farm land and help hasten the rural retreat, and filling of the interstices between and among the hedgehopped areas.

And, as subdivisions mushroom, the competition for land bids up its price; the farmer may thus decide to sell because of a highly favorable offer.

Pressure From Park Land

Milwaukee County has an excellent park system; parks, whether within the city limits or the county are administered by the Milwaukee County Park Commission. In 1961 the park acreage was 10,361. Eleven and a half square miles of this, 7,414 acres, is located beyond the closely-built portions of the city and its immediate and long-establishment suburbs. Virtually all of the outlying park land was in farms twenty to thirty years ago; some of it was cultivated as recently as two to five years ago; within the three years of 1958–1960 about two square miles of farm land was added to the system.

The land in parks includes large single blocks and streamside parkways. Plans were drawn in the 1910's and 1920's for the parking of every stream course in the county, and of much of the Lake Michigan frontage. Today there are parkways along nine different streams, and this facet of the plans is nearing consummation. Recent purchases of land for the streamside parkways, however, are of large blocks rather than narrow strips, and remove many farms from the tax rolls, as well as change the landscape from one of fields and pastures to one of planned landscape-planting or of county-owned golf courses. For example, in the southern part of the county the Commission has obtained, in three adjacent sections (square miles) acreages of 93, 45, 250, and 188; of this total area the Root River flows through only three 40-acre plots. Nearby, 280 acres were added to obtain one 40-acre area through which the river flows.

Obviously, *with all considerations of the greatest good for the largest number of people and the wisest use of land for the many put aside,* the park developments have created pressures upon farm land, particularly stream-side land. The acquiring of land originally in narrow strips removed lowland pasture from some farms, made the creeks and rivers inaccessible for watering cattle, access rights-of-way split other landholdings on the periphery of the parkway, and some farms were split in two. The present purchases remove whole farms from agriculture. The farmers owning stream-side land know they have a potential buyer if they wish to sell; however, in effect they have no alternative buyer to turn to. As money becomes available the Park Commission negotiates for purchase in order to obtain the land at "agricultural prices." If Commission and farmer fail to agree on a price the land may be condemned. The Commission now attempts to obtain land before the appearance of competition from subdividers, who might threaten otherwise to buy the non-streamside portion of large farms; thus the "new" buying practice affects, or may affect, the entire farm. It reflects, economically, the fact of competition of land users for the shortage item in the county—land.

The removal of park land from agriculture, coupled with the advent of subdivisions in the vicinity, places increasing tax burdens upon the remaining farm land. In one case the park land is removed from taxation, placing the tax base upon the remaining land; in the other the tax pressures engendered by the subdivisions appear. Offsetting this in many districts is the attraction of parkside land to the subdivider and builder of high quality houses. Several discontinuous hedgehopped subdivisions margin parks and parkways in outlying areas; many streamside parks close to the city are now paralled by houses on either side. Eventually the overall tax base is increased.

From the standpoint of the farmer, the park land hastens rural retreat. A farmer whose acreage contains potential park land, like farmers in the interstices among subdivisions, thus hesitates to invest in improvements to continue in dairying; for example, in 1956 the Milwaukee milk market shifted from the collection of milk in cans and in bulk tanks to its collection alone from bulk tanks installed on the farms. Most farmers along stream courses and in interstices did not invest the $2500 to $3000 necessary for the bulk tanks even though they could receive some aid from milk distributors—the investment might never be returned or amortized. Instead they sold their herds, some sold their farms, and others shifted to a cash-grain crop agriculture.

Pressure From Church-owned, School, and Public Land

Long-established churches and schools occupy small sites in the zone of rural retreat, sites inherited from rural days. Quite in contrast, the sites purchased for new churches and schools are generous.

In the subdivision zone in Milwaukee County the sites purchased by the various Protestant denominations are generally from five to 30 acres. Sites owned by various units associated with the Roman Catholic Church include lands of this acreage, and blocks of larger size. The Archdiocese of Milwaukee owns separate blocks of 38 acres, 39, 75, and 244 acres. The Xaverian Fathers own 58 acres, the Servite Brothers 153, the Sacred Heart Monastery 128, the Sisters of St. Francis 80, and there are several others; the total of larger church landholdings of the Roman Catholic Church in the urban sprawl-rural retreat zone exceeds 1000 acres. Some few are operated temporarily as farms.

School sites of 20 to 40 acres are usual. Seventy and 80-acre "campuses" for public schools have been obtained, such as that for the Granville High School.

The Milwaukee airport of more than three square miles, another airport of nearly three-quarters of a square mile, several smaller airports and landing strips, and a partial ring of United States-owned land for various defense installations are all on former agricultural land, some of it in crops very recently. One of the principal former market gardening areas, comprised of intensively cultivated vegetable farms, is now almost completely obliterated by the Milwaukee airport and the urbanized districts that have grown in its surroundings.

Pressure from Other Uses

The industrial and miscellaneous land uses are highly diverse in character and type. Some of the sites occupied by new factories—long and low buildings surrounded by extensive parking lots—include 200 or more acres; a power company owns nearly 400. Private golf courses, several in number, occupy about a quarter-section (160 acres) apiece. Cemeteries are about the same in size. Shopping centers in the urban sprawl-rural-retreat zone either are using or have reserved from 80 to 100 or more acres apiece. One Drive-In Movie Theater occupies 80 acres. Private schools, Boy Scout camps, outlying railroad yards, dumps, yards of construction companies, gravel pits, a polo club, archery club, curling club, and other organizations are users of land. Collectively some 7000 or more acres beyond the closely-built urban areas are occupied by industrial and miscellaneous land uses. Certain of these users come into competition with projected public use. The Lake Michigan shore property toward the south county line is scheduled for park-use by the Park Commission. Two or three miles are owned presently by manufacturing companies, but not entirely in industrial use; rather they are farmed by renters, and in crops and orchards. The eventual use of this land is thus subject, perhaps, to litigation or condemnation.

Interstate Highways remove land from farming or other uses. The projected continuance of an Interstate Highway from the southern line of Milwaukee County to the city has already at scheduled outlets, included nearly 80 acres of each outlet, and 120 at clover leaf interchanges.

Composite Land Uses

The total pressure upon farm land is owing to the composite of all non-rural uses of land. Although the hedgehopped subdivision receives the bulk of farmer criticism, and is most obvious in the landscape because of its multiplicity of generally similar houses, the competition for land from schools, parks, churches, industries, golf clubs, cemeteries, and a host of other users is severe. But the subdivisions contain the school children, the voters and the vocal element of the population, desiring services. Thus the subdivisions receive the publicity.

Collectively the nonfarm users of land in a township within the subdivision zone may occupy as much area as the remaining farm land—and in time will exceed it. The city (former township) of Franklin, the southwestern unit of Milwaukee County, contained in 1961 some six square miles—out of about 34—of park, school, church, and other public land, including in the last a 752-acre County Home of Correction and associated farm and a 150-acre shrub and tree nursery operated by the City of Milwaukee. In addition to this, the growing number of hedgehopped subdivisions consume acreage annually. When the Root River Parkway plan is completed, three or four more square miles of present farm land (depending on the size of purchases) will be removed. Franklin is the "most rural" portion of the county. In 1944 Franklin contained 327 farms, primarily of the dairy type; ten years later the number of farms was halved. By 1961 only a few more than a hundred *commercial* farms remained (out of 237 in Milwaukee County), and only 18 of these in Franklin still engaged in 1961 in milk production for the Milwaukee market.

The Rise and Fall of Farming in Milwaukee County

Milwaukee County is perhaps unique in the state in that it has long contained both a large urban population and has been very important in agriculture. Its small total size has precluded it from being a major farming county in the state except when measured on a *per unit area* basis. Nevertheless, despite size, the county as a unit has been among the top 100 agricultural counties of the nation in the past in the production of certain items, such as cabbage. The present urban sprawl is to top quality farming land, some of the most productive agriculturally in the state of Wisconsin. The use of this land for crops is well on its way to oblivion.

The southern part of Milwaukee County contained outliers of the extensive prairies farther south. Oak openings—giant oaks growing separately in grasslands— occupied other southern and southwestern areas. The central and northern portions of the county were in the dense hardwood forests. A strip of mixed northern forest, hemlocks and birches mingling with hardwoods, occupied the narrow red clay strip between the Milwaukee River and Lake Michigan. The soils developed on the glacial drift, and in this vegetation and climate setting, were heavy soils of high quality. The environment continued westward into eastern Waukesha County until the more stony glacial drift and the rougher surfaces of the Kettle Interlobate Moraine and the inland lake district was (or is now) reached.

Three broad, smooth-sloped morainal ridges extend north–south more or less parallel to the shore of Lake Michigan. These are separated by shallow north–south trending valleys or broad swales in the glacial drift. Surface-wise no portion of the county, save for wave cut cliffs facing Lake Michigan, was (or is) too steep for cultivation, nor for present land uses and urban housing. Drainage was and is a problem locally in the swales, and in some of the present subdivisions in rural territory certain of the heavier soils are not particularly receptive to drainage from septic tanks.

Agriculture expanded from an almost-subsistence stage at one time, through the wheat boom in Wisconsin during the 1850's to 1870's, to the dairy stage. Dairying was always of some importance, considering the local city market, and in the 1890's and early 1900's even contributed enough surplus milk to support cheese factories in the southern portion of the county.

The Rural Land Use of the Recent Past—Late 1920's

Milwaukee County contained just under 100,000 acres of farm land on more than 2,000 farms in the late 1920's. The acreage of corn and small grains combined was greater than the present total farm acreage included in commercial farms; in the late 1910's it was greater than all present acreage in farms, part-time, residential, and commercial combined. The county was an outstanding center of market gardening, a source of sugar beets for neaby sugar mills, a principal cabbage-producing area both for fresh cabbage and for canners of sauerkraut, contributed peas and tomatoes to canneries, and overall was outstanding in dairying and part of the important region of intensive dairying in southeastern Wisconsin. A leading celery-producing district, specializing in part in celery for the New York market, and located on muck lands where parts of West Milwaukee and West Allis exist at present, had succumbed to urbanization. Although the average size of farm was only 43 acres, this average obscured the extremes of small, intensively cultivated market gardens of about 20 acres each, and dairy farms averaging more than 80 acres in size. Hay, oats, and corn were the leading crops in order of acreage on the dairy farms. The cabbage, sugar beets, peas and tomatoes were cash crops on these same farms. Corn was grown for silage almost exclusively; only about a quarter of the acreage was matured for grain. All home-grown grain, principally oats, was used in the dairy feed, and for horse feed—7,000 horses still were maintained on farms of the county in 1928. Income from the sale of chickens and eggs was a sideline on most farms; swine were very few—grain was fed to cattle and there was no skim milk for pigs, as whole milk was sold to Milwaukee distributors.

Market gardens, nearly 300 in number, clustered near the margins of the city, and along the principal highways leading from it. The gardeners grew a complete array of vegetables in season. And other farms, general and dairy in type, contributed fresh vegetables in season as a sideline activity. Many of the market gardens were on drained muck land at the southern edge of the urbanized areas of the time. Others were prominent on the loamy outwash terraces of the Milwaukee River valley immediately north of the city. A network of radiating electric interurban lines, in operation until the mid-1930's, localized still others on soils of suitable warmth and friability near their stations. The largest numbers of gardeners were of second or third generation German ancestry, and persons of Polish birth. These last were generally immigrants from peasant areas in Poland (or, prior to World War I, of German Poland) who came to Milwaukee as factory workers, and whose prior training and inclination led them back into agriculture when finances or opportunity permitted.

More than 600 dairy farms surrounded the urban and gardening areas. In the late 1920's the northwestern township (Granville) and the two southern townships (Franklin, Oak Creek) were occupied almost entirely by dairy farms; the other townships contained suburban, market gardening, and dairy districts. Although some dairymen were of eastern American ancestry, the majority were third and fourth generation Americans of German extraction, descendents of the German immigrants of pre-Civil War days. Farms were highly developed. Barns were large, painted red, and well-kept. Nearly all were basement barns, the foundations of the older ones were of glacial boulders or blocks of the local Niagara Limestone; more recently-built ones had concrete walls around the excavated basement. Farm houses of wood, stone, or brick were substantial and in good repair. The dairy farms of the late 1920's maintained more than 10,000 cows and heifers, two years of age and over, kept as milkers, and some 14,000 dairy stock in total, counting young stock, calves, and bulls.

The urbanized areas of Milwaukee, of Wauwatosa, West Allis, Cudahy, South Milwaukee and other suburbs, were compact. In fact, there was farm land along the Lake Michigan shore in the southern part of the county, and farm land west of Wauwatosa to the west county line. Northward the high-class residential suburbs of Shorewood, Whitefish Bay, and Fox Point occupied narrow strips along the lake bank and farms lay west of them, mainly market gardens along the Milwaukee River terraces. The one remnant of the level of former Lake Michigan (its glacial-lake ancestor), a flat terrace just above the elevation of the current lake, and below the wave-cut bluff at Fox Point, had been under cultivation as recently as the early 1920's. The estate district in the upper Milwaukee River Valley (now River Hills) was passing from farm land to large county-estate properties. The town (township) of Milwaukee, the northeastern town, although generally impinged between the lake and the river still contained more than 100 farms.

Rural Land Use—Early 1960's

The percentage of the county in farms is now only ten by recent assessor's reports, in contrast to 50 in the early 1930's, and 21 in 1959 as reported by the Census. Milk cows numbered but 1,800 in 1959, fewer now. Only 215 horses remained. Of the 557 farms recorded by the Census of 1960, sixty per cent were "unclassified," principally residential or part-time landholdings. The theoretical (and formerly actual) zones have disappeared or been fractured; only 35 market gardens exist, and except for two small clusters, their pattern is one of dispersal rather than close to the city. Dairy farms number but about 50 only 26 of which shipped milk to the city in August 1961; 16 farmers in the southwestern part of the county shifted to the Chicago milkshed; the others sell class B or manufactural milk to condenseries in the reverse direction from the city market. The acreage of the former cash crops has declined enormously—sugar beets from 1,000 to 12 acres, cabbage acreage from more than 1,000 to but 131. The 237 remaining commercial farms of 1961 are about equally divided in number between the two southern former townships (present cities) of Franklin and Oak Creek at the very southern part of the county. A few remain in the northwestern corner.

Farmers ceased dairying in numbers during the middle and late 1950's. In part this was owing to the urban sprawl and the elimination of farms by presures engendered by the hedgehopped subdivisions, and the resulting tax pressures. The former Town of Greenfield contained 185 farms in 1944, and only eight in 1955. In part, during the middle and late 1950's, the rapid decline in dairying was coupled with the shift of the Milwaukee milk distributors to the collection of milk entirely from bulk tanks installed on the farms of the milkshed. The combination of the costs of installation (even with financial help from the dairy companies), the incurrence of a debt for this capital equipment, and the mounting taxes on the remaining farm land in the county, caused the rapid decline in dairying and the shift to cash-crop agriculture, or the decision to sell to a subdivider. The numbers of Milwaukee County farms on the milkshed dropped rapidly, from 300, to 200, to 111 by 1956, 41 by 1958, and 26 by 1961. The county by 1962 contributed only one per cent of Milwaukee's milk supply, despite its propinquity to market.

Cash-grain farming has appeared and has increased relatively on the remaining farms and on land awaiting subdivision, or on land owned by speculators. It is a response of many farmers—old and young—to their situation with respect to an uncertain immediate future, and to the competition of the nearby city and suburban factories for the labor necessary for an animal enterprise, and to the variety of pressures upon their farm land. Also, the operator can devote part of his time to farming and part of off-farm work, something not too feasible in an intensive dairy economy. Today small grains (oats, wheat, barley, rye, flax for seed) and corn for grain are grown on over half (55 per cent) of the total cultivated acreage; the percentage of the corn acreage now harvested for grain has risen to 80. Ninety per cent of the wheat crop, more than half of the corn crop, and a third of the oats are sold. Half of the remaining farms in the county sell cash grain. And on some two dozen commercial farms the sales in 1959 were of a magnitude to have them classified by the 1960 Census as cash-grain farms. And soybeans have been introduced as a cash crop.

Nursery and greenhouse products from 119 enterprises gross more than three million dollars a year. In value this horticultural activity is now close to half of the total of all "farm" production remaining in Milwaukee County. The activity culminates the rapid shifts in urban counties—in response to the nearby market, the ability to use land intensively, to produce flowers and nursery stock of a value high enough to carry the taxes and other charges, and to persist under the economic situation of location near subdivisions, or at the very edge of urban development, or even within it.

The Future

What of the future of agriculture in Milwaukee County and nearby areas? No doubt most, if not all, of Milwaukee County will become urbanized or rather completely suburbanized in the not too distant future, judging from present trends and the rapid changes of the last fifteen or so years. Each Census reports a larger and larger percentage of the population of the United States resident in a Metropolitan Area, of which the Milwaukee region is one. How far this area will stretch cannot be forecast accurately. Certainly an increasing acreage of some of the finest land in the state will cease to be used for farming.

What of agriculture in the outer fringe area, as westward into Waukesha County or even in the southwestern sections of Milwaukee? Can they be saved for farming? The current usual answers to the problem of rural retreat near major cities (not as yet attempted in the Milwaukee region) are: (1) strictly enforced zoning for agricultural use only; (2) tax adjustments in urban counties to prevent farmers from being forced out of agriculture; and (3) rural incorporation. Loudoun County, Virginia, near the urban sprawl of Washington, and some other counties have passed zoning ordinances for the preservation of farming. Three dairy cities have been incorporated southeast of Los Angeles to keep people out, cows in.

Will these efforts elsewhere—or in Wisconsin—prove permanent? The residents of a subdivision in a township can outvote the farmers. Zoning can be changed by voters or their elected representatives. The present dairy cities in southern California may vote to unincorporate if land values reach astronomical figures. And the voters in urban counties as well as the voters in the subdivisions of the townships of fringe counties are urban in outlook and look with disfavor upon proposals for possible tax relief on farm land of the present, or farm land zoned only for agricultural use. Furthermore, they have been conditioned for most if not all of their adult years by talk and writings about farm surpluses, crop-control programs, soil banks, benefit payments, commodity-storage programs, increasing productivity, new fertilizers, increased yields of crops and animals, government give-away programs, and other items. Therefore it is natural that the milieu is one of apathy on the part of the majority of our inhabitants.

Perhaps in the future high quality farm land may be treated differently, just as forest land received protective and tax dispensations as it became a shortage item in the early years of the present century, and water shortages now engage public attention.

FREEDOM OF SPEECH IN WISCONSIN, 1870–1880

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Wisconsin, like any state, has its contradictions, but in general it has a reputation for being a leader in social progress and social legislation. This reputation has been built up over a number of years through the words and actions of its citizens and we are privileged to be the heirs of a fine tradition.

A look into the past is interesting both from a historical point of view and also because of what it reveals concerning our heritage. The decade, 1870–1880, was a transitional period. The passions engendered by the Civil War were beginning to abate. The isolation of the agrarian culture was still present, but improved means of transportation and communication were beginning to remove it. However, the mobility of the automobile and good highways had not yet begun to enlarge local communities into the more urban and closely related units typical of today.

Citizens of the state in 1870–1880 were particularly conscious of their rights and their opportunities. Many of them were new citizens who had emigrated from foreign countries where the right of "free speech" had been abridged. All of them were anxious to preserve the freedoms granted them under the democratic form of government and they were quick to voice their opinions.

"Free speech" gave them the right to criticize when social conditions were adverse; it gave them the right to criticize when things were going well. Some abused the privilege in speeches and writings, which judged by today's standards would be considered libelous or slanderous. However, it should be noted that "free speech" of the 1870's was not subject to the legalistic refinements of today.

In short, Wisconsin in those days afforded a favorable environment for "free speech", which in turn helped create the tradition of free speech which we enjoy today.

Let us examine, by considering some examples taken from newspapers published in those days, some of the characteristic problems of the day and evidences of how freedom of speech was interpreted.

Then as now, political occasions were numerous and constituted a prime source for the interchange of ideas and viewpoints. Newspapers of the day carried public notices of meetings and partisan editors took pains to invite members of the opposition parties to their functions. They were always careful, however, to credit the success of an occasion to the party of their choice. A meeting reported by the Democratic editor of the Lafayette County Democrat stated that:

> "The meeting was about three-fourths democratic, and consequently the best of order prevailed—no one interrupted the speakers and the contest was fair in every particular."[1]

An Oshkosh editor, with obviously a preference for the Republican point of view was a little more forthright in his analysis of a somewhat similar meeting for he reported it in this fashion:

> "Doolittle (ex-Sen. Doolittle—the Democratic candidate) squirmed and writhed under this torture like an eel on a hot skillet; but Washburne (Gen. C. C. Washburne) was relentless, and answered every charge brought against the republican party, out of the very mouth of his adversary."[2]

Both the citizens and the speakers of the day must have had considerable stamina for the occasions were numerous, the speeches long and numerous, and the newspaper reports of the speeches were almost equally long and numerous.

For example, in the 1871 gubernatorial campaign between Gen. Washburne and Sen. Doolittle a series of nine debates patterned after the Lincoln-Douglas debates was held in major cities of Wisconsin, and occurred within a one month period. In every one of these meetings the candidates spoke for one and one half hours each, plus a discussion period. The La Crosse Leader not only summarized the occasion but carried the complete text of more than 12,000 words of General Washburne's speech and a lengthy summary of Doolittle's remarks.[3]

However, the persuasion was felt to be most effective in oral form rather than printed, for as one editor put it:

> "persons in need of sound political gospel, will listen to a good speech and be impressed and moved by the truths it contains, but they will not bother themselves by reading the same speech in print."[4]

But freedom of speech carried with it some of the same hazards it does today in the form of opposition which is lacking in restraint. For example, a political orator spoke one night at Reedsburg where the Democrats caused considerable annoyance to him by "building a bonfire near his place of speaking, firing anvils and beating pans so loudly . . . as to almost drown the speaker's voice."[5]

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1 Lafayette County Democrat, August 27, 1871 (Darlington).
2 Oshkosh Journal, August 7, 1871.
3 LaCrosse Leader, October 14, 1871.
4 Fond du Lac Commonwealth, October 18, 1879.
5 Baraboo Republic, October 18, 1876.

On another occasion in Watertown at a meeting called "for the purpose of taking measure against the present rule of mismanagement and corruption in our city" the meeting "was broken up by a band of Union Leaguers who took this method of showing their appreciation of free speech and the rights of American citizens to quietly assemble and express their sentiments." After attempting to oust the chairman who had already been chosen by the sympathizers "the meeting soon resolved itself into a sort of pandemonium through the League influence, until finally the lights were put out and the crowd dispersed."[6]

In our newspapers today, we normally expect editorial comment concerning the days events to be confined to the editorial sections. Columns devote dto news reports are supposed to be objective, and factual in nature. This was not so with newspapers of the 1870–1880 era and is well illustrated by the following accounts of a political campaign speech delivered in Watertown by Gen. E. S. Bragg. One Watertown newspaper reported that:

> "The political meeting . . . was numerously attended by our citizens, to hear the brave and eloquent General express his sentiments . . . he . . . aroused a good deal of interest, giving his hearers a simple, dignified, and truthful presentation of facts in matters of reform that were beyond question and utterly unanswerable."[7]

Another Watertown newspaper had this to say of the same occasion:

> "The Reform meeting addressed by Gen. E. S. Bragg . . . was a very slim and dull affair, considering the preparations that had been made for it . . . The orator was introduced . . . to an audience of just 250 persons all told, a large proportion of whom were republicans . . . His remarks were rambling and desultory, and he seemed to lose sight of his subject all the way through."[8]

Once elected to a state legislative position, the politician could expect his constituents to be just as interested in what he said in the state legislature as they were in what he said while running for office. State affairs commanded just as much attention as did national affairs and many local newspapers—not just those from the larger cities—maintained a correspondent in Madison during the legislative sessions. He would issue a general report on each week's legislative activities with particular emphasis on the local representative. Knowing they would be called to account for their stewardship, state and local legislative body representatives made it a policy to report to their constituents at public meetings at which the electorate gathered.

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[6] Watertown Republican, March 17, 1874.
[7] Watertown Democrat, October 28, 1875.
[8] Watertown Republican, October 27, 1875.

For example, a "large audience (which) assembled at the Court House" in Chippewa Falls in March, 1876, did so in order to "hear Judge Wiltse" render an account of how he had discharged his obligations. They listened for more than an hour to his "able and forcible" remarks. Approval of his conduct was then voiced through a unanimous vote of thanks.[9]

When the issue was of sufficient importance to warrant direct action Wisconsin citizens of the 1870's did not rely upon lobbyists to exert persuasive pressures, but sent delegations from the local areas to ensure desirable action by their representative. When the proposed Graham liquor licensing bill was before the legislature in 1872,

> "the lobbies and galleries of the Assembly Chamber were crowded at an early hour and soon the floor of the house underwent a systematic packing and presented a very pleasing spectacle of 'fair men and brave women' who came to give courage and sympathy to the great popular reform measure . . . It was a time well calculated to inspire the best efforts of the friends of reform."[10]

Public meetings were widely attended by Wisconsinites and provided both social and educational fare for the people. In addition to that, the tendency toward free and open discussion of topics shaped the course of Wisconsin's growth in some rather obvious ways. Wisconsin's reputation, as a dairy state, is due in part at least, to the widespread discussions held by farm groups concerning agricultural developments. As an indication of this, consider the following frank opinions expressed at a meeting of the Freedom Farmer's club to discuss going "into the so called breeds of cattle".

> "Mr. H. W. Armstrong thought not, believed that by giving his native cows the same care and feed . . . they would yield as much milk and butter and make as fine animals as pure bloods . . . Wm. Sowders thought that native stock was good enough for anybody; thought if people would stay at home and take care of their farms and cattle instead of running around to farmers clubs and fairs they would be better off. Pat. Monahan believed in introducing blooded stock. E. Nye kept two cows, natives; thought the blooded stock too tender for common farmers to keep . . . thought that his wife had as much to do with the quantity and quality of the butter as the cows did . . . F. P. Wolf wanted to improve his cows . . . and meant to improve his stock, wanted better cows than he got . . . T. R. Alvord believed that all this talk was a humbug . . . he was too old to be fooled by such nonsense."[11]

Apparently the remarks of the gentleman who felt farmers' club meetings to be a waste of time were not heeded, even by himself, for according to the records he was present also at the next

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[9] Chippewa Times, March 22, 1876.

[10] La Crosse Republican and Leader, March 2, 1872.

[11] Appleton Crescent, February 3, 1872.

meeting of the club when farm accounts and farm labor were equally frankly discussed.

Ordinarily topics for discussion at this type of meeting were decided upon in advance as when the Greenville Farmers' Club announced its question for the forthcoming meeting to be "Will clover hay give a horse the heaves?"[12] Another common practice however, was to put discussion questions in a basket and draw forth a topic which might be a serious one such as the value of "cooperative labor" or a topic of a less serious nature such as "how does Miss Ella White make her plants look so thrifty?"[13]

As it does today, public opinion changed with almost frightening rapidity during that period 90 years ago, and what was popular one day might before long be condemned—sometimes with good reason as in the case of the railroad expansion and exploitation.

The public road system, being as it was in those days, an alternate series of quagmires or choking dust clouds, it was not unusual that the railroads with their promise of rapid, reliable, all weather communication were eagerly sought. Meetings to discuss railroads were common and well attended. Upon being organized they were addressed by prominent local officials and citizens; resolutions were then proposed and discussed and committees appointed to mature the plans.

When finally the petitioning, memorializing, imploring and pleading were over and the railroad actually arrived, it touched off elaborate celebrations which were as colorful as they possibly could be made. In Green Bay, 10,000 people were on hand to greet the arrival of the first train and hear the speeches upon the occasion.[14] The 3,000 excursionists who arrived in Wausau to inspect the town upon the completion of its railroad connection, were met by 5,000 Wausau natives, the Mayor and the Common Council, the Fire Department, a colorbearer, two bands and the salutes of all the bells, steam whistles and cannon in the city. The procession was then escorted to the Music Hall and Forest Hall where they heard addresses and a banquet was prepared for nearly 4,000 people.[15]

However, with the coming of the financial depression of 1873 the people's joy with their newly acquired railroads sometimes turned to deepest gloom. Scarcely a month after their big railroad jubilee, the Wausau paper noted that the Wisconsin Central Railroad "exhibits as great capacity for ugliness as it does for bond getting and land grabbing."[16]

[12] Appleton Crescent, November 30, 1872.

[13] Oshkosh Journal, December 3, 1870.

[14] Green Bay Advocate, June 26, 1873.

[15] Wisconsin River Pilot (Wausau), November 14, 1873.

[16] Wisconsin River Pilot (Wausau), December 19, 1873.

The protest meetings following this experience and similar experiences, in which citizens expressed their dissatisfaction culminatd in the passage of the regulatory "Potter Law" which formed the basis for corporate law in Wisconsin. This law, "the elucidation of which . . . occupied nearly four hours" on the part of Chief Justice J. P. Ryan was "pronounced one of the most masterly and scholarly efforts ever produced in our courts."[17]

Another public meeting which left little doubt as to the effectiveness of the free expression of opinion which took place, occurred in Aztalan where the owner of land which had been used for many years as a picnic site decided to fence it off from the public. He dug post holes for this purpose and the citizens filled them up. Then they tried without apparent success to reason with him. Finally they sent word through town about the condition of affairs and requested a meeting that evening. According to succeeding reports:

> "About 120 of the citizens assembled full of indignity for their townsman, and after some not over conciliatory speeches, and an organization . . . they arranged themselves along the fence and lifted it out. The next day Mr. A. rebuilt it and the next afternoon the citizens removed it piling it (very?) carefully on Mr. A's premises and the third day likewise."[18]

Freedom of speech in Wisconsin in the 1870's meant not only wide latitude in what a person could speak or write; it also meant a great amount of speaking and writing on the part of a great number of citizens. One facet of life which provided some distinctive occasions for speaking were the religious meetings.

Camp meetings, revivals, "bush meetings" as well as the regularly organized religious services were common, and were reported in great detail.

Probably the most distinctive were the "camp meetings" which were held out of doors, usually during the summer months and most often in shady groves where good water was available and tents could be pitched. From early morning bell to the final benediction in the evening the campers heard the word of God dispensed in English, Danish, Norwegian, German and several other languages. In between sermons they visited or spent their time strolling through the grove in which the meeting was held.

Revivals were commonly held too throughout the state and had the same purpose as camp meetings, but generally the approach was different. In addition to seeking converts of those who attended the meetings, the revivalists sought also to secure the active participation of the stay-at-homes.

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[17] Superior Times, September 18, 1874.

[18] Watertown Republican, May 26, 1875.

Religion was attractive to the female speakers of the day. One of the most successful revivalists in the state was Mrs. Van Cott, a lady of very large proportions, whose "pleasant, animated features, sparkling blue eyes and a head that would show well in plaster" led one reporter to proclaim her an even greater speaker than the famous Senator Matt. Carpenter. Her prowess was so great that as "she prayed to God to loose the purse strings of the members (of the congregation) so that the outstanding debt of the church might be paid", the debt of $1,500 was twenty per cent oversubscribed.[19]

Congregation members as well as their clerical leaders took part in discussion of social issues as well as religious matters. It may seem strange to us that topics such as attendance at circuses and games such as croquet came under close scrutiny as possible as sources of evil, but discussions of these topics were of serious concern.[20] Questions of individual conduct were also discussed freely as for instance when the Mutual Council of Plymouth Church met to consider the "sufficiency and validity of Mrs. Moulton's reasons for abstaining so long from the services and sacraments of the church."[21]

Of all the causes responsible for discussion perhaps none was as vehemently supported or on the other hand condemned as vigorously as temperance. Nearly all citizens had firmly held beliefs regarding temperance and they were not hesitant to express them.

Temperance meetings were usually sponsored by organizations. Some were organized along denominational lines; others according to nationality groups. Most were general in their membership. Ladies took an active part in the temperance occasions and it was at this time that a Wisconsin woman, Frances Willard, began work in the Women's Christian Temperance Union, and became nationally known from her temperance speaking.

Temperance gatherings called for the same elaborate preparations, parades, welcoming processions, and cannon salutes, as did political and ceremonial occasions.

Not all groups proposed the same solution. The Janesville Ladies Temperance Union proposed to establish a free library and reading room to keep young men out of saloons.[22] Hon. S. D. Hastings proposed a constitutional amendment outlawing liquor,[23] and many favored going into the saloons to hold prayer meetings and afterward, to take direct action. Apparently few speeches which espoused the cause of liquor were delivered, or at least found their way into print.

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[19] La Crosse Republican and Leader, April 6, 1872.
[20] Oshkosh Journal, November 5, 1870.
[21] Chippewa Times, January 5, 1876.
[22] Janesville Gazette, March 7, 1874.
[23] Western Advance (Portage), September 23, 1874.

These then, are but a few of the many evidences of freedom of speech in Wisconsin in 1870–1880. There was little mention of freedom of speech as such, but there was indeed much of it.

Perhaps citizens then, as now, had become so used to being allowed to think and speak as they wished, that they took this freedom as a matter of course. Fortunately for us, they did set a good precedent, even though at times they seemed to go so far as to abuse the privilege.

But we should be grateful to them for their interest and for their willingness to express themselves on matters which have as much relevance and as much importance in 1962 as they did in 1872.

"ALL THE RUNNING WE CAN DO!"—CONTINUING EDUCATION FOR ALUMNI*

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"The man who stands still today is actually slipping backward" chides the abstract covered booklet offered to more than ten thousand University of Wisconsin alumni in the Milwaukee area. "Learning for Living" is the theme of the continuing education program provided late afternoons and evenings for adults. More than one hundred courses each semester are listed to entice the adult to continue to use his brain power.

Most alumni recognize the validity of the admonition of the Dean of Extension at the University of California, Dr. Paul Sheats, who warns, "Learn or Perish" (*Time,* February 2, 1962). The University of Wisconsin–Milwaukee and the Extension Division remind the adult, "Every day brings new advances in scientific and social theories, and each of us to keep pace must do quite a bit of educational running." One of our major objectives in the adult program is to help alumni learn of the new developments in their respective fields. Slowly there is the recognition of the essentiality for educating adults to insure the security, productivity, and adaptability of the individual to a society continually changing. For example, a recent class entitled, "The Utilization of Radio Isotopes in Medical Radiology," was taught by a group of distinguished scientists; and it drew physicians, radiologists, and medical technicians, all trying to keep up with advances in the field. Professor Richard John, Coordinator of Commerce Extension programs, developed a course, "Accounting for Managers"; of the 21 enrolled, 20 were college graduates, but 17 had never before attended an evening adult class.

Wisconsinites are fortunate for the vision of President Charles R. Van Hise, Louis E. Reber, William H. Lighty, and Frederick Jackson Turner, all of whom had a realization that adult education is an imperative for modern man. As early as 1904 Van Hise proclaimed, "I shall not rest content until the beneficent influences of the great University of Wisconsin are made available to the people of the state." The University Extension Division was the outgrowth of his organizational genius, which resulted from the prodding of

* Paper read at the 92nd annual meeting of the Wisconsin Academy of Sciences, Arts, and Letters.

Dr. Charles McCarthy, that great friend of libraries and adult education. The once "Cow College," as recently described so picturesquely by President Elvehjem has become one af the world leaders in continuing education. The University can be justly proud of the search, and *public service*—the diffusion of knowledge to the people third leg of the milking stool of higher education—teaching, reof the state.

Study of Alumni Education

There has been far too little study of alumni education. In a small volume "New Directions for Alumni: Continuing Education for the College Graduate" Ernest E. McMahon, Dean of University College of Rutgers describes the history of alumni education and many of the programs now being carried on by institutions of higher learning. His concern is with the extent to which American colleges and universities provide educational resources to aid the alumnus to continue his personal, political, philosophical, and social growth.[1]

As early as 1917 President Alexander Meiklejohn of Amherst College made a plea for a closer relationship between the college and its graduates. Meiklejohn stated that the real test of a graduate's loyalty is that of membership in a college community. "If the college has given itself up to the pursuit of knowledge and appreciation, jhilosophic, literary, scientific, humanistic, no man who has ceased from that pursuit is in any genuine sense a member of the college community. I sometimes think that the *only real test* of our teaching is that of the extent to which pupils continue to study our subjects after they leave us . . . I am dreaming of the college community as a body of thousands of men—teachers, graduates, undergraduates—all of whom are engaged in the same intellectual operation, in the same great enterprise of the mind."[2]

In 1956 a survey was made among seven hundred members of the American Alumni Council by Robert J. Ahrens. Only 267 institutions replied. Seventy-two institutions reported current or past programs of continuing education among alumni, and 195 replied that they did not have nor had they ever had such a program. Sixteen reported the programs as unsuccessful, while forty-four rated their efforts as successful. Ahrens found that the highest percentage of continuing education programs was carried on by private women's colleges.[3]

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[1] Ernest E. McMahon, *New Directions for Alumni,* Published by the Center for the Study of Liberal Education for Adults, 1960, 52 pp.

[2] *Rutgers College, The Celebration of the One Hundred and Fiftieth Anniversary of Its Founding as Queen's College* (New Brunswick: Rutgers College, 1917) pp. 118–21. Quoted by McMahon. p. 6.

[3] Robert J. Ahrens, "Working Papers", for the Shoreham Conference on Continuing Alumni Education. (Washington: American Alumni Council).

UNIVERSITY OF WISCONSIN LEADER IN ALUMNI EDUCATION

Alumni education is not new to the University of Wisconsin. Although President Ernest Martin Hopkins of Dartmouth is generally credited with the first call for alumni education in 1916, the records of the *Wisconsin Alumnus* show that William H. Lighty, organizer of the Correspondence Study Department of the University of Wisconsin Extension Division, was urging alumni to continue their education as far back as December, 1907. Lighty wrote enthusiastically of the "NEW UNIVERSITY EXTENSION" which he had helped organize with the help of Frank A. Hutchins and Dr. Charles McCarthy. Lighty reminded alumni that at that time there had been organized one hundred and seventy-five courses offered by correspondence instruction, taught by fifty-eight professors of the University representing twenty-five departments. As early as 1907 non-degree programs were offered alumni. Lighty wrote: "Some special post-graduate work is also offered not for university credit purposes, but as a practical means of keeping abreast of the times in a most effective way through contact with the scholar and specialist." A special course was then being organized for physicians on "Immunity and Infection" . . . "Thus," he says, "the practitioner may be effectively in touch with the newer and established results of research that apply to medical practice."[4] So far as I can find, Lighty was the first in the United States to promote alumni education, and his urging of continuing education was perpetual; his motto until his dying day at 93 was, "Keep abreast of the times."

Today, however, at the University of Wisconsin new programs are being developed especially for alumni. A program organized recently is the Summer Alumni Seminar now to be offered both on the Madison and Milwaukee campuses. Under the able leadership of Dr. Robert Schacht, a specialist on residential adult education, a program of liberal adult education has gained national recognition for the University of Wisconsin. This summer the themes for the six one-week seminars in Madison are "Scientists at Work at Wisconsin," "The Future of Cities and Metropolitan Areas," "The Nature of Marxism," "The Exploration of the Universe," "Africa: A Continent in Transition" and "Political Power in America".

In Milwaukee, a new residential seminar will be held at spacious Marietta House on the Kenwood Campus near Lake Michigan. Leading scholars will discuss their concern over the immersion of the individual in a stream of conformity under the title, "The Role of the Individual in Today's Mass Society." A week will be spent in the residential seminar, not too different from the format of the Danish Folk School, where persons gather for consideration of problems

[4] *Wisconsin Alumnus*, December, 1907, p. 101.

confronting their contemporary society. Living in, there will be lectures and discussion in history, economics, and sociology, dealing with the conditions which produced the kind of society with which alumni come face to face today. Through selected readings and group participation, alumni will examine certain basic concepts of individualism, such as self-reliance and self-assertion, and try to determine whether the loss of these values is an inevitable consequence of our societal and economic systems. Guest lecturers include Dr. Earl S. Johnson, Visiting Professor of Secondary Education, The University of Wisconsin–Milwaukee; Dr. Warren L. Susman, Assistant Professor of History, Rutgers University and Dr. Herbert F. Klingman, Director of the Division of Commerce and Professor of Commerce UW–M. Visitations will be made to interesting places in Milwaukee during the evening hours.

OPPORTUNITIES UNLIMITED FOR CONTINUING EDUCATION

Unlike yesteryears, alumni today have numerous rich programs from which to choose. Study-travel, institutes, conferences, evening classes and correspondence study, all are available through Extension Centers and a statewide service of University Extension. Radio and television add numerous opportunities for continuous learning. The Milwaukee program, like the other adult programs throughout the state, is designed to aid citizens in their pursuit of intellectual interests and in the acquiring of skills necessary for personal achievement and progress. Through the "Learning for Living" program, new theories in the physical sciences, new methods in the arts, and new thought in the social sciences are brought to the greater Metropolitan Milwaukee community. Through University Extension the total resources of the University are made available to the citizens of the state.

It is never too late to learn! Longfellow reminds us:

> "Ah! Nothing is too late
> Till the tired heart shall cease to palpitate.
> Cato learned Greek at eighty; Sophocles
> Wrote his grand Oedipus, and Simonides
> Bore off the prize of verse from his compeers,
> When each had numbered more than fourscore years."

And today, fellow holders of sheepskins, we must admit, it takes all the running we can do to stay in the same place!

THE CROSS-MEDIA APPROACH TO TEACHING AND ITS EFFECT ON THE ACQUISITION AND RETENTION OF SCIENCE AND SOCIAL STUDIES VOCABULARY LEARNINGS AT SELECTED GRADE LEVELS[1]

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Previous investigations in the field of audio-visual education have been largely concerned with the gaining and retention of factual information and of gains in vocabulary directly employed by the media used. The studies described in this paper constitute an attempt to investigate the interactions which appear when, *not one but many,* carefully chosen, wisely used audio-visual materials are selected and used in combination. This interrelated use of audio-visual materials is known as the cross-media approach.

DEFINITION OF THE PROBLEM

The two studies described in this paper were designed to identify the effects of the use of several selected audio-visual materials in a cross-media approach on vocabulary learnings in science and social studies. The classes used in the science vocabulary experiment were selected from grades 5, 6, and 7 while the classes used in the social studies vocabulary experiment were selected from grades 6, 7, and 8. All of the students were from the Shorewood Public Schools and the Whitefish Bay Public Schools.

These studies specifically attempt to find possible answers to the questions: (1) Do children learn more of the vocabulary of science and social studies units when motion picture films and projected still pictures are added to the use of other audio-visual materials? And (2) Do children retain more of the vocabulary of science and social studies units when motion picture films and projected still pictures are added to the use of other audio-visual materials?

The participating classes were rotated so that each served in turn as an experimental and a control group. Blackboards, bulletin

[1] This paper presents the findings of two separate, but closely related studies in the cross-media approach to the teaching-learning situation. The reader will note the similarity of conclusions for both studies.

boards, charts, models, flat pictures, and field trips were used both in the control and experimental situations, but motion pictures and projected still pictures (filmstrips, 2 x 2 and 3¼ x 4 slides, and pictures used with the opaque projector) were used only in the experimental situations and served as the experimental factors. Vocabulary test results, supplemented by the reactions of teachers, and students, provided the means of judging the contributions of the experimental factors.

SIGNIFICANCE OF THE PROBLEM

Vocabulary development has been a source of greatly increased concern recently and much attention has been centered upon the importance of vocabulary usage as a basic skill or learning tool. A high value has been set upon a student's vocabulary as a means of improving his effectiveness in speech and writing as well as in reading. This emphasis on a larger and more useful vocabulary for the student has been in marked contrast to previous practice of severly curtailing the size of the vocabulary to be acquired at each grade level in the theory that such severe restriction would facilitate more effective learning. Witty[2] points out the following:

> As a result of word counts and recommendations by educators, some publishers assumed that vocabularies in reading textbooks should be rigidly controlled and limited. During this period 1925 to 1940, the makers of these textbooks not only tended to restrict vocabulary narrowly, but also to repeat words again and again in order that "basic" vocabularies might be thoroughly mastered . . . Moreover, the repetition of words was so great that monotony resulted and children lost interest in the stories.

Recent investigations have discredited the extreme practice of severe limitations of vocabulary estimates for each grade level. Seashore[3] and others have presented studies which lead one to conclude that most vocabulary estimates have been too low. Stone[4] also voiced his concern as follows:

> In methods and materials in reading, we have tried to go to extremes, of which the presently unjustifiable restriction of vocabulary is an example. We have the problem of providing for adequate vocabulary expansion along with the problem of providing sufficiently easy material at each level.

The provision for maximum pupil growth calls for the use of all effective means for its accomplishment. It is an objective of these studies to determine the effectiveness of selected audio-visual aids in the facilitation of the accomplishment of this task.

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[2] Paul Witty, *Reading in Modern Education* (Boston: D. C. Heath Co., 1949).

[3] Robert H. Seashore, "How Many Words Do Children Know?" *The Packet*, Vol. II, No. 2 (Boston: D. C. Heath Co., November, 1947).

[4] Clarence R. Stone, "A Vocabulary Based on 107 Primary-Grade Books," *The Elementary School Journal*, XLII, 1942.

It is felt that an increase in as basic a skill as vocabulary comprehension is worthy of every consideration for the beneficial effect this increase may have in generally improving learning. A purpose of these studies is to provide information which may be of value in helping to satisfy the need for the improvement of this skill.

It is also hoped that these studies will stimulate thinking in terms of the effectiveness of teaching and will increase an awareness on the part of the teacher of the value of the growing numbers of mechanical aids available for use in improving the effectiveness of teaching-learning situations.

Another important point is that these studies do not attempt to determine the effectiveness of a single audio-visual material over other visual materials such as slides, demonstrations, maps, and the like, or the more traditional classroom procedures using verbal instruction by means of textbooks or supplementary reading. Instead, these studies attempt to determine the effectiveness of an audio-visual utilization in which *several* audio-visual materials are employed over an audio-visual utilization in which a limited number of audo-visual material are used. Dale[5] states that experimentors often neglect to establish normal schoolroom procedures in their investigation which may result in lessening the value of their data. The procedures in these studies seem to follow a realistic classroom situation. Many schools use some audio-visual materials, but according to various surveys many schools do not have an audio-visual program which includes the use of several audio-visual materials in the cross-media approach. If the findings of these studies should point out that better learning is achieved when certain audio-visual materials are employed throughout a unit of study, it might suggest that these materials be included as an integral part of the instructional program.

Limitations of the Studies

These studies attempt to determine the effects of the use of selected audio-visual materials including carefully selected and appropriately used 16 mm. motion picture films, 35 mm. filmstrips, and other projected pictures on vocabulary growth in the science and social studies in specific situations. There were certain inherent limitations in the studies as they were planned. The first limitation concerns the size of the population. The studies were carried on in two villages having a total population of thirty-eight thousand. The total elementary school population in the public schools of these communities is approximately four thousand six hundred students, of whom two thousand four hundred were enrolled in grades five,

[5] Edgar Dale, Fannie W. Dunn, Charles F. Hoban Jr., and Etta Schneider, *Motion Pictures in Education,* The H. W. Wilson Company, New York, New York, 1938.

six, seven, and eight. Of these students fewer than three hundred eighty have participated in the studies. The size of the number of subjects was limited.

A second limitation concerns the nature of the communities involved in the studies. Both Whitefish Bay and Shorewood are residential suburbs of the City of Milwaukee. Both communities are desirable places in which to live with the socio-economic status of the residents a high one. These communities are composed of a large percentage of professional and business people possessing homes with many advantages for their children, often including a wealth of books, magazines, newspapers, and other reading materials. In addition, many of the parents of the children in the communities have backgrounds of college training. All of these are important environmental factors which would tend to affect the achievement of the children in school and their performance in these studies. In short, the population tested was not a cross section of over-all population but rather a limited segment of it.

Another limiting factor was the availability of suitable materials used in the experimental situation, namely 16 mm motion picture films and 35 mm filmstrips. For the purposes of these studies, a careful survey was made of all these materials which were available and which were pertinent to the studies and selection was made of those which were most suitable for the units involved and appropriate to the grade levels being tested. This survey pointed out the need for more materials of this type for use in our schools today.

An additional limiting factor was the nature of the instruments used to evaluate pupil growth in terms of vocabulary. A multiple choice objective test was carefully constructed for use with each unit of study, but the very nature of the instrument made inevitable inherent limitations. The judgements of the teachers in subjectively gauging progress in vocabulary growth were of value in supplementing the information gained from use of the objective tests.

These points are brought out to emphasize that the results of these studies need to be interpreted in the light of the nature of the studies and that the results of the studies are applicable to this situation.

DESIGN OF THE STUDIES[6]

Rotation Technique. The rotation-group technique of experimentation was used in order to minimize the effect of several uncontrollable factors such as initiative, industry, or study habits. The rotation method ". . . involves an exchange for the groups at intervals, in terms of the procedures followed."[7] This technique was used

[6] A description of the Science Vocabulary Experiment procedures is included in this paper. The procedures used in the Social Studies Vocabulary Experiment were similar.

[7] Carter V. Good and Douglas E. Scates, *Methods of Research,* Appleton-Centruy-Crofts, Inc., New York, New York, 1954.

with both the classes and the teachers. During each unit of study for each grade level, one class was designated as the "control" group while the other class was designated as the "experimental" group. The "control" group was the group which used only the following audio-visual materials: bulletin boards, blackboards, charts, models, flat pictures, and field trips. The "experimental" group not only used the materials listed for the control group, but also used sixteen millimeter motion picture films and projected still pictures.

Selection of Groups Participating. Equal numbers of children in the fifth and sixth grades from the Lake Bluff School of Shorewood, Wisconsin, and from the seventh grade from Cumberland School of Whitefish Bay, Wisconsin were included. These groups were equated within feasible limits on the basis of I.Q. scores and standardized reading vocabulary test scores.

The Selection of the Vocabulary Words and the Construction of Tests. Prior to the experiment, the investigator reviewed all of the science textbooks from the third grade level through the ninth grade level to assemble the vocabulary essential to the understanding of the core ideas to be developed within a unit of study. In addition to looking through the available textbooks, the investigator reviewed each article in the *World Book Encyclopedia*[8] that pertained to a particular unit of study. A review by the investigator of all the available textbooks in each of the participating schools from the third grade level through the ninth grade level, was designed to provide a range of science words from the third through the ninth grade level.

These lists of words were then carefully reviewed by a committee made up of teachers participating in this study. Also, teachers who were especially interested in the teaching of science and had had several years of experience in this field, were asked to check this list of words carefully. After the vocabulary lists were approved by this committee, test items were developed which included all of the words in the list. In each unit approximately 250 words were recorded. This made possible the construction of a 50-item vocabulary test. Wherever possible a word meaning nearly the same as the key word was obtained from the list of 250 words. For example, part of the vocabulary from the sixth grade unit of study, *Sound,* includes the following:

reception	loudness	decrease
range	spread	velocity
transmit	mute	speed
amplitude	intensity	amplify
supersonic	audio	

[8] *The World Book Encyclopedia,* Field Enterprises, Inc., 1952.

From the above list, the committee of teachers selected and designated the word "velocity" as a key word. The test item then included five different words, one being the correct answer. Whenever possible a word which had the same, or nearly the same meaning was obtained from the list of 250 words. This word was considered the correct response.

The tests used as instruments of measure in this study were of the multiple-choice objective type.

Validity and Reliability of the Test Items. A high degree of curricular validity could be assumed since the vocabulary was closely correlated with the curricular content of each unit of study.

Reliability was estimated by administering the vocabulary tests to groups not participating in this study. The split-half method was used. This necessitated obtaining separate scores on odd and even-numbered items. A coefficient of correlation was obtained between these two scores by the product-moment method. By means of the Spearman-Brown formula, an estimate of the reliability of a test as long as the two halves combined was obtained.

Administration of the Vocabulary Tests. Prior to teaching the units of study, tests for each grade level were given to the control and experimental groups. These tests were administered two hours apart so as to reduce practice effect. The scores are designated as the "pre-test scores". At the termination of each unit of study which took five weeks, "final tests" were given. Six months after the "final tests", the participants were given the same test. These scores are designated as "retention test scores".

The Selection of the Units of Study. A committee of teachers selected two units of study for each grade level based on the following criteria: (1) availability of audio-visual materials related to the various units of study, and (2) extent of previous experiences in the particular unit of study. Specific problems to be covered in each unit of study were defined by the teachers so as to insure some degree of uniformity in both experimental and control groups.

The Selection of Audio-Visual Materials for the Experimental Group. The criteria determined by the participating teachers included: (1) Does the audio-visual material contribute to the objectives of the unit of study? (2) Does the audio-visual material suit the experiences, intellectual maturity, and grade level of the students? (3) Is the audio-visual material accurate and authentic? (4) Is the audio-visual material significant? Any audio-visual materials previewed that did not meet the above criteria were not used in this study.

The procedure for showing audio-visual materials was carefully planned by the group. Such procedures were demonstrated in an in-service meeting.

Procedure in the Selection of Pupil and Teacher Responses. Subjective evidence was gathered on the reactions of pupils and teachers to the utilization of audio-visual materials in the classroom. Specifically, teachers were asked to respond in writing to the following question; "What reactions do you have concerning teaching a unit of study in which a limited number of audio-visual materials are used as contrasted with a situation in which several audio-visual materials are used." The reports were then submitted at the termination of a ten-week experimental period.

The boys and girls were asked to react to the following question: "What reactions do you have concerning the first unit of study in science and the second unit of study?" Responses to this question were recorded immediately by the participating teachers, or, when possible, a stenographer was employed.

PRESENTATION OF FINDINGS AND INTERPRETATION

Science Vocabulary Test Results. The findings for the fifth, sixth, and seventh grade groups using the rotation-group technique are summarized in Table 1.

Table 1 points out that the fifth grade classes in the unit on *Electricity* had a mean score of 7.24 words on the pre-test for the experimental group, and a mean score of 11.45 for the control group. In the final test scores given five weeks after the pre-test, the experimental group scored a mean of 23.62 words while the control group scored a mean of 21.93 words. In this particular unit the experimental group had a mean gain of 16.38 while the control group had a mean gain of 10.48. The experimental group in the unit on *Electricity* had a mean gain of 5.90 words over the control group.

TABLE 1. SUMMARY OF MEAN SCORES ACHIEVED IN PRE-TESTS, FINAL TESTS AND GAINS FOR BOTH EXPERIMENTAL AND CONTROL GROUPS IN ALL UNITS OF STUDY

Grade	Unit of Study	Pre-Test Mean Scores		Final Test Mean Scores		Mean Gains*	
		Control Group	Experimental Group	Control Group	Experimental Group	Control Group	Experimental Group
5	Electricity..	11.45	7.24	21.93	23.62	10.48	16.38
5	Rocks......	17.40	15.06	21.10	29.38	3.76	14.31
6	Astronomy .	14.00	15.68	21.72	34.84	7.72	19.16
6	Sound......	15.00	13.88	21.52	30.72	6.45	16.84
7	Air........	19.80	22.68	24.16	35.68	4.36	13.00
7	Soil........	21.68	22.64	25.48	34.20	3.84	11.56

*Final Test Score Minus Pre-Test Score.

In the remaining units of study the experimental groups had the following mean gains over the control group:

Astronomy: Mean gain of 11.44 words
Sound: Mean gain of 10.39 words
Air: Mean gain of 8.64 words
Soil: Mean gain of 7.72 words
Rocks: Mean gain of 10.55 words

Table 2 summarizes the percentage of gain achieved by the experimental group over the control group in the amount of vocabulary acquired by the boys and girls in these groups.

All experimental groups using the motion picture films and projected still pictures had a range of mean scores from 6.90 to 11.44 words gained over the control groups. This indicated a large increase in words gained over the control groups. Thus it may be concluded that the children of this particular population acquired to a greater extent the vocabulary in a unit of study when motion picture films and projected still pictures were introduced.

Six months following the completion of the unit of study the boys and girls were given vocabulary tests on the particular unit so as to determine the amount of vocabulary retained over this period of time. Table 3 summarizes the results achieved in the re-test vocabulary tests.

A close examination of the retention test and final test scores shows that retention test scores of the experimental group were lower in the *Rock* and *Astronomy* units of study. Retention test scores were higher in the control groups for all units of study.

TABLE 2. PERCENTAGE OF GAIN ACHIEVED BY CONTROL GROUP COMPARED TO THE EXPERIMENTAL GROUP IN ALL UNITS OF STUDY IN GRADES FIVE, SIX, AND SEVEN

Grade Level	Unit of Study	Actual Mean Gain		Percentage of Gain Achieved by Control Group Compared to Experimental Group
		Control I	Experimental II	
5	Electricity	10.48	16.38	63.9%
5	Rocks	3.76	14.31	26.2%
6	Astronomy	7.72	19.16	40.3%
6	Sound	6.45	16.84	38.3%
7	Air	4.36	13.00	33.5%
7	Soil	3.84	11.56	33.0%

TABLE 3. SUMMARY OF MEAN RETENTION SCORES AND MEAN GAINS FOR BOTH EXPERIMENTAL AND CONTROL GROUPS IN ALL UNITS OF STUDY

GRADE	UNIT OF STUDY	RETENTION SCORES—MEANS	
		Control Group	Experimental Group
5	Electricity	25.41	27.82
5	Rocks	22.62	27.97
6	Astronomy	26.52	33.08
6	Sound	25.08	31.68
7	Air	31.64	38.84
7	Soil	31.80	39.16

The following may indicate reasons for this increase in scores: (1) the science program did not terminate following the experimental period. All classes continued with the science instructional program, and throughout the instructional program classes utilized many audio-visual materials including films and projected still pictures. An examination of the units of study and the audio-visual materials used following the experimental period show that some of the vocabulary words included in the vocabulary tests were used. This may account for the gains in the retention test vocabulary scores for both the control and the experimental groups. (2) During the period between the pre-test and the final test both science and social studies were taught as part of the daily instructional program. An attempt was made not to include social studies units which were closely allied or related to the science units of study. This procedure eliminated to a certain extent the duplication of terms or vocabulary which might have been included in the vocabulary tests. Following the final tests the social studies and science programs might have been correlated, but in any case both classes received the same or similar activities.

An analysis was done so as to check on the possibilities that the experimental group gains could be accounted for by the presence of key words in the media to which the control group may not have had access. Table 4 summarizes the vocabulary included in the audio-visual materials used in the experimental group for the unit on *Astronomy*. Many duplications of words were found, but only 138 different words were included in the audio-visual materials as compared to 250 words in the vocabulary tests. This is 55 percent of the total number of words included in the *Astronomy* vocabulary tests. Of the 138 words only 14 were key words or only 28 percent of the 50 key words included in the test.

TABLE 4. TABULATION OF VOCABULARY INCLUDED IN THE AUDIO-VISUAL MATERIALS USED IN THE EXPERIMENTAL GROUP FOR THE SIXTH GRADE UNIT ON ASTRONOMY

Audio-Visual Material	Title	Number of Words Identical to Words Used in Vocabulary Test	Percentage of Words in Audio-Visual Material as Compared to Words in Vocabulary Test
Filmstrip	*The Sun's Family* (Jam Handy)	29	12%
Filmstrip	*The Changing Moon* (Jam Handy)	20	8%
Filmstrip	*How We Learn About the Sky* (Jam Handy)	16	6%
Filmstrip	*Earth in Motion* (Jam Handy)	16	6%
Filmstrip	*Interesting Things About the Planets* (Jam Handy)	26	11%
Film	*Moon* (Encyclopaedia Britannica Films)	29	12%
Film	*Solar Family* (Encyclopaedia Britannica Films)	32	13%
Film	*Trip to the Sky* (Gutlohn)	27	11%
Filmstrip	*Story of Constellation* (Jam Handy)	15	6%

Is There a Relationship Between the I.Q. and the Child's Gains in the Vocabulary Tests in the Experimental Group?

The Pearson-Product-Moment Test for correlation was found between the child's I.Q. score and the gains he achieved in the vocabulary tests. The vocabulary test gains were derived by subtracting the pre-test score from the final test score. In each of the units of study, the correlations obtained are shown in Table 5.

In the units of study on *Astronomy, Rocks,* and *Air,* there is no relationship while in the remaining units of study, *Electricity, Sound,* and *Soil,* there is a slight relationship between I.Q. scores and gains achieved in the vocabulary tests. In conclusion, no definite relationship exists as to I.Q. scores and gains achieved in the vocabulary tests in any of the units of study. The foregoing conclusion also means that the bright, average and slow child profited somewhat the same in this study, or stated another way, the gains achieved in the vocabulary tests do not necessarily depend upon the intellectual level of the individual.

Is There a Relationship Between the Standardized Reading Vocabulary Scores and the Gains Achieved in the Vocabulary Tests by the Experimental Groups?

Table 6 shows that in only two units of study, *Rocks* and *Air*, there is a definite correlation which exists between standardized reading vocabulary scores and the vocabulary test scores in this study. In the remaining four units of study there is only a slight relationship.

TABLE 5. CORRELATIONS BETWEEN I.Q. SCORES AND GAINS ACHIEVED IN THE VOCABULARY TESTS BY THE EXPERIMENTAL GROUPS IN THE SCIENCE UNITS, GRADES 5, 6, AND 7

GRADE	UNIT OF STUDY	CORRELATION
5	Electricity	+.38
5	Rocks	—.01
6	Astronomy	—.15
6	Sound	+.21
7	Soil	+.33
7	Air	+.06

TABLE 6. PEARSON PRODUCT-MOMENT TEST FOR CORRELATION BETWEEN READING VOCABULARY SCORES ON STANDARDIZED TESTS, AND GAINS ACHIEVED IN THE VOCABULARY TESTS FOR ALL UNITS OF STUDY

GRADE	UNITS OF STUDY	CORRELATIONS
5	Electricity	+.18
5	Rocks	+.54
6	Astronomy	—.21
6	Sound	+.09
7	Soil	+.18
7	Air	+.69

Pupil and Teacher Reactions to Audio-Visual Materials. The reactions of pupils and teachers represent the subjective evaluation of the use of various audio-visual materials in the classroom. All of the teachers in the study point out the intrinsic value of the use of audio-visual materials in making for a more effective teaching-learning situation. The reports from both teachers and pupils in a situation in which a limited number of audio-visual materials were employed is a negative one. A more enthusiastic learning situation seemed to develop in the classroom situation in which several audio-visual materials were used in a cross-media approach.

Summary of the Findings for Science Vocabulary Experiment

1. In each unit of study, the experimental classes using the experimental factors showed larger unit learning gains than the control groups in the vocabulary acquired. The unit learning gains by experimental groups were doubled as compared to those achieved by the control groups, in all units of study except the fifth grade *Electricity* unit.

2. Retention test scores of the experimental group in the *Rock* and *Astronomy* units were lower than the final test scores while in all the other units of study for the experimental group and for all the units of the control groups, the retention test scores were higher than the final test scores. There was a slight loss in retention for the experimental group in only two of the units of study.

3. No definite relationship exists between I.Q. scores and unit learning gains achieved in the science vocabulary tests in any of the units of study in the fifth, sixth, and seventh grades.

4. There was a definite relationship between standardized reading vocabulary scores and unit learning gains achieved in the science vocabulary tests in one-third of the units. A slight relationship exists in the remaining units of study.

5. Vocabulary unit learning gains achieved by the experimental group were acquired from the vocabulary of the total instructional program rather than solely from the vocabulary of the 16 mm motion picture films and projected still pictures used in this study.

Summary of Findings in the Social Studies Vocabulary Experiment

1. Unit learning gains in the experimental groups using the experimental audio-visual materials were greater than the unit learning gains made by control groups which did not use these materials.

2. Residual learning gains [retention scores over pre-test scores], made by the experimental groups were greater than the residual learning gains made by the control groups.

3. Gains made by the experimental group were not made because of the test vocabulary contained in the films and filmstrips. Gains made by the experimental group were acquired from the total instructional program including the use of films and filmstrips.

4. A definite relationship between standardized reading vocabulary test scores and vocabulary unit learning gains made in this study was found to exist in two units. In the remaining four units there was a slight relationship or none between these factors.

5. As determined by instruments used in this study, there is no relationship between I.Q. scores and vocabulary unit learning gains made by students in five of the six units. In one unit, there was a definite relationship between these factors.

IMPLICATIONS

The implications of the findings of these studies are presented in relation to the role of projected audio-visual materials used in the cross-media approach in science and social studies learnings.

Vocabulary gains achieved by experimental groups which used motion pictures, filmstrips, and other projected pictures in combination with other audio-visual materials in a cross-media approach exceeded those of groups which limited themselves to audio-visual media other than the above named items. An increase in as basic a skill as vocabulary comprehension is worthy of every consideration for the beneficial effect this may have in generally improving learning. This is further emphasized by the fact that the control groups in these studies were not in situations which were barren of of audio-visual materials but were free to make use of any of these except the experimental items. In view of the marked superiority of the gains in vocabulary growth achieved by the experimental groups over those of the control groups, it appears that serious consideration needs to be given by teachers to the carefully planned effective use of films, filmstrips, and other projected pictures in combination with other audio-visual materials for the benefits that may result in vocabulary growth and subsequently in general learning.

One of the major objectives in science and social studies is the development of important understandings or concepts. These concepts are expressed through word symbols, that is, vocabulary. The ability to interpret word symbols may play an essential part in aiding comprehension and understanding of these concepts. These studies may have important implications for the enrichment of the child's basic science and social studies concepts.

There is a need for closer cooperation between the producers of audio-visual materials and the educator so that the needs of our instructional programs are better met in terms of films and filmstrips.

The acquisition of vocabulary, one of the important skills in reading, is a prerequisite to adequate comprehension and interpretation in reading. The utilization of audio-visual materials enhances the acquisition and tention of vocabulary, and these should therefore be included in the instructional program.

A further implication has to do with the training of prospective teachers. Every effort should be made to have these students enroll in audio-visual courses. Too often, beginning teachers limit their instructional program to the use of one or two audio-visual materials rather than a combination of these materials. Learning the simple operation of these tools of instruction is important, but of greater consequence is the knowledge of how to use these materials fully and effectively in the teaching-learning situation.

ALLIS-CHALMERS: TECHNOLOGY AND THE FARM 1925–1940

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Under the direction of General Otto H. Falk, Allis-Chalmers entered the farm equipment field to further diversify the company's products and to make the company name known beyond the area of heavy machinery. This venture was to change the technology of the American farm, particularly during the decade of the 1930's. Broadly speaking, technology is the way people do things. This being the case, patterns of agricultural life and production had changed but little over the centuries until very recent times. It is true that steam power had come to many farms in the last quarter of the nineteenth century, but steam merely supplemented the traditional horsepower—it did not replace it. From 1914 to 1920 about 20,000,000 horses and 5,000,000 mules were used on American farms.[1] However, the horse had been brought to its highest efficiency while the tractor was being markedly improved with each passing year.

The first Allis-Chalmers tractor went into production late in 1914. By modern standards it was a most cumbersome piece of equipment. An unwieldy tricycle type with one speed forward and one reverse, it weighed 4,000 pounds and sold for $1,950. Largely an experimental tractor, it never achieved a wide sale to the American farmer.[2] During World War I and the early 1920's, tractor manufacturers constantly improved their products as engineers simplified design, reduced the weight, and provided greater ease in operation. As farmers became increasingly aware of the advantages of the tractor, the number of horses began to decrease. By 1928 the number of horses had fallen to 15,000,000; one quarter less than eight years before.[3]

One of the most important events in the history of the Tractor Division of the Allis-Chalmers Manufacturing Company was the appointment of Harry G. Merritt as manager on January 1, 1926.[4] His job, as he saw it, was to produce a quality tractor at a price

[1] Preston W. Slosson, *The Great Crusade and After, 1914–1928,* (New York, 1931), p. 194.
[2] *A–C Views,* July 24, 1952, p. 5; *Pioneer Power,* (Milwaukee, 1942), p. 81.
[3] Preston W. Slosson, *The Great Crusade and After,* p. 194.
[4] *President's Circular Letter,* No. 173, December 29, 1925; W. F. Strehlow to author, June 13, 1961; Malcolm C. Maloney to author, June 19, 1961.

that the depression-ridden farmers of the 20's were willing to pay. As he and Allis-Chalmers engineers set about redesigning the standard 20–35 tractor, non-essential apparatus was stripped from the old model and essential parts were replaced by lighter ones. Concentrating on the tractor's general appearance, they gave it what Merritt called tractor "sex appeal." The finished product was a trim, snappy looking tractor that was more efficient, half a ton lighter, and priced at $700 less than its predecessors.[5]

Under Merritt's direction, change and improvement were constant in the Tractor Division. Engineers were sometimes reluctant to suggest ideas for improvement as Merritt would invariably ask them to proceed immediately. This policy produced greater sales and, consequently, more money for research and development.[6] The willingness of Allis-Chalmers to take a smaller profit had a good deal to do with its success in producing a cheaper tractor and its rapid emergence as the third largest manufacturer of farm equipment.[7]

Administrative change was equally rapid. The appointment of W. A. Roberts as General Sales Manager made it possible for Merritt to concentrate on his primary interest, that of tractor engineering.[8] Allis-Chalmers purchased the well-known La Crosse Plow Company so that it could join the ranks of the "full line" companies and compete on more even terms with other major producers.[9] When it was found that its distribution system was inadequate, Allis-Chalmers purchased the Advance-Rumley Corporation of La Porte, Indiana, which had 24 branch houses and about 2,500 dealers, along with Advance-Rumley's well-known harvesters and threshing equipment.[10] Through expansion Allis-Chalmers put itself in a position to engage in imaginative engineering which would revolutionize American agriculture.

Allis-Chalmers, in common with all other tractor producers, faced the cold fact that the tractor had not been universally adopted for farm use and was not in a position to really replace the horse on

[5] "Allis–Chalmers; 'America's Krupp' ", *Fortune,* May, 1939, p. 150; W. J. Klein to author, April 10, 1962.

[6] A. W. Van Hercke, W. F. Strehlow, and John Ernst to author, June 13, 1961.

[7] *Fortune,* May 1939, p. 150. Accordingto this article, a report of the Federal Trade Commission indicated that in the period of the 1930's, the average Allis–Chalmers profit on new farm machines and implements in some years was less than 4 per cent, compared to an average of 6.7 per cent for International Harvester, and a whopping 18.1 per cent for Deere and Company.

[8] *Power Review,* September, 1941, pp. 27 f. W. A. Roberts succeeded Harry Merritt as Manager of the Tractor Division in 1941, and in 1951 became president of the company.

[9] *Sales Bulletin,* September, 1929, p. 815; *The La Crosse Tribune,* October 7, 1929; A. W. Van Hercke and W. F. Strehlow to author, June 13, 1961; *The Ace Reporter,* "Silver Anniversary, Allis–Chalmers La Crosse Works, 1929–1954," *passim.*

[10] *Sales Bulletin,* April to July, 1931, p .1049; *Chicago Journal of Commerce,* May 13, 1931; *A–C Line,* "Allis–Chalmers La Porte Works, Silver Anniversary." December, 1956, *passim.*

the farm as the automobile and the truck had replaced him on the highway. This was due to the limitations and inefficiency of the type of wheel equipment used. The lugs on the steel wheels damaged meadows, orchards, and barnyards; and signs stating "Tractors with Lugs Prohibited" were appearing on most well-surfaced roads.[11]

The sheer inefficiency of the lug-type wheel is indicated in the old tractor ratings of 10–18 and 20–35. The first figure represented the useful power delivered at the drawbar and the latter the rated power of the motor. Tests proved that the tractive efficiency, the ratio between the power delivered at the drawbar and the power produced by the motor under field conditions, varied from a low of 40 per cent to a high of about 65 per cent. Very simply, it took power to push the lugs in and power to pull them out. The end result was that even on level ground the tractor was compelled to constantly climb a rather steep grade. As the speed of the tractor was increased, more of the total horsepower was required merely to move the tractor. At higher speeds it tended to approach the total output of the engine, leaving little power for useful work. The consequence of this was that conventional tractor work had to be done slowly, inefficiently and with a high rate of fuel consumption.[12]

Engineers had flirted with the idea of putting rubber tires on tractors. Experiments were conducted with both hard rubber tires and high pressure pneumatic tires, similar to those used on trucks. But when attempts were made to plow with this equipment it was found that the tractor could perform only under the most favorable ground conditions, and it was absolutely useless on wet ground. However, the tractor engineering staff finally arrived at the solution to the problem. They conceived of the idea of a low pressure tire with a flexible casing that would allow the tread to spread out and distribute the load, thus giving the needed traction.[13] The development of the "air-tire" was a significant break-through for the entire industry. As the *Farm Implement News* put it on October 13, 1932, "Just about the time this industry seems to have dropped into a rut and reached a static point with no outstanding developments in sight, something arises to change its course. Rubber may be the pivot of the next turn."[14]

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[11] *Sales Bulletin,* October–November–December, 1931, p. 67; J. W. Shields, *Pneumatic Tires for Agricultural Tractors,* undated mss. Shields was a field engineer for the Firestone Tire and Rubber Company.

[12] J. Brownlee Davidson, "Riding on Rubber," *Successful Farming,* January, 1935, pp. 8, 34; J. W. Shields, *Pneumatic Tires for Agricultural Tractors;* R. A. Crosby to author, June 15, 1961.

[13] *WE,* July, 1947, p. 4; R. A. Crosby to author, June 15, 1961; According to *Fortune,* May, 1939, p .150, Deere and Company offered solid rubber tires for tractors in 1926 and high pressure pneumatic tires beginning in 1928. However, it is generally accepted that Allis–Chalmers introduced the first low pressure, or air-tire.

[14] *Farm Implement News,* October 13, 1932, p. 24.

A program of testing was set up; Allis-Chalmers tractors equipped with air-tires were put on selected farms so that the tests could be conducted under a wide variety of work and conditions. The reports were uniformly enthusiastic. Rubber actually seemed tougher than steel; the tractors rode more comfortably and the air-tires were easier on the tools used. They provided greater fuel economy, presented greater tractive surface, and most important, permitted greater speed of travel in the fields. The farm tractor equipped with air-tires was no longer limited to a narrow field of operation but had become a general utility machine to be used wherever power was required.[15] Harry G. Merritt in 1933 summarized the agricultural advance made possible by the air-tire in these words:

> We regard this new development as marking the dawn of a new era in American agriculture and the most important advancement in Tractor engineering in years. It eases a bit more of the farmer's yoke, making his work easier, shortening his hours and reducing his costs of production.[16]

While one group of Allis-Chalmers engineers was developing the air-tire and thus solving one problem—how to make the tractor an all-purpose machine, another group of engineers was tackling another knotty problem—how to design and produce a practical combine of small size for use particularly on the small Mid-Western farm. A combine is basically a threshing machine with a harvesting attachment which heads, threshes, and cleans the grain as it moves over the field. Crude combines had been devised as early as the mid-ninteenth century and with later refinements they came to be used effectively on the great wheat farms of the Far West and Northwest. These huge machines were drawn by 40 to 50 horses and cut a swath 30 to 40 feet wide. As the conventional combine crept eastward to the Kansas wheat fields its size was reduced to 20 to 30 feet. But it was successful primarily with wheat which could simply be headed and the heads rammed through a small throat into the threshing cylinder. It proved totally unable to harvest such crops as sweet clover, alfalfa and bush beans which inevitably clogged the small threshing cylinder. Eventually, the size was cut to 10 to 12 feet for the Mississippi Valley. Although these 10 and 12 foot combines were a vast improvement over the binder-thresher method of putting up grain, they still cost $1,250 to $1,500 and required a three-plow tractor and the services of two or three men to operate them.

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[15] *Farm Implement News,* June 23, 1932, quoted in *A Decade of Allis–Chalmers Pioneering,* undated mss., pp. 22 f: Also see William A. McGarry, "The Farm Tractor Takes Wings," *The Magazine of Wall Street,* December 7, 1935, p. 198. The original Model "U" tractor equipped with the original Firestone airplane tires used in the first experiments is now on permanent exhibit at the Museum of the State Historical Society of Wisconsin.

[16] Unmarked tractor mss., p. 2.

Allis-Chalmers set out to develop a totally new harvester that could, as one man put it, harvest everything from bird seed to beans. Other specifications were that it had to be light enough to be pulled by a two-plow tractor and operate from its power take-off, and it must sell at a price low enough that a farmer could afford to buy it. To provide a basis for development of such a machine the company in 1930 purchased the rights to a small five-foot combine manufactured in California. While they found it cumbersome and inefficient, it was a basis for experimentation and development. When Advance-Rumley was purchased in 1930, their long experience in threshers was utilized in the continued designing and testing of the proposed combine.[17]

The basic idea that was to make this machine different from and better than its predecessors was having a threshing cylinder the same width as the cutter bar. This permitted the grain to be fed into the cylinder in a thin stream rather than trying to ram a large quantity of grain into the narrow cylinder throat. Behind the threshing cylinder there was a wide rack which allowed the stream of straw to move toward the back of the machine making it easier to shake the grain out of the straw. It was no longer necessary to hammer the straw to pieces. The farmer who was feeding livestock could now save the entire yield of straw as well as the grain. This new concept of threshing also kept the weeds and green stuff out of the grain thus revolutionizing the harvesting of crops on the smaller farms of the United States.[18]

The first demonstration of the "Corn Belt Combine," as this machine was originally named, was described in the *Indiana Farmer's Guide:*

> A new development in high-speed grain harvesting was demonstrated a few weeks ago on a farm in La Porte County, Indiana, when a baby combine, travelling 5 miles an hour cut and threshed wheat and oats at one operation with such ease and speed as to amaze the more than 200 spectators gathered from all parts of the country. This new type machine, the product of the factory of the Allis-Chalmers Company, marks a distinctive milestone in the advancement of American agriculture, quite as much as did the advent of the reaper, more than a hundred years ago.[19]

When the "Corn Belt Combine" was put to the test in 1935, it was found that it exceeded all expectations. By 1936 it had successfully harvested 84 different small seed and bean crops, including even rice and sunflower seed. Eventually it was to harvest over 100 different crops, and the name was logically changed to the All-Crop

[17] *A Decade of Allis–Chalmers Pioneering,* pp. 41 f; R. A. Crosby to author, June 15, 1961. Mr. Crosby came to Allis–halmers from Advance–Rumley where he worked from 1912 to 1931. *Sales Bulletin,* November–December, 1930, p. 114.

[18] *A Decade of Allis–Chalmers Pioneering,* pp. 42 f; R. A. Crosby to author.

[19] *Allis–Chalmers Milestones in Farm Mechanization,* (Milwaukee, 1953), p. 17, quoting *The Indians Farmer's Guide,* Huntington, Indiana.

Harvester. In 1935, 550 machines were sold. Adverse harvesting conditions throughout the country stimulated sales because it was found that the All-Crop could harvest grain when no other conventional combine could. In 1936 the sales of All-Crop Harvesters jumped ten times, to 5,500. In 1937 the number was 10,500 and in 1938, 16,500 more replaced the binders and threshing machines. In fact, the All-Crop Harvester came to be known as the "successor to the binder," for as Allis-Chalmers production increased to meet demand, total binder production in the United States declined from 66,000 in 1936 to 15,000 in 1939.[20]

But the real merit of the new machine and its revolutionary nature received outstanding recognition when the Allis-Chalmers All-Crop Harvester was awarded the Royal Silver Medal at the Royal British Agricultural Exposition held at Bristol, England. It was held that this machine represented the most notable advancement of the year in agricultural machinery. This was the first time in twelve years that this coveted award had been won by an American manufacturer.[21]

The All-Crop Harvester made the small Mid-Western farmer competitive with the large Western grain grower. By combining his grain the large farmer could put his grain in the bin for about 9¢ a bushel. By comparison, the small farmer found that the cost of binding, shocking and threshing cost him at least 20¢ a bushel. By combining the operations with an All-Crop Harvester he found that he could put his grain in the bin for 10¢ less a bushel than before and could pay for his machine with his new profits in less than two years.[22]

Allis-Chalmers research in a third area met a long-standing need. As early as 1871, Horace Greeley envisioned a small, inexpensive form of power on the farm in these words:

> What our farmers need is not a steam plow as a specialty, but a locomotive that can travel with facility, not only on common wagon roads, but across even freshly plowed fields, without embarrassment, and prove as docile to its manager's touch as an average span of horses.
>
> Such a locomotive should not cost more than five hundred dollars, nor weigh more than a ton.

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[20] *A Decade of Allis–Chalmers Pioneering,* pp. 47 ff; *Sales Bulletin,* October, 1935, p. 33, and July, 1936, p. 64; *Allis–Chalmers Milestones in Farm Mechanization,* p. 18.

[21] *Sales Bulletin,* October, 1936, p. 9.

[22] *A Decade of Allis–Chalmers Pioneering,* p. 47; R. A. Crosby to author. By 1936 the Tractor Division was the largest single division of the company, selling more than 300 different products from four large plants. The West Allis Works manufactured wheel-type tractors, and the engines for the tractors and equipment built in other plants. The La Porte, Indiana, factory built the All-Crop Harvester together with an impressive line of threshers, big combines, clover and alfalfa hullers. The La Crosse Works at La Crosse, Wisconsin, manufactured the extensive line of Allis–Chalmers farm implements, including cultivators, plows, bedders, harrows, mowers, and other power machinery tools.

> It should be so contrived that it can be hitched in a minute to a plow, a harrow, a wagon or cart, a saw or grist mill, a mower or reaper, a thresher or a stalk cutter, a stump or rock puller, and made useful in pumping or draining operations, digging a cellar or laying up a wall, also in ditching and trenching.
>
> We may have to wait several years yet for a servant so dextrous and docile, yet I feel confident that our children will enjoy and appreciate its handiwork.[23]

Allis-Chalmers provided the fulfillment of this dream.[24]

Merritt studied the farm census figures and discovered that of the 6,800,000 American farms, some 4,000,000 were under 100 acres. But most of the 1,200,000 tractors in the country were working farms of more than 100 acres. In order to bring tractors into use on smaller farms, the Model "B" tractor was designed and placed in production in 1938. It was revolutionary in regard to price, weight and adaptability. This 2,100 pound tractor cost only $495. It weighed and cost only one-third as much as tractors of ten years before, but it would do 20 per cent more work with 25 per cent less fuel. It could pull a sixteen-inch moldboard plow at 3 to 4 miles per hour. To haul a load of hay a farmer could hitch a trailer and roll it along (on rubber tires) at about 7 miles per hour. To saw logs, he could attach a belt to the pulley wheel which would be geared to the tractor transmission. The belt could operate a circular saw. Also ,shaft-driven machinery such as a mower could be powered by a take-off on the rear axle. Designated as the "successor to the horse," the Model "B" was all that Horace Greeley had called for, and much more.[25]

For the first time in agricultural history it was possible to operate a completely mechanized farm of 100 acres for an investment of only $10 an acre. The Model "B" cost $495. The next most expensive investment might be the 40-inch All-Crop Harvester with power take-off which cost $345. With these machines the small farmer could thresh all his small grains, beans, and seeds without outside help. For plowing, a farmer could buy an Allis-Chalmers no. 116 Moldboard Plow for $85; it plowed the soil deeper and

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[23] Quoted in *Rubber Invades the Farm,* undated tractor mss., pp. 5 f.

[24] In 1915 Allis–Chalmers engineers developed the radically different 6–12 tractor as a direct substitute for the horse. This unique tractor had two steel driving wheels in front, pivoted by a turning mechanism at the center. The driving wheels were obviously the direct substitute for the horse and the operator sat at the end of a long pole on lighter wheels at the rear. By removing the sulky, the tractor could be attached to any two-row, horse drawn implement, thus saving the farmer a great deal of expense. Although the 6–12 was an ingenious machine it never captured the imagination of the conservative American farmer who was just becoming accustomed to the conventional tractor.

[25] *Annual Review,* 1937, p. 64; Arthur Van Vlissingen, "50,000,000 New Dollars a Year," *Forbes,* June 1, 1938, pp. 34 f; *A Decade of Allis–Chalmers Pioneering* p. 30, also, p. 50 f; *Allis–Chalmers Milestones in Farm Mechanization,* p. 10; *Fortune,* May, 1939, p. 150. The *Fortune* article points out that by 1938 the protests of the Horse and Mule Association had been reduced to the rather obvious fact that tractors were inferior to animals because they produced no manure.

pulverised it better at twice the speed of horses. Finally, he could buy a one-row cultivator for $50.25, which was adaptable to all row crops.[26] If, as some have maintained, the small farmer has traditionally been the backbone of American society, Allis-Chalmers did much in the 1930's to maintain his independence by making him economically competitive.

Allis-Chalmers' engineering and innovation had a profound effect on the agricultural equipment industry as a whole. From a position of relative insignificance as a producer of tractors and agricultural equipment, the company shot rapidly upward to third place in this field during the middle and late 30's. It is estimated that during that decade, Allis-Chalmers had no more than one-twelfth of the salesmen in the field, but by 1937 it was selling 13 percent of the products of the industry as a whole. This percentage increased during the two succeeding years so that by 1939 the company was selling more than one-fifth of the national product.[27]

The Tractor Division had gained a significant, in fact, a predominant position within the company. It had also, through the revolutionary nature and excellence of its products, produced a revitalization of the industry as a whole. But perhaps more importantly it had contributed in a significant fashion to American agriculture and the economy of the nation as a whole. Calvin Coolidge once remarked philosophically, "Farmers have never made money, I don't believe we can do much about it."[28] Allis-Chalmers' tractors and implements in the decade of the 30's helped the farmer in general and the small farmer in particular perform his work more effectively, more efficiently, and more profitably than ever before. In the early days of the American Republic, something like 85 per cent of the nation's workers were actually needed to produce food for themselves and the other 15 per cent of the population. By 1940, 15 per cent of the population could feed themselves and all other Americans as well as export enormous amounts of food stuffs to our allies during World War II.[29] Allis-Chalmers had played a leading role in the agricultural revolution of the 1930's.

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[26] *Allis-Chalmers Milestones in Farm Mechanization,* p. 11.

[27] A. W. Van Hercke to author, June 19, 1961.

[28] Quoted in Arthur M. Schlesinger, Jr., *The Crisis of the Old Order,* (New York, 1957), p. 67.

[29] Stewart H. Holbrook, *Machines of Plenty,* (New York, 1955), p. 224; Bert S. Gitting, *Land of Plenty,* (Chicago, 1959), p. 50.

ARTS AND LETTERS

A HISTORY OF THE WISCONSIN ACADEMY OF SCIENCES, ARTS AND LETTERS

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The organization meeting of the Academy was held in the State Agricultural Rooms in Madison on February 16, 1870.[1] A call for a meeting to form an Academy was issued in December, 1869, under the signature of 105 prominent citizens of the state. About two years previously there was an attempt made to organize "The Wisconsin Academy of Science." Apparently there were too few scientists to support an organization of this nature so the base was broadened to a "comprehensive State Academy of Sciences, Arts, and Letters."

A constitution was adopted at 7:30 P.M. on February 16, and the first formal meeting was held at 9:00 P.M. The by-laws were adopted the following morning. John W. Hoyt,[2] who came to Madison in 1857, was elected President. Prior to his arrival in Madison he taught chemistry at several institutions in Ohio. When the burden of organizing the Academy was on his shoulders, he was Secretary of the State Agricultural Society. On February 12, 1911, he wrote of this task to Arthur Beatty: "I can never forget the difficulty I had in making a beginning—how nearly everybody I approached, while admitting that such an institution, in itself, would be immeasurably useful, thought it yet too early in the history of a new Western State." Thirty-six letters approving the organization of an Academy were printed in the first Bulletin.

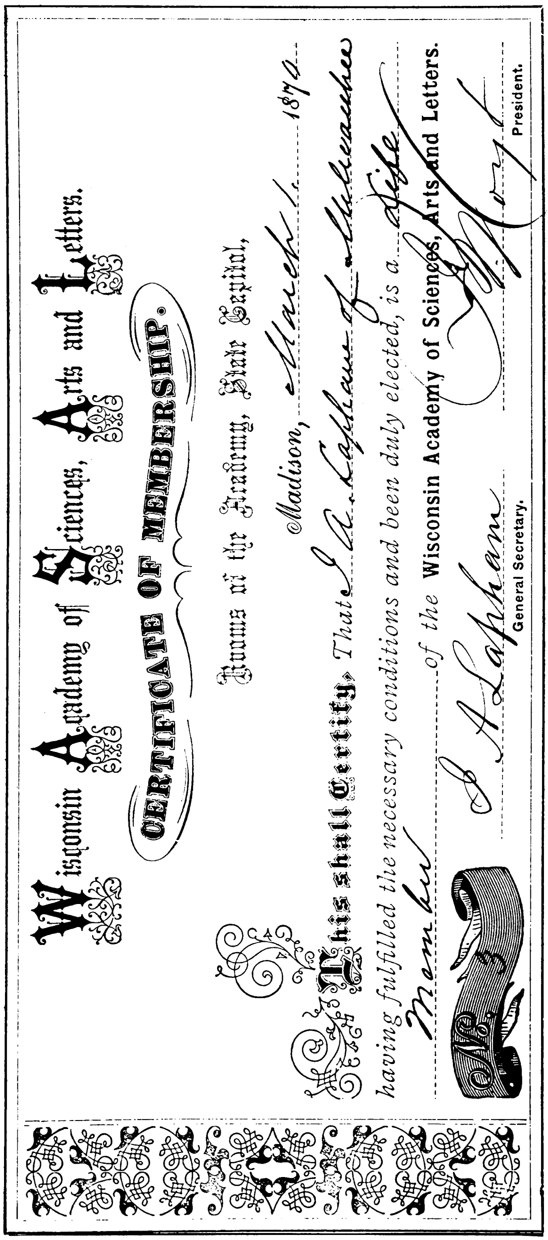
At the preliminary meeting from one-fourth to one-third of the audience consisted of women "as listeners." Hoyt added: "The reason, I suppose, for this absolute silence on their part was that, in Wisconsin, the antagonism to woman suffrage as a political and social measure was at its height. Women sometimes have extraordinary common sense, expressed in extraordinary ways, and this was one such occasion." In spite of this encomium, women were barred from membership. There was even reluctance to admit Catholics.

Ardent support for the formation of the Academy came from Dr. P. R. Hoy of Racine and Increase A. Lapham of Milwaukee. Hoy was the foremost ornithologist, mammalogist, entomologist, and icthyologist in the state. Lapham, who was elected General Secretary, was active in botany, geology, archeology, zoology, and meteorology. His efforts in inducing the United States Weather Bureau to install a system of storm warnings for the Great Lakes resulted in impressive savings of life and property.[3] J. G. Knapp was elected to the important position of Librarian while William Dudley became Director of the Museum. It was ruled that no books were to be taken from the Library or specimens from the Museum without the authority of the General Council. This was not an age of impatience.

The Department of the Sciences only was organized at the first meeting, those of Arts and Letters in 1871. A Department of the Social and Political Sciences came into existence in 1872 and there was a proposal for one on Speculative Philosophy. Each department had its own officers. Lyman C. Draper, "the accomplished and indefatigable" Corresponding Secretary of the State Historical Society, signed the special call for the organization meeting and in 1872 became one of the Counselors of the Department of Letters. Strangely, his name is not to be found in the list of members until 1878.

The charter was approved by the Legislature on March 16, 1870. It provided that the Academy be furnished space in the Capitol for an office, library, and collections, the latter comprising the Museum of Natural History and the Useful Arts. The President reported in 1874 that a large, adequate museum was highly desirable but progress was slow as additions to the collections depended upon the spare time of the officers.[4] On December 29, 1891, a resolution was passed to deposit the collection of fossils in the University, the Academy to retain title.[5] Its library was moved in September, 1900 to the "magnificent fire-proof building" of the State Historical Society, housing the library of the Society and that of the University.[6] At this time the chief geologist was required by law to collect and present to the Academy, State University, incorporated colleges, and normal schools, if they so requested, specimens of rocks, ores, fossils, and minerals.

The ambitions of the Academy were beyond its resources, both human and pecuniary. The Charter states: "The general objects of the Academy shall be to encourage investigation and disseminate correct views in the various departments of science, literature and the arts." The arts were to comprise the useful and the fine. President Hoyt reported in 1874 that there had been no success with the fine arts, a condition that has existed up to the present. Two years later he reported that only the Department of the Natural Sciences was in a flourishing condition. In 1881 an amendment was introduced to abolish the Department of the Arts but it failed to pass at the next annual meeting.[7] Departments, as entities, have ceased to exist. Of the five that existed at one time only those of Sciences and Letters remain active.



Wisconsin Academy of Sciences, Arts and Letters.

CERTIFICATE OF MEMBERSHIP.

Rooms of the Academy, State Capitol,

Madison, March 1. 1870

This shall Certify, *That* I. A. Lapham of Milwaukee *having fulfilled the necessary conditions and been duly elected, is a* Life Member *of the* Wisconsin Academy of Sciences, Arts and Letters.

No. 3

I. A. Lapham
General Secretary.

President.

Certificate of membership of Increase A. Lapham.

For the year ending February 13, 1872, the Academy had 28 corresponding, 12 life, and 56 annual members. Its growth was so slow that thirty years later the Academy had but 12 life and 196 annual members. With this small membership it was impossible to marshal a sufficiently large group to maintain a live interest in philosophy, or the fine arts. The founding of the Academy was due largely to the efforts of scientists and they have constituted the majority of the members. In an address on the founding of the Academy at the 50th annual meeting T. C. Chamberlain stated: "Of the papers presented during the first two years, 35 per cent related to geological subjects, 23 per cent to biological, 17 per cent to physical and mathematical science, 15 per cent to political and sociological subjects, and the remaining 10 per cent to historical and philological subjects or to topics not readily classified."[8] The preponderance of geological papers was due particularly to the charter members, I. A. Lapham, J. H. Eaton, and T. C. Chamberlain. The very useful index compiled by L. E. Noland shows that of the papers published by the Academy, 1870–1932, approximately 80 per cent are on scientific and related subjects. Botany led the field followed by zoology. The Transactions form an ideal medium for papers on the natural resources of the state so that many of the articles are of this type.

Exchanges of the Transactions for the publications of other learned societies has led to the formation of a superb library having approximately 36,000 volumes. President Hoyt reported in 1874: "It is not the policy of the Academy to build up a separate library, but rather to cooperate with the State Historical Society in sustaining and strengthening the Scientific, Art and Literary Departments of its already extensive Library. This it will be able to do in a large degree by securing an exchange of the Academy's Transactions with those of kindred institutions throughout the world, provided its own publications are regularly issued at short intervals—annually, if possible." W. A. Germain,[9] Acting Librarian, in 1878, recommended that a certain sum be made available for binding as the accessions consisted largely of pamphlets and unbound publications, not usable in their present state. A list of the publications owned by the Academy covered eight pages. In 1881 $100 was appropriated for binding. E. A. Birge,[10] then librarian, stated that the library now "*crowds* about 100 feet of shelving." He was able to report that all complete volumes were bound or in process of binding. The cost of binding in 1893 ran from 50 cents to as high as 90 cents for one-half Morocco. The average cost per volume was 68 cents!

The initial caution in loaning books did not last long. A resolution was passed in 1878 that any member of the Academy could borrow books for a period of one year. The librarian's report for

1893 reads in part: "The room should not be left open without an attendant, as we have already suffered too much from depredations."[11] And: "Should the librarian have reason to think the books were no longer in use and retained because of neglect, he might at his discretion call them in." The Academy accepted an offer from R. G. Thwaites, Secretary of the Wisconsin Historical Society to aid in the loan of books by furnishing a member of his staff when the librarian or his assistant could not be in attendance. The Academy would be expected to pay for this service if it proved to be a "considerable burden."

The library was maintained in the Capitol under difficult conditions. W. H. Hobbs,[12] in 1891, had great difficulty in arranging and cataloging the books owing to the use of the quarters for law and history classes. Access to the rooms could be had only on Saturdays and during vacations. This was not the sole trouble. Two years later the librarian complained: "As the cases have no backs, but rest against the rough plaster, it is impossible to keep from the books finely disintegrated plaster which shakes down from the walls. The books become covered with a considerable layer of this material, which is so gritty as to abrade the skin when the books are handled. On opening a book this material gets between the leaves and plates."[11] New tenants, committees of the Legislature and compilers of the state census, occupied the library for most of 1895. The last straw was added in 1897 when the Academy's room was divided by a partition, one part being used as a committee room, the other as a cloak room.[13] The library was now virtually inaccessible. In December, 1898 it was agreed that the library be placed in the custody of the State Historical Society, the arrangements to be left to the discretion of the Council of the Academy.

As early as 1892 a resolution was passed to memorialize the Legislature on the construction of a building for the libraries of the Historical Society, University, and Academy.[14] The building was obtained but was not ready for occupancy until 1900. A year later it could be announced that the Regents of the University had been of great service to the Academy "by placing at the disposal of the Librarian of the Academy the library staff of the University under the direction of Librarian Smith." It was not only logical but almost inevitable that the library of the Academy be combined with that of the University and initial action to this end began in 1909. The University Librarian in 1954 began to reclassify the periodicals and journals of the Academy in changing from the Cutter system to that of the Library of Congress. The integration is now so complete that the library of the Academy has lost its identity; however the Academy retains title.

The Academy has published the *Bulletin, Transactions,* and *Review*. Five Bulletins were printed during the years 1870–1871. The pages are numbered consecutively and total 81. Bulletins 2 and 3, and 4 and 5 are bound together. These Bulletins give information on the founding of the Academy, Proceedings, and abstracts of papers. The *Transactions* consist of original papers, and the Proceedings. The Review is published quarterly, the first volume appearing in 1954. It contains information on the activities of the members, obituaries, brief articles by members of the Academy and those of the Junior Academy, reports on the annual meetings, and book reviews. This publication sustains interest in the Academy between the annual intervals of the appearance of the *Transactions*.

In 1920 the fiftieth anniversary of the Academy was commemorated by the publication of a volume of 776 pages for which the Legislature made a special appropriation of $2000. T. C. Chamberlin, one of the incorporators and presidents of the Academy, and formerly President of the University of Wisconsin was given the honorary degree of Doctor of Science. There was a special exhibit of photographs of former officers and members, correspondence and scrapbooks of the early secretaries, programs of past meetings, and copies of early and recent publications.

A handsome medallion by the artist Leonard Crunelle of Chicago was struck. The obverse carries the figure of Minerva with the motto, *Naturae species ratioque*. On the reverse were the portraits of six eminent members: William Francis Allen, historian; Thomas Crowder Chamberlin, geologist; Philo Romayne Hoy, physician and naturalist; Roland Duer Irving, geologist; Increase Allen Lapham, naturalist and geologist; and George Williams Peckham, zoologist.

The number of meetings held by the Academy varied. Three meetings were held in 1870. The following year there were special and semi-annual meetings. In 1896 only one meeting, the annual, was held, a practice that has been continued. There was the perennial problem of how to make the meetings of greater interest. At that of December 27, 1893, the President asked E. A. Birge to open the discussion of the subject.[15] Most of the members present ventured suggestions. Joint meetings were held at intervals with other societies such as the Wisconsin Archeological Society, the Wisconsin Mycological Society, the Wisconsin Natural History Society, the Wisconsin Section of the American Chemical Society, and others, without apparent benefit. At the present time the Academy does meet with the Junior Academy which it fosters.

Every effort was made to keep the expense of attendance at meetings low. On July 4, 1871, President Hoyt wrote to Lapham that the railroads would carry members to the meeting on the 18th at

60 per cent of the regular rate.[2] Meals and lodging by modern standards were fantastically low. When the meeting was held at Ripon College in 1892, supper, lodging, and breakfast could be had at Wood's Hotel for $1.25. The fare for the excursion to Green Lake was 18 cents. On December 18, 1902, Secretary Ernest B. Skinner sent the Madison members a card reading: "It has been customary whenever the Academy has met in Madison for the resident members to give a complimentary banquet to the visiting members. The banquet will be held this year in the Unitarian Church, Friday evening, December 26, at 6 o'clock sharp. The cost to Madison members will not exceed $1.25 each. Members may bring guests by paying for each guest an amount equal to the actual cost per plate." When the Academy met in Milwaukee the following year the Plankinton House offered to serve a dinner in a private dining room at $1.00 per plate "provided as many as thirty people wish to avail themselves of the privilege."

The original constitution provided for an initiation fee of $5.00 and annual dues of $2.00. The Treasurer reported in 1877 that only 62 of about 200 members had paid dues of any kind.[16] Nevertheless the annual dues were increased to $3.00. In 1880 remedial steps were taken to strengthen the membership. The initiation fee was reduced to $2.00 and the annual dues to $1.00.[17] In addition the old members were given credit for future annual dues to the amount paid in the past in excess of these dues. In spite of these heroic measures 31 members were suspended for non-payment of dues. The initiation fee was subsequently dropped. In 1952 a family membership was inaugurated for the sum of $4.00, the co-member paying $1.00. Only one copy of the *Transactions* went to the family.

The Academy has had financial problems during most of the years of its existence. It is vital that the *Transactions* appear annually for the purpose of exchange. This can not be done by dues alone. President Hoyt[2] wrote to Lapham on February 28, 1870, that he considered it inadvisable to ask the Legislature for pecuniary aid until the Academy had shown that it could do useful work for the state. He soon reached the conclusion that the organization was worthy for on March 22, 1872, he wrote to Lapham that he had succeeded in getting through the Legislature a joint resolution providing for the printing of 2000 copies of the first volume of the *Transactions* to consist of 200 pages. For years afterward the Legislature authorized printing by the state printer of one volume biennially. In 1913, for the first time, a sum of money for printing was placed directly at the disposal of the Academy. Since that date appropriations have varied from zero to $5,000 biennially. The result has been that during the 91 years of the existence of the Academy only 50 volumes of the *Transactions* have been printed. This is far short of the desirable one volume annually.

The constitution provided that life members contribute $100, patrons $500, and founders $1000. At the second meeting of the Academy, July 19, 1870, a resolution was passed to place all monies from life memberships in a permanent endowment, the income from which was to be available for the general purposes of the Academy.[18] The Treasurer reported $807.25 in this fund on February 14, 1872. C. S. Slichter wrote to Secretary Arthur Beatty in 1920: "I think that the Academy is making a great mistake by not soliciting more vigorously the interest of prominent families in the state as patrons of our work. When the Academy was originally started this particular function of its work was 'emphatically emphasized.' "[2] In spite of the long existence of the Academy the endowment fund does not exceed $7500. This is far from the $100,000 contemplated by the founders.

The Academy from the beginning was interested in determining the natural resources of the state including geological and topographical surveys. A resolution was introduced by T. C. Chamberlin[19] at the third meeting that the secretary present an outline of the scientific investigations that have been made in the state and indicate those investigations that were most worthy of pursuit. He was authorized to assign the projects to various members of the Academy. Little or nothing was accomplished in this direction. The President reported in 1872 that "no single county has been thoroughly examined in its relation to all departments of natural history, and much the larger portion of the State . . . has not been favored with so much as a general reconnaissance."[20]

Geological investigations were intermittent. The first State Geologist, Edward Daniels, was appointed in 1853. The following year he was succeeded by James C. Percival who served until his death on May 2, 1856. The Legislature ordered a general geologic survey in 1873. It was commenced under Lapham who served two years, then O. W. Wright took over for two years. T. C. Chamberlin became State Geologist in February, 1876. The field work was published in four volumes between 1879 and 1883. In the latter year the organization passed out of existence. It was not until 1879 that geologic work under state auspices was again resumed.

The Academy was in no position to conduct geological and natural history surveys, but it could influence the Legislature to establish a department for this purpose. At the December 28, 1894, meeting a proposal for establishing a survey of this nature was discussed, and a committee was appointed to draft a bill and secure support for its passage. In Volume X (1895) of the Transactions there appeared the "Report of the Committee on the Proposed Geological and Natural History Survey of Wisconsin." The report was printed as a separate of twelve pages under a somewhat different title. Specific objectives for the survey were outlined. The iron bearing formations were to be mapped, materials for building roads located, and samples of soils collected for examination. Attention was called to the diminishing forest resources and the desirability of knowing what trees to plant on particular soils. Nutritive forage plants should be sought for the large areas of sandy soil unsuitable for agriculture. The zoological investigations would be devoted mainly to the food and enemies of fish. Supporting arguments were: "As an example, we may refer to the whitefish. No one knows anything of the fate of the millions of fry planted in this and adjoining states. No one knows anything of the food, enemies, or habits of the young whitefish." An unsuspected resource were the pearls taken from the Sugar River. This stream during the past six years had produced pearls valued at $500,000 to $600,000. The pearls were removed by killing the clams but they could and should be removed without injury.

The chief supporters of the bill were Charles Van Hise, geologist, and E. A. Birge, zoologist. On January 1, 1895, the following letter, on Academy stationery, was sent to potential supporters:[2]

> Dear Sir:
>
> There are enclosed herewith two copies of the following: the perfected bill for the establishment of a Geological and Natural History Survey in the State of Wisconsin, and a statement of the reasons for the establishment of such a survey, with a map showing the progress of surveys in Wisconsin.
>
> Signed: C. R. VAN HISE, *President.*
> C. R. BARNES, *Secretary.*

In giving their reasons for the survey the pearls were cast aside. A law was passed in the spring of 1897 creating the Survey.

The Natural History Division of the Survey was under E. A. Birge from the beginning. He served without compensation and was paid only for travel and field expenses. His assistant, Chauncey Juday, was employed full time. These gentlemen published in the TRANSACTIONS a long series of papers on the limnology of Wisconsin lakes. Their work is classic.

A few of the minor activities of the Academy may be mentioned. In February, 1874, a committee was appointed to "wait on the proper legislative committee to urge such changes relating to marriage certificates as are recommended in Mr. Holland's paper."[21] Some months later another committee was appointed to investigate an Indian mound near Madison at a cost to the Academy not exceeding $25.00. Resolutions were passed on February 11, 1909, for the conservation of natural resources and copies were sent to the Governor, members of State Board of Forestry, members of the Legislature, and the Public Press.[22] Resolutions were also passed against a proposed extension of the open season for the shooting of ducks in April. Shortly thereafter Congress was urged to pass the proposed bill for the protection of migratory birds.

The latest important achievement has been the establishment of a Junior Academy of Science comprising the Science Clubs organized in the High Schools of the state. For a long time there had been discussion of the desirability of forming a Junior Academy but no concrete plan had emerged. Early in 1944 I discussed with President C. A. Dykstra the potential benefits to be derived from a Junior Academy. The project was placed in the competent hands of E. B. Fred who took the steps necessary to support a junior organization as a University activity. The budget of May 23, 1944, carried an appropriation of $2800 for an unselected person to organize and direct on part time a Junior Academy. The budget was approved on June 15 and John W. Thomson, Jr., was appointed to the position on August 18, 1944. He served until February 1, 1961. Too much credit cannot be given to Dr. Thomson for the organization and supervision of the Junior Academy, and for his long and faithful service. The head of the Junior Academy carries the title Chairman of the Junior Academy Committee. This title expresses inadequately the dignity and responsibility of the position.

The state is divided into seven districts. Each district holds a meeting at which three of the best papers are selected so that there are twenty-one papers presented by pupils at the annual meeting. The meetings of the Junior and Senior Academies are held separately, but at the same time and place. The purpose behind the founding of the Junior Academy was to encourage high school students showing ability and interest in science to follow it as a life profession. This aim has been well realized since 90 per cent of the pupils that attend the district and annual meetings have pursued science in one form or another.

The major accomplishments of the Academy have been the publication of the Transactions ,the building of a science library, and promotion of the Geological and Natural History Survey and the Junior Academy of Sciences. It is doubtful if any other Wisconsin organization has accomplished so much at so little cost to its citizens.

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THE SIGNIFICANCE OF THOREAU'S TRIP TO THE UPPER MISSISSIPPI IN 1861*

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Exactly one hundred years to the day of the time of the last Wisconsin Academy meeting—that is, on May 6, 1862—there died in Concord, Massachusetts, that provocative individualist, Henry David Thoreau. Now the centennial of a man's birth or death—especially of a man of such international stature as Thoreau—often elicits a spate of magazine commentary and academic research. Such seems to be the case in the present instance. However, since the longest trip this stalwart individualist ever made was that taken during the last year of his life to our Upper Mississippi region, and since the general topic of the ninety-second Academy session was the Upper Mississippi, it seemed appropriate that one paper of the conference should deal with this last journey of Thoreau's.

Because contemporary research of that journey had concerned itself largely with summarizing surveys of the records of the trip made both by Thoreau[1] and by his travelling companion, Horace Mann, Jr.,[2] this writer will not attempt a replowing of that terrain but instead will analyze the Thoreau-Mann records from a topical approach, purposing to discuss the significance of the journey from a three-fold aspect: its interest to today's readers for what Thoreau's account reveals of Upper Mississippi cultural and natural history; the probable importance of that trip to seventeen year old Horace Mann, Jr., Thoreau's travelling companion on the two-month Western jaunt; and the significance of that journey to Thoreau himself.

Although Thoreau had originally intended a *three*-month trip for his health,[3] in actuality he was away from home only two months—

* Paper read at the 92nd annual meeting of the Wisconsin Academy of Sciences, Arts, and Letters.

1 The first contemporary research in the field was John Flanagan's "Thoreau in Minnesota," *Minnesota History,* XVI (1935), 35–46. This study is based on the Sanborn edition of Thoreau's record, however.

2 Robert L. Straker, "Thoreau's Journey to Minnesota," *New England Quarterly,* XIV (September 1941), 549–55. This article, based on Mann's letters to his mother, presents the trip as viewed by Thoreau's companion. Walter Harding, ed., "Thoreau and Mann on the Minnesota River, June 1861," *Minnesota History* 37:225–8, supplements the Straker study by giving one more, although uncompleted, letter of Horace Mann's.

3 See Thoreau's letter to H.G.O. Blake of May 3, 1861, in Walter Harding and Carl Bode, *The Correspondence of Henry David Thoreau* (New York, 1958), p. 615.

leaving his native Concord on May 11, 1861 and returning on July 10—just in time to spend his forty-fourth (and last) birthday with his family. But since part of this two months was used in botanizing in the East (at Niagara Falls on the way out and at Mackinac Island on the return trip), only about five weeks were actually devoted to the Mississippi region—from May 23—when the pair boarded the *Itasca* at Dunleith (now East Dubuque) for the up-river trip to the St. Paul area, to June 27 (when they left the Mississippi at Prairie du Chien to entrain for Milwaukee and thence to sail to Mackinac). Of these five weeks, most of their time—about three weeks—was spent in the then-frontier St. Anthony-Minneapolis-St. Paul section, with the most interesting part of their sojourn (from June 5–June 14) at the private boarding home of a Mrs. Hamilton on Lake Calhoun,[4] exploring what was at that time comparatively wild terrain about Lake Calhoun and Lake Harriet. Since boats were the major means of early public transport in Minnesota before the first ten miles of railroad were laid in 1862, about one week of Thoreau's Minnesota visit was spent aboard the excursion boat, *The Franklin Steele,* with some hundred other passengers, making a winding trip up the Minnesota River to Redwood—there to observe the Sioux Indians receiving their annual payment from the government at the Indian agency;[5] and three days and four nights were similarly spent on the Mississippi boats en route to and from St. Paul. A three-day sojourn in Red Wing, exploring the river bluffs of that region, accounted for the travellers' last time-allotment in Minnesota.

Unfortunately Thoreau had neither the health nor the energy after his return to Concord to organize the jottings of his observations made on this last journey into his usual readable Journal form; so his record remains only in fragmentary jottings. The original copy of these jottings is now on deposit in the Huntington Library, California.[6] The only *published* record of these notes was

[4] After research through old records and journals in the Minnesota State Historical Society Library, this writer believes evidence points to the location of widow Hamilton's home at the southern tip of Lake Calhoun: Emma Grimes, compiler of *Biographical and Geneological Data of Some Pioneer Families of School District No. 18, Hennepin County, Minnesota,* (1938 typed memoir now in the Minnesota State Historical Society Library) states on p. 3 of the section titled "Mr. and Mrs. Grimes in Minnesota": "One summer Mr. Henry D. Thoreau came to Minnesota to try and regain his health. He boarded with a Mrs. Hamilton who had an exclusive boarding house on the shore of Lake Calhoun, where the residence of the late Judge Ueland now stands." This site is now right near Berry and Lyndale parks, on the strip of land lying between Lake Calhoun and Lake Harriet.

[5] One year later this area along the Minnesota was the site of the bloody Sioux massacres of 1862.

[6] I am deeply indebted to the Museum of Natural History at the University of Minnesota for graciously allowing me access to their photostatic copy of this manuscript for careful study. Throughout this paper, allusion to this document will be symbolized by TM (Thoreau Manuscript), followed by the paging.

made by Franklin Sanborn, Thoreau's editor, in 1905;[7] but this publication was in a limited, private edition, not readily available today; and, even if available, it is likely to be more puzzling than helpful to the modern reader because of Sanborn's usual free editing, haphazard arrangement, and misinterpretation of Thoreau's notations.[8] Since the published Mann letters and the Flanagan study, previously cited, constitute the only accessible printed material on Thoreau's trip but tend toward chronological summary in their treatment, it would seem that a topical presentation, highlighting some of the significant aspects of the trip, is justifiable.

To the contemporary reader interested in the cultural history of the Upper Mississippi area, that aspect of Thoreau's account which undoubtedly would prove most fascinating is the glimpse he gives of life along the Great River in the early 1860's. It was, according to one authority, the heyday of Upper Mississippi boat trade.[9] Immigrants were pouring westward by train as far as the River and then journeying up it to settle in western Wisconsin and Minnesota. The region was also becoming noted for its therapeutic, health-giving qualities—Thoreau's reason for going there.[10] Magazine articles of the 1850's[11] and that popular art creation—the travelling panorama[12]—had done much to acquaint Easterners with the region.

But even before his actual start up the Mississippi, Thoreau had been impressed by the prairie wheat country in Western Illinois—farm land so very different from that of New England! As he described it—

> Distances on prairie deceptive—A stack of wheat straw looks like a hill in the horizon, ¼ or ½ mile off—it stands out so bold & high . . . Small houses—without barns surrounded & overshadowed by great stacks of wheat straw—it being threshed on the ground . . . The inhabitants remind you of mice nesting in a wheat stack midst their wealth. Women working in fields quite commonly. Fences of narrow boards. Towns are as it were stations on a R.R.[13]

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[7] Franklin Benjamin Sanborn, ed., *First and Last Journeys of Thoreau,* II (Boston, Bibliophile Society, 1905). This volume will hereafter be cited in this paper as *Journneys.* I am grateful to the Newberry Library for allowing me access to their copy, one of the 492 copies that were printed.

[8] Evadene B. Swanson, "Manuscript Journal of Thoreau's Last Journey," *Minnesota History* 20 (June 1939), 169–73, indicates some of the more obvious errors made by Sanborn.

[9] Mildred Hartshough, *From Canoe to Steel Barge on the Upper Mississippi* (University of Minnesota press, 1934), pp. 41–108. This author includes, too, interesting historical detail about the three boats on which Thoreau journeyed: *The Itasca,* pp. 132–4; *The War Eagle,* pp. 132 and 140–1; and *The Franklin Steele,* p. 168.

[10] See Theodore Blegen. "The 'Fashionable Tour' on the Upper Mississippi," *Minnesota History,* 20 (Dec., 1939), 377–96, and William J. Petersen, *Steamboating on the Upper Mississippi,* (Iowa City, 1937), pp. 298–352.

[11] Catherine Sedgwick's "Great Excursion to the Falls of St. Anthony," *Putnam's* 4 (September 1854), 320–5, describing the famed trip of excursionists to celebrate the completion of the railroads to the Mississippi, had doubtless been read by Thoreau, since he published in the same periodical.

[12] Thoreau's essay, "Walking," in *The Writings of Henry David Thoreau* (Boston, 1906), V: 224, gives his impressions of one of the Mississippi panoramas.

[13] TM, 4.

Later, when actually aboard *The Itasca* headed up the Mississippi for St. Paul, Thoreau gives an impression of the isolation along the great waterway—with the little river towns lining its banks appearing as rather lonely outposts of civilization, tucked in wherever a level resting spot could be found between tall river bluffs. Occasionally, he notes

> a little lonely house on a flat or slope—often deserted—banks in a primitive condition bet. the towns which is almost everywhere—[14]

However, when the daily boats arrived in one of these isolated towns, then the little lonely outpost woke up. Thoreau's description of this awakening is somewhat reminiscent of that famed passage in Mark Twain's *Life on the Mississippi,* describing the steamboat's arrival in the more southerly Hannibal,[15] yet Thoreau's notation was written over twenty years before. It does, however, record the same sudden revival to life of a town when the steamboat approaches:

> Every town a wharf with a storage building or several & as many hotels as anything—& commission merchants. "Storage, Forwarding, & Commission" one or all these words on the most prominent new building close to the waterside—Perhaps a heap of sacks filled with wheat on the natural quay or levee close by—or about Dubuque and Dunleith a blue stacks of pig lead—which is in no danger of being washed away . . . . The steamer whistles—Then strikes its bell about 6 times funereally, with a pause after the 3^d—You see the whole village making haste to the landing—commonly the raw stony or sandy shore—the postmaster with his bag—the passenger—& almost every dog and pig in the town—of commonly one narrow street under the bluff—& back yards at angles of about 45° with the horizon.[16]

If the river towns were sleepy and somewhat isolated, the river itself presented much life: Besides the passenger boats which made connections with the railroads on the eastern banks of the Mississippi at Prairie du Chien, Dunleith, La Crosse, etc., there were various lumber rafts floating southward, which Thoreau described in a later letter to Sanborn:

> The lumber, as you know, is sawed chiefly at the Falls of St. Anthony (what is not rafted in the log to ports far below) having given rise to the towns of St. Anthony, Minneapolis &c &c In coming up the river from Dunleith you meet with great rafts of sawed timber and of logs—20 rods or more in length, by 5 or 6 wide, floating down, all from the pine region above the Falls.[17]

The "wooding up process"—so important in those days before coal, oil, or atomic energy were being utilized for boat power—is alluded to in several places. At Fountain City, for instance, they

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[14] *Ibid.,* 5.
[15] See second paragraph of Chapter IV, of *Life on the Mississippi.*
[16] TM, 7–8. Cf. *Journeys,* 26–27.
[17] Letter of June 25, 1861, in Harding and Bode, *op. cit.,* p. 619.

took a wood boat along with them and they "wooded up again before reaching L Pepin taking the boat along with us—now on this side then on that."[18] The actual wood-loading was speeded up by labor co-operation, it seems, for he speaks of twenty men loading "some 9–10 cords of wood in 10 minutes" at one landing.[19]

In regard to the river towns which they passed, Thoreau has a personal notation about almost every one: At Prairie du Chien "the smartest town on the river," exporting the "most wheat of any town bet. St. Pauls and St. Louis", he noted great sacks of this wheat piled up, "covered at night—& all over the ground & the only *bread* wheat."[20] At Cassville he observed "holes in the side of the hills" where lead had been dug, as he had similarly seen the bluffs mutilated for the same purpose near Galena.[21] Winona, "a pretty place" was the spot to which they "towed a flat boat load of stoneware pots from Dubuque."[22] His only comment about La Crosse was that the white pines started half a dozen miles above it; but, knowing Thoreau's love of the white pine, perhaps La Crosse residents can be proud of this memorable association.[23] Below Wabasha he noted an Indian encampment "with Dacotah-shaped wigwams". Here too he saw a loon on the lake and fish leaping.[24]

After leaving the steamer at St. Paul, Thoreau next recorded brief hints of what other frontier communities of the region were like in 1861. Of St. Paul itself he commented that the residents "dig their building stone out of the cellar—but of poor stuff."[25] Although Minneapolis boasted five drug stores, its main streets were "the unaltered prairie with burr and other oaks left;" while of its road over the prairie to Ft. Snelling, he commented that it was "a mere trail more or less broad and distinct."[26] The now-fashionable residential sector of the Lake Harriet-Lake Calhoun area was, in the days that Thoreau and Mann lived at Mrs. Hamilton's, wild enough to reveal pasenger pigeons. The fledgling University of Minnesota, for which ground had recently been set aside in St. Anthony, Thoreau felt looked quite "artificial" in its burr oak setting.[27] Ft. Snelling apparently proved more interesting to Thoreau for the wealth of nature offerings in its vicinity than for its history; but he was fascinated by the mechanical technique by

[18] TM, 8.
[19] *Ibid.,* 5.
[20] *Ibid.,* 5–6.
[21] *Ibid.,* 5 and 7.
[22] *Ibid.,* 9.
[23] *Ibid.,* 6.
[24] *Ibid.,* 7.
[25] *Ibid.,* 8.
[26] *Ibid.,* 16 and 17.
[27] *Ibid.,* 11.

which its ferry utilized the river current to make its crossing and even drew a picture of the ferry's working principle. Yet he devoted a mere two lines to the item that there were 600 volunteers in training at the Fort at the time, with 300 leaving for duty the morning of his visit.[28]

As for the Minnesota river towns which they passed on their three-hundred mile jaunt upstream to Redwood on the *Franklin Steele,* he gives similar brief glimpses: New Ulm consisted "wholly of Germans. We left them 100 barrels of salt, which will be worth something more when the water is lowest, than at present."[29] Near Mankato, the boat "pushed over a tree and disturbed the bats", a fog delayed them for several hours, and the captain ran the boat on a rock![30] Redwood itself, their destination, was apparently more significant to Thoreau because it gave him a glimpse of the open prairie than it was for its Sioux natives on annual display for tourist benefit:

> We were now fairly on the great plains, and looking south, and after walking that way 3 miles, could see no tree in that horizon. The buffalo was said to be feeding within 25 or 30 miles.[31]

But they did not hike toward the buffalo. Nor did they explore Redwood itself—"a mere locality, scarcely an Indian village—where there is a store & some houses . . . built for them." Instead, the travellers made good use of their one-day sojourn at Redwood to investigate prairie botanical offerings.

Red Wing, the pair's last stopping-point in Minnesota, seems to have entranced the two naturalists most. Thoreau had noticed jutting Barn Bluff as an outstanding feature of the community on his way up-river to St. Paul; now on their stay in Red Wing on their return trip they delighted in exploring that bluff for its botanical offerings and Indian artifacts,[32] and in swimming in the Mississippi.[33] In fact, though the community now claims renown for its ceramic offerings, it might also lure travellers by advertising "Thoreau slept here the last three nights he was in Minnesota!"

Modern boat owners of small pleasure craft might find interesting reading in two portions of Thoreau's record for experiencing vicariously, or actually, water journeyings of their own: In one part of his Journal, he gives a detailed listing of the tables of distances between every hamlet along the Mississippi from La Crosse to St. Paul—probably a copy of some steamboat table, such as that

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[28] *Ibid.,* 16.
[29] Letter to Sanborn, June 25, 1861, in Harding and Bode, 621.
[30] *Journeys,* 58; TM, 66–7.
[31] Letter to Sanborn, June 25, 1861, in Harding and Bode, 621.
[32] TM 69–74. Cf. *Journeys,* 54–64.
[33] Straker, 554.

of *The Itasca* or *The Franklin Steele*.[34] The second is the graphic description he gives of the 160 foot *Franklin Steele* being maneuvered up the winding Minnesota—sometimes running squarely into the bank, sometimes breaking down trees, sometimes getting "grounded" so that a windlass and cable were necessary to free the boat. Some river bends were so pronounced that passengers even got off the boat and walked across the isthmus to rejoin the slower-moving boat-crowd later.[35]

Although those portions dealing with local river history are perhaps the most readable parts of Thoreau's record, Thoreau himself seems to have been mainly concerned with botanical observations; certainly from the time of his arrival in the St. Anthony area on, he devoted more and more space to these observations—making the account a treasure-trove for botanists but offering, it must be admitted, certain hazards for the lay reader. In fact, one of the difficulties the average reader encounters in examining either the Thoreau manuscript or the Sanborn edition of that manuscript is the constant interruption of Thoreau's daily account by his detailed annotations of flowers observed in different areas, as well as by several summarizing lists he includes, which occupy several pages. One of these lists records plants which Thoreau had known in Concord but which he had also observed in the St. Anthony-Minneapolis area.[36] Another list, consisting of some 113 flower annotations, notes the dates of bloom of various species from the time he began his observations at Niagara up through his sojourn at Mackinac Island.[37] This latter list, which he has labeled "Notes on the Journey West", he may have intended to use later for purposes of comparison with his Concord Calendar, which he had kept for a period of years in recording similar data.

Perhaps someday when the record of Thoreau's last trip becomes more accessible to the general public, naturalists in the Twin Cities' area, the Redwood area and the Red Wing locale will give themselves a "botanists' holiday" by making parallel trips and comparing their present-day findings with those made by Thoreau in 1861.[38] Space limitations, however, will necessitate touching on only a few high points of his findings here:

Thoreau's first botanical observations, on the trip up the Mississippi, had been generalized ones, concerned with comments about the trees that lined the river banks as compared to those that grew

[34] TM, 61. Cf. *Journeys*, 59.
[35] TM, 67, and Letter to Sanborn of June 25, 1861, Harding and Bode, 620.
[36] TM, 94–7. Note also another list, TM, 40–45.
[37] *Ibid.*, 29–36A.
[38] The Eloise Butler Wild Flower Garden in Minneapolis, devoted mainly to plants native to Minnesota, has a list of its plantings compiled by Martha E. Crone, curator of the garden in 1951. The author of this paper, as a hobby, has been checking Thoreau's listings with the Crone list and finds a high parallelism.

on the tops of bluffs and on the bluff slopes;[39] but afterwards, in the Twin Cities' area, he became more and more committed to detailed observations about flowering plants, although he was still making tree and shrub observations (noting among his findings: the butternut and hickory; American, cork-barked and slippery elm; scarlet, red, white and burr oak; the hop horn beam; white and sugar maple and box elder; various species of poplar, willow and birch; hazel bushes as well as two species of elder; sand-, pin- and choke-cherry; hawthorne; "tree cranberry", hackberry and waahoo).[40]

On the first day of the Mississippi river trip, he had noted at Prairie du Chien particularly the pasque flower (which he termed *"Pulsatilla Nutalliana"*), the bird-foot violet (*Viola pedata*), and the hoary puccoon *(Lithospermum canescens)*—commenting on the root-use of the latter for dye by the Indians. Later, apparently using Gray, Parry, and Wood for sources of reference and comparison in his botanical researchings, he proceeded (with the same zeal he had exhibited in his New England study) to acquaint himself intimately with every living plant he found in each patch of ground he traversed in the St. Anthony-Minneapolis region. While here he recorded many of the flowers that he had known in Concord previously before sighting them in their Minnesota locale, perhaps now recorded as "friends from home" to the nostalgic Thoreau: the marsh marigold *(Caltha palustris)*, blood-root *(Sanguinaria canadensis)*, dutchman's breeches *(Dicentra cucullaria)*, columbine *(Aquilegia canadensis)*, baneberry *(Actaea)*, four species of violet, meadow parsnip *(Thaspium aureum)*, Jack-in-the-pulpit, painted cup *(Castilleja coccinea)*, wood betony *(Pedicularis canadensis)*, blue flag *(Iris versicolor)*, star-grass *(Hypoxis hirsuta)*, bunchberry *(Cornus canadensis)*, wild ginger *(Asarum canadense)*—to mention but a few of those he had located.[41]

Although today congested Nicollet Island in downtown Minneapolis might appear more fruitful for sociological study, as an extension of certain "Skid Row elements" from the nearby depot area across the river, in Thoreau's time it offered more for the naturalist than the sociologist. In fact, it was wilderness enough so that Thoreau sighted a deer there—whether a wild one or one tamed, he does not say. And as for flowers, he spent the first day of his botanical investigations in the St. Anthony area here. On it, and later on nearby Hennepin Island, we find him recording such species as blue phlox (*Phlox divaricata*), prickly ash (*Xanthoxylum*

[39] TM, 5, 6.

[40] *Ibid.*, 10, 12–17, 49–50 and 95–7.

[41] *Ibid.*, 6, 94–7.

americanum), spiderwort (*Tradescantia virginiana*), wild balsam apple *(Echinocystis lobata)* and the frost grape *(Vitis riparia)*.[42]

On his second day of botanical investigation in the St. Anthony area, made on a ride to the Lake Calhoun-Lake Harriet region with his new, naturalist-friend Dr. Anderson, Thoreau seems to have been particularly impressed with the shrubbery; for he mentions noticing the June berry *(Amelanchier)*, the snowberry *(Symphoricarpos occidentalis)*, the wild plum *(Prunus americana)*, and the honey-suckle *(Lonicera parviflora)*; but on closer woodland investigation, they also found such flowering plants as the bell wort *(Uvularia grandiflora)*, the wild crane's bill *(Geranium maculatum)*, and the showy orchis *(Orchis spectabilis)*.[43]

Thoreau's journey to Minnehaha and explorations there and about Fort Snelling the following day revealed to him, among other species: the horse gentian *(Triosteum perfoliatum)*, the blue cohosh *(Caulophyllum thalictroides)*, the common trillium, waahoo, the prickly gooseberry *(Ribes Cynosbati)*, the skunk cabbage *(Symplocarpus)*, and the giant reed ("Arundo Phragmites ten feet high" he records).[44]

Thoreau's ten-day sojourn at Mrs. Hamilton's on the shore of Lake Calhoun, gave him opportunity to observe plants of the lake-shore, woodland, and open prairie—depending on which direction he went for his daily botanical investigations. For the dates from June 5–14, therefore, there are to be found noted among his various plant observations: wild artichokes, the yellow and showy lady slipper *(Cypripedium pubescens* and *C. spectabile)*, the ground cherry *(Physalis viscosa)*, the prairie phlox *(Phlox pilosa)*, the prairie rose *(Rosa blanda)*, the wild hyssop *(Lophanthus anisatus)* —which led him on a tantalizing nose-tingling hunt until he had identified it, the ground plum *(Astragalus caryocarpus)*, and—most note-worthy—the wild apple.[45]

This last discovery, that of the wild apple, was to him the most exciting of Thoreau's botanical findings in the Lake Calhoun region—a discovery which he alludes to later in one of his last, before-death essays: "Wild Apples".[46] Thoreau's botanical "sleuthing" in regard to its discovery reminds one of his parallel excitement in 1853, in tracking down the only pink azalea which grew in the Concord area.[47]

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[42] *Ibid.*, 82, 9, 19, 36, 37, 85.

[43] *Ibid.*, 12–13, 36, 36A.

[44] *Ibid.*, 15, 17, 18, 36A.

[45] *Ibid.*, 92, 49, 51, 52, 53–4, 54–5, 57, 58, 31–2.

[46] Henry David Thoreau, "Wild Apples", in *Writings of Henry D. Thoreau*, (Boston, 1906), V: 302.

[47] See his entry for May 31, 1853 in *Writings, Journal*, V: 203–8.

The first clue that there might be wild apples in the region had come to him on the train through Illinois, where he had noted "flowered, apple-like trees . . . which may be the Pyrus Coronaria."[48] Later, at Lake Calhoun, his landlady—Mrs. Hamilton—informed him that there *had* been wild apples on her premises, transplanted from the wood by her husband but that they had all died. Thoreau went in search of them in the locale where she affirmed that they had grown natively but found only the June berry and wild thorn. Then a neighbor directed him to the home of a Mr. Grimes[49]—then absent, but whose boy

> showed me some of the trees he had set out this spring but they had all died—having a long tap root and being taken up too late, but then I was convinced by the sight of a just expanding though withered leaf—and plucked a solitary withered flower best to analyze. Finally stayed and went in search of it with the father in his pasture—when I found it first myself—quite a cluster of them.[50]

On the road between St. Anthony and St. Paul, just previous to taking the boat-trip up the Minnesota River, Thoreau had been impressed by the profusion of large-flowered beard-tongue *(Penstemon grandiflorus)* and blue harebell *(Campanula rotundifolia);* while on the trip on the river he noted "acres of roses in the intervales" between the trees, "grape in bloom on a cottonwood," the prairie larkspur *(Delphinium azureum),* and the great ragweed *(Ambrosia trifida),* in particular.[51] At Redwood, prairie plants proved an exciting discovery.[52] In fact, he devotes more space to his listings of them than he does his notations about the Indian ritual, although observation of the Indian seems to have been the original intent of the Minnesota River trip.

The traveller's last sojourn in Minnesota—their three-day stay at Red Wing, offered them interesting contrast in plant study between those growing on the river bluff tops and sides and those in swampy areas near the river. Listed among the plants which they observed here were the pale spiked lobelia *(Lobelia spicata),* another painted cup *(Castilleja sessiliflora),* the hornless and green milkweed *(Acerates viridiflora* and *Acerates monocephala),* hairy pucoon *(Lithospermum hirtum),* black-eyed Susan *(Rudbeckia hirta),* bladder fern *(Cystopteris),* the ox-eye *(Heliopsis laevis),*

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[48] TM, 3–4.

[49] Mr. Grimes owned the Edina Mills in the region and later ran a nursery on the Calhoun road, winning fame both in Minnesota and nationally as a horticulturist. (Eight pages of memoirs of J. T. Grimes in *Biographical and Geneological Data of Some Pioneer Families of School District No. 18, Hennepin County, Minnesota,* previously cited.)

[50] TM, 54–5.

[51] *Ibid.,* 58, 62, 63, 33.

[52] *Ibid.,* 65, 66, 34, 71. Among plants at Redwood he notes *Geum onosmodium,* a sanicle, *Heliopsis laevis,* a Zygadene, and *Coreopsis palmata.*

porcupine grass, bishop's cap *(Mitella diphylla)*, dragon-head mint *(Dracocephalum parviflorum)*, and *Lepidium.*[53]

Thoreau's only comments on Wisconsin plants—which he sighted merely from the train en route from Prairie du Chien to Milwaukee—are a generalized view that a train-observer would necessarily have:

> 1st 60 miles up the Valley of the Wisconsin—which looked broad and shallow—bluffs 2 or 3 miles apart—Great abundance of tall spiderwort—also red lilly [sic]—rudbeckia, blue flag—white and yel. lilly [sic] & white water ranunculus—Abundance of mullein in Wisconsin.[54]

Thoreau's cataloging of birds in the Mississippi region is not as extensive nor as scientific as his botanical listings. However, he takes time out at Minneapolis to enumerate all the birds he had noticed along the way since leaving Chicago; and throughout his botanical observations there are comments, too, of the birds he noted in the same areas.[55] But the two species which seemed most to excite his observation in Minnesota were the wild pigeon and the rose-breasted grosbeak—the first of which is now extinct and the other comparatively rare. Yet at the time of Thoreau's expedition he noted that the grosbeak was "very abundant in the woods of the Minnehaha—and about the fort—singing robin-like all the while;" while at Mrs. Hamilton's he found it "common as any bird in the woods." He even describes the nest of one he had found in a bass wood with its "4 eggs green spotted with brown."[56]

Just as minutely he described the wild pigeon's nest—having located four such nests, all told, in the region near Mrs. Hamilton's: "2 in bass—1 in oak and 1 in hop horn beam."[57] Although the hop horn beam may still be found in the woodland park between Lake Calhoun and Lake Harriet, one will search in vain for the passenger pigeon's nest! Instead, the contemporary naturalist will have to content himself with experiencing vicariously, with Thoreau, *his* discovery of one loosely woven nest in a bass tree (a nest which he describes minutely and even illustrates); or watch with

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[53] *Ibid.,* 69–72.

[54] *Ibid.,* 74.

[55] Among birds in Thoreau's lists were the red-wing black bird ("the prevailing" bird), whip-poor-will, kingfisher, white-bellied swallow, red-headed woodpecker, killdeer, smaller plover, brown thrasher, kingbird, phoebe, "peet-weet," redstart, humming bird, catbird, wood thrush, Wilson's thrush, goldfinch, yellow-throated and warbling vireos, "cherry bird", cowbird, chewink, snipe ("boom on prairie at St. Anthony"), loon, "flocks of cranes, bittern or heron flying up Mississippi", marsh hawk, night hawk, Maryland yellow throat, myrtle warbler, horned lark ("very tame"), bluebird, bay-wing, white-throated sparrow, tanager, flicker, chestnut-sided warbler, black-and-white creeper, "young eagle eating blue jay in Minnetonaka lake", shrike, cuckoo, passenger pigeon, rose-breasted grosbeak, and meadow lark (TM, 5, 6, 10–16, 50, 52–3, 56, 58, 62, 80, 83, 91–2).

[56] TM, 16 and 50.

[57] *Ibid.,* 80.

him as he peers into another nest and finds therein its young bird "dirty yellowish and leaden with pin feathers"; and, observe, in imagination the distracting antics of the guardian bird as she "slipped to the ground fluttering as if wounded 2 or 3 times as she went off amid the shrubs."[58] But the contemporary naturalist may have twinges of nostalgic regret when he reads that in that long-ago summer of 1861, on the Minnesota River near Shakopee, the "Big Woods" were "alive with pigeons flying across our track."[59]

Besides the wild pigeon and the rose-breasted grosbeak, other birds which engaged Thoreau's special scrutiny were the horned lark, whose song he describes as "a low jingling . . . note—sparrow-like;"[60] the turkey buzzard, which he noted both at Lake Calhoun and along the Minnesota; blue herons and loons. Also, commenting on the difference in song between the Western lark and the common meadow lark, he indicates that the Western lark's note was "very handsome heard at the same time as the common meadow lark—much louder on toodle-em note."[61]

Besides birds, other kinds of wild life that Thoreau included in his annotated comments were bats seen along both the Mississippi and the Minnesota rivers;[62] hyla "cr-a-a-ck" ing in the sloughs of the prairie near St. Anthony;[63] "shad froggs hopping and dripping their water all over;"[64] turtles of various kinds, some of which engaged his attention for that same detailed description that he had recorded in his Concord writing;[65] varieties of snakes, observed on the prairie, at Mrs. Hamilton's and at Red Wing, and which he describes in such generalized terms as—"ribbon snakes," "chicken snakes," "striped snakes," and rattle snakes;[66] "great flight of large ephermae this AM on L Harriet shore & this eve on L. Calhoun;"[67] and, lest Minnesota seem too paradisical in its wild life, tormenting him the first day at Mrs. Hamilton's were "myriads of mosquitoes—wood ticks."[68]

The animal which most intrigued Thoreau, however, was the gopher—presenting a sight novel to his New England eyes. He apparently believed he had noted three different species: the striped gopher, the Missouri gopher, and the Franklin ground squirrel.[69]

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[58] *Ibid.*, 48, 52, 53, 80.
[59] *Ibid.*, 62.
[60] *Ibid.*, 17.
[61] *Ibid.*, 56.
[62] *Ibid.*, 5 and 67.
[63] *Ibid.*, 10.
[64] *Ibid.*, 52.
[65] *Ibid.*, 51, 62, 63, 82.
[66] *Ibid.*, 13, 17, 57, 73–4, 83.
[67] *Ibid.*, 55–6.
[68] *Ibid.*, 92.
[69] TM: 13, 14–15, 57, 82 and 92 for *Spermophilus tridecemlineatus;* TM: 13, 15, 19 and 83 for *Geomys bursarius;* and TM: 91 for S. *Franklini.*

Of these, the striped specimen, "Spermophile Tridecemlineatus erect", most fascinated him. He depicts it as "making a queer note, like a plover over his hole," and graphically describes its stripings as—

> 6 dirty tawny—clay-colored or *very* light brown lines—alternating with broad (3 times as broad) dark brown lines striped—the last having an interrupted line of square spots of the same color with the first mentioned—running down their middle—reminding me of the rude pattern of some indian work—porcupine quills—gopher baskets & pottery—[70]

Before termination of this discussion of the natural and cultural history reflected in Thoreau's jottings, some comment should be made about his notations on the Red Man. When one considers that Thoreau had spent his life studying the Indians, so that at his death he had accumulated eleven volumes of observations for a projected history of this first American,[71] it is disappointing that in his Upper Mississippi record there is a dearth of comment on this native inhabitant. Although when at Mrs. Hamilton's, Thoreau lived in the locale of a former Sioux village on Lake Calhoun, he makes no comment of that fact; however, he does describe the site of the old Pond mission nearby as being then "overgrown with sumac and covered with gopher heaps."[72] True, he had noted the Indian encampment at Wabasha on the way up, and he had discovered some Indian graves—both at Minneapolis and, later, on the top of Red Wing bluff (the chief's grave).[73] But the Redwood trip, probably taken for study of the Sioux first-hand, offers little information except a description of an Indian pipe-lighting ceremony (obtained from the "Illinois Man" on the boat) and some jottings on the Indian dance he had witnessed at the Agency, put on for tourist benefit.[74] In a later commentary to his friends, Sanborn and Ricketson, however, made after the trip was over, Thoreau gave more explicit details about the Sioux gathering in Redwood:

> A regular council was held with the Indians, who had come on their ponies, and speeches were made on both sides thro' an interpreter, quite in the described mode; the Indians, as usual having the advantage in point of truth and earnestness and therefore of eloquence. The most prominent chief was named Little Crow. They were quite dissatisfied with the white man's treatment of them and probably have reason to be so. This council was to be continued for 2 or 3 days—the payment to be made the 2d day . . . . In the afternoon the half-naked Indians performed a dance at the request of the governor for our amusement and their own benefit . . . . In the dance were thirty men dancing and twelve musicians

[70] TM, 13, 14–15.

[71] See Sanborn's comment in *Journeys*, I, xxxvi, and Albert Keiser, "Thoreau—Friend of the Native," in *The Indian in American Literature* (New York, 1933), pp. 209–32.

[72] TM, 91.

[73] *Ibid.*, 7, 82, and 71.

[74] *Ibid.*, 65–66, 66, 68, and 73.

> with drums, while others struck their arrows against their bows. The dancers blew some flutes and kept good time, moving their feet or their shoulders—sometimes one, sometimes both. They wore no shirts. Five bands of Indians came in and were feasted on an ox cut into five parts, one for each band.[75]

It is probable that Thoreau, sincere in his own respect for the Red Man, may have been disgusted with the political tinge of the trip to Redwood. In fact, he also comments in his letter to Sanborn—after first listing the government notables aboard *The Franklin Steele:*

> also a German band from St. Paul, a small cannon for salutes, & money for the Indians (aye and the gamblers, it was said, who were to bring it back in another boat).[76]

Although the space devoted to discussion of the social and natural history of the Upper Mississippi, as reflected in Thoreau's record, may seem extensively treated in this paper, the writer feels that such space-emphasis is justifiable: For, sick though he was, this New England individualist recorded for future citizenry brief but revealing glimpses of life along the Mississippi in 1861; and, even more significant, he included detailed observations of its botany. There remain, however, the two even more important aspects of this journey to discuss—the significance of the experience to Horace Mann, Jr., and its significance to Thoreau himself.

In regard to the trip's importance to the seventeen year old Horace Mann, it seems to this writer that this is one aspect of the journey which has not yet been sufficiently emphasized and explored. What an experience it must have been for the shy, grave adolescent that Sanborn describes to have been with Thoreau—even an ill Thoreau—for two months of botanizing and woodland exploration! In fact, it is the theory of the present writer that this experience may possibly have determined Mann's future vocational career—that of botanist. To prove this statement, let us briefly examine certain facts.

Mann, son of thef amous educator and Mary Peabody Mann and nephew of Elizabeth Peabody of kindergarten fame, was the educator's first child, born in his father's forty-eighth year. In fact, so proudly excited was the father at the birth of this first child that he put aside those famed journals in which he was wont to record edu-

[75] *Journeys*, II: 55–6. Compare this account to portion from Thoreau's letter to Sanborn, in Harding and Bode, pp. 621–2, noting that Sanborn has added to the original Thoreau letter his own description of the native dance—probably based on Thoreau's manuscript jottings (TM:66) and his own recollection of Thoreau's oral account to Ricketson and Sanborn.

[76] Harding and Bode, 621.

cational philosophizing and recordings and started a new, leather-bound volume whose first page entry bore the news:

> February 28, 1844
> Yesterday at 1/2 past 10 o'clock P. M. a male child was born to me. Another Spirit was ushered into being. . . . Whether it shall soar or sink, whether it shall rejoice or mourn—or how much of this depends upon the guidance he will receive. . . . What a responsibility.[77]

That Mann, his wife, and Aunt Elizabeth took that responsibility seriously there is ample evidence. True, at the age of three the child was disappointing his father because he had not yet learned to write; but then he had "made some progress in reading . . . taught by the phonetic method."[78] Fortunately at five the precocious lad was doing better; for he had begun the study of Latin and soon could tell one of Aesop's fables—that of the wolf and the lamb—in either English or Latin.[79] No wonder that in later years he could handle Latin botanical names with facility!

After the elder Mann's death at Antioch College in 1859, Mrs. Mann had returned to Massachusetts, bought a home in Concord, and enrolled the three Mann boys in Franklin Sanborn's school.[80] It was at this time that the friendship between Thoreau and the young adolescent had begun.

Now if one examines Thoreau's Journal entries for 1860 and 1861—the years of their growing acquaintance—a curious fact is revealed: Although Thoreau makes several entries concerning young Horace and the natural history specimens he was bringing in at the time to show the ailing Thoreau, not one entry exhibits any botanical interest on Mann's part! Instead, the youth was either describing or bringing samples to Thoreau of—"a painted turtle," mussels, " a skeleton of a blue heron," "a stake-driver . . . freshly killed," a crow, a screech owl, the eggs of *Sternothoerus odoratus,* a bull frog, hermit thrush, buffle-headed duck, etc.[81] And if one examines the contents of Horace Mann's letters written home to his mother while on the Minnesota trip, the reader will note that many of his early comments concern the collecting of animals: shells, fossils, a prairie gopher and some bird specimens—including a rose-breasted grosbeak. But when the two travellers were at Redwood, it was Mann, not Thoreau, who was bringing in specimens

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[77] Louise Hall Tharp, *Until Victory: Horace Mann and Mary Peabody* (Boston, 1953), p. 199.

[78] *Ibid.,* 212.

[79] *Ibid.,* 238.

[80] *Ibid.,* 317–8 and Straker, 549–50.

[81] See Thoreau's *Journal* entries for October 6 and 10, 1860; and January 11 and 14, February 5, April 16, 20, 22, 25 and May 4, 1861 in Henry David Thoreau, *Writings* (Boston, 1906), XIV: 102, 110, 309, 313, 314, 337 and 338.

of prairie plants; and by the time they had arrived at Red Wing, he exhibits a definite interest in plants.[82] [An ironic sidelight of this botanical interest at Red Wing deserves notice: According to Mrs. Tharp, biographer of the Mann family, there is now in the possession of the Houghton Library at Harvard the leather-bound volume that Horace Mann Senior had used for recording the birth of his son and which later that son apparently used for a flower-press on the Western trip with Thoreau. One of the pressed flowers therein still bears the label "Pulsatilla Nutatalliana, Redwing Bluff, Redwing, Minn., June 24, 1861 (Journey with Mr. Thoreau)"][83]

Whether the Minnesota trip marked the turning point in young Mann's life from emphasis on animal-study to botany, one can only theorize; but upon his return from the West, he entered Harvard that fall—there later to take botany from Gray, under whom he afterwards served as an assistant in the department. Mann was graduated from Harvard with a Bachelor of Science degree—his Bachelor's thesis being a study of Hawaiian plants, based on a research expedition to Hawaii one summer even before getting his degree. At the time of his death at twenty-four (from tuberculosis contracted on a botanical trip to Brazil), he had not only served as curator of the Harvard Herbarium for two years and was being groomed for the head of the botany department subsequent to the retirement of Gray, but he also had some noteworthy publications to his credit: two studies of Hawaiian plants, and a botanical catalog describing the ferns, ground pine, and horsetail east of the Mississippi.[84] Somewhere along the line, perhaps in Minnesota with Thoreau, Mann's interest had shifted from a study of bird and animal life to that of botany.

In regard to the third point under consideration in this paper—the significance of the Upper Mississippi journey to Thoreau—it might be pertinent to our analysis to examine the content of his Western record to see what it reveals of the writer as compared to that earlier Thoreau who had penned *Walden* and revealed himself therein as a composite Man—one who was Poet, Naturalist, Humorist, Philosopher, and Practical Economist. In making such a comparison, we discover that the Poet-Naturalist of the *Walden* era has almost disappeared; in his stead the itemizing Naturalist has taken over—one pre-occupied with plant and animal listings.

[82] Straker, 552–4, and TM, 66.

[83] Tharp, 336.

[84] Straker, 555 and Tharp, 317. Mrs. Tharp names *Revision of the genus Schiedea, and of Hawaiian Rutaceae* and *Enumeration of Hawaiian Plants* as the product of Mann's Hawaiian research; and *Catalogue of the phaenogamous plants of the United States east of the Mississippi and of vascular cryptogamous plants of North America, north of Mexico* as the other study.

True, the imagery used in describing some of the animal and river life has, at times, some of the poetic tinge of his earlier period; but, particularly toward the last of his Minnesota jottings, Thoreau seems to be resolving himself from some inner turmoil by a very objective preoccupation with these natural history listings. And the Humorist that is so delightfully reflected from the *Walden* pages, seems to have vanished almost completely, except for a wry comment or two in regard to the white Man's treatment of the Indian. As for Thoreau, the Philosopher, he too seems to be definitely absent from the pages of the Western Journal. Perhaps had time and energy permitted, however, these jottings, too, might have been reworked into the philosophical vein of his earlier writing.

One will find evidences, however, of that Thoreau the Economist, who delighted many readers in his first chapter of *Walden;* for several pages of the Minnesota manuscript are devoted to an exact itemization of just how he spent the nearly $180 he had with him on the trip—with listings of each expenditure down to the very last cent used in each locale, whether it be the 50¢ to $1.00 for a night's lodging to the 5¢ he spent for apples on the train.[85] In one place, the ever-honest Thoreau, apparently noting that his accountings for the day didn't total up correctly, even tabulated "cheated 5¢!" Besides this list of expenditures there is an inclusion of just how he was dividing up his travelling money for safe carriage while on the trip: "Left pocket, $78.10; right, $60; bosom, $40"—totalling $178.10.[86]

Now if one considers the purpose for which Thoreau took the Western trip—to recover his health—the manuscript of his upper Mississippi journey becomes highly illuminating: For, although he never mentions his health in it, there is in his itemized list of expenditures and equipment the revealing fact that he spent 50¢ for "trochees" and $1.00 for "pectoral"—both medications for relief of chest congestion.[87] So, indifferent though his Journal appears to make him about health matters, here is a clue that he was willing to spend as much for medicine as for a night's lodging, in the vain hope of relieving his chest congestion.

The manuscript of the journey is also revealing of some definite change in Thoreau's physical and mental state after arriving in the St. Anthony area, for the penmanship becomes more and more irregular—particularly from the recordings of the Minnesota River trip on; and the content of the manuscript also changes, as we have noted, from graphic observations to mere listings of plants, animals and artifacts found in various localities. It is apparent that some-

[85] TM, pages B and C.
[86] *Ibid.*, page A.
[87] *Ibid.*, B, C.

thing had happened to Thoreau during the course of the trip—whether it was a worsening of his physical condition because of primitive boat-travel conditions, homesickness (for he was never happy long from his native Concord), or a traumatic experience. Whatever the causative factor, Thoreau decided to curtail his trip at the end of two months instead of the three he had originally planned.

Although we cannot discount completely the several disappointments at the beginning of the trip which together may have had a traumatic effect on Thoreau—the fact that his plans for both Channing and Blake as his travelling companions fell through so that the seventeen year old Mann became their substitute,[88] and the fact that on his arrival in St. Anthony, he found Thatcher, a Maine friend and distant relative, seriously ill from the after-effects of a carriage-accident so that social recourse in that direction was truncated[89]—yet it is more probable that homesickness and physical illness were the prompting factors in his decision to shorten his trip. For, although Horace Mann's letters to his mother indicate his belief that Thoreau's health was improving or at least remaining about the same,[90] these are the observations of a seventeen year old; Thoreau himself, in his June 25 letter to Sanborn, admitted that he had "performed this journey in a very dead and alive manner."[91] Also, there is the evidence that when his friend, Daniel Ricketson, saw Thoreau in late August—a little over a month after the latter's return from the West, Ricketson was alarmed at his friend's physical condition.[92]

Now if a summation is made of the internal and external evidence revealed in Thoreau's manuscript—the change in penmanship, the shift to a pre-occupation with objective listings, the nota-

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[88] Sanborn's comment in *Journeys,* II: 8–10.

[89] Thoreau's letter of May 27 to his sister, Sophia, on Thatcher's illness (TM:1; Harding and Bode, 617) is more revealing for what it does *not* say than what it does. He asks that letters be continued to be directed to Thatcher's, "for I cannot see where I may be a fortnight hence." But Thatcher's serious illness ("He is much worse in consequence of having been recently thrown from a carriage—so as to have had watchers within a few nights past") precluded any friendly visiting. Fortunately Thatcher gave Thoreau a letter of introduction to Dr. Anderson, the physician and naturalist, so that Thoreau had other social recourse. Thatcher, a merchant in St. Anthony, died that August. He was the brother of the George Thatcher of Bangor, Maine, at whose home Sophia Thoreau died in 1876. (Ricketson, cited below, pp. 181–2). Both George and Samuel of St. Anthony were sons of the Hon. Samuel Thatcher, who had married Sarah Brown, originally of Concord. (One of *their* children, Elizabeth, had been born in Concord.) George Thatcher's wife, Rebecca Jane Billings, was the daughter of Nancy (Thoreau) Billings. (George Thomas Little, *Geneological and Family History of the State of Maine,* New York: 1909, III: p. 1493, is the source of this information on the Thatcher family.)

Since Thoreau's several letters to George Thatcher of Bangor were addressed "Dear Cousin" (Harding and Bode, 229–30, 240–1, 321–2, 485–86, 495, 502–3, 555–56, 630), we can assume he also regarded George's brother, Samuel Thatcher, as his kinsman.

[90] Straker, 551, 552, 553.

[91] June 25, 1861 letter to Sanborn, in Harding and Bode, 618.

[92] Anna and Walter Ricketson, *Daniel Ricketson and his Friends,* (Boston, 1902), pp. 317–22, 16–17, 115–7.

tions of medical purchases for chest trouble, the several allusions to New England people, both in the manuscript and the Sanborn letter (possibly indicating homesickness)—and we add to this evidence Thoreau's own statement of his "dead and alive" condition on his journeying, together with Ricketson's impressions of Thoreau after his return, certain conclusions may probably be drawn: Although Thoreau had taken the Western trip for his health, sometime during the Minnesota sojourn he doubtless realized that purpose was in vain; his health was not improving but worsening. Therefore the significance of the Upper Mississippi trip to Thoreau was that it taught him its uselessness as a health-restorative! In fact, he had learned the meaning of the Emersonian statement on travel preached in "Self-Reliance"—that your Giant goes with you on your journeyings. Ill Health was Thoreau's Giant; and evidently there was to be no release for him from this companion—in Minnesota or on this earth. Instead, Thoreau may even have felt that his time was running out and that Death stood around a near corner.

One can understand, therefore, why the Western trip was truncated at the end of two months. Knowing Thoreau's philosophy of economy—which meant saving one's time, money and energies for the great significant experiences—one can guess why he made an earlier return to Concord. What to him were the flowers and fauna of Minnesota when his own time was so limited? He undoubtedly preferred spending what little remained of life in his beloved Concord. And there were so many things to do in that remaining time:

The only man left in the family as provider for his mother and sister, Thoreau may have decided that publication comprised the "nest egg" on which they could depend. Certainly it is significant that an examination of the extant letters of the last year of his life reveals how few of these letters were friendly epistles and, instead, how many were devoted to business matters.[93] Perhaps those critics who have made Thoreau out as lacking in family responsibility may have wronged him![94] The evidence seems to point otherwise. For, in the limited time and energy that remained to him, we find a man using that time and energy for the future welfare of his family: There were arrangements to be made with Ticknor and Fields concerning the publication of a second edition of *Walden* and a rebinding, for sale, of some 596 copies of *A Week on the Concord and*

[93] See Harding and Bode, pp. 618–45.

[94] Note Edward Emerson's comments in his *Henry Thoreau As Remembered by a Young Friend* (Boston, 1917), pp. 32–8, that it was Thoreau's research on black-lead manufacture that made the family's pencil and graphite manufacture more successful. Evidence seems to indicate, too, that after his father's death in 1859, Thoreau took charge of the family industry. (Note numerous letters for payments on graphite by business firms to Thoreau, in Harding and Bode, 553–5, 570, 576, 586, 595, 602, 605–6, 629, 630, etc.)

Merrimack.[95] There was the feverish readying for publication in *The Atlantic* of several essays enlarged from previous lectures—essays which one critic (Sherman Paul)[96] regards as significant for their revelation of Thoreau's ripening philosophy: "Autumnal Tints," "Walking," "Life Without Principle," "Wild Apples," and "Night and Moonlight."[97] Toward the last, working against time and too ill to hold a pencil, Thoreau was forced to dictate his ideas to his sister, Sophia, who prepared them for *Atlantic* publication.

One other final preparation remained—the readying of that reddish-stained pine chest, built as a repository for his thirty-nine journals and into which they exactly fit—so that the "record of his days and thoughts . . . which cover a quarter of a century"[98] could be preserved for future readers.

From an earlier river trip with his brother John, Thoreau had gathered material for his first book—*A Week on the Concord and Merrimack Rivers.* From his last trip—that to the Upper Mississippi region—there remains no book, only fragmentary jottings. A longer journey lay too close at hand—that universal one which all men must take. Yet, according to all reports from family and friends, his attitude toward this final journey was one of serenity.[99] He had accepted its inevitability earlier, when he wrote in the second chapter of *Walden:*

> Time is but the stream I go a-fishing in. I drink at it; but while I drink I see the sandy bottom and detect how shallow it is. Its thin current slides away, but eternity remains. I would drink deeper; fish in the sky, whose bottom is pebbly with stars.

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[95] Letters to Ticknor and Fields, in Harding and Bode, 637–38 and 638–9.

[96] Sherman Paul, *The Shores of America: Thoreau's Inward Exploration,* (Urbana, 1958), pp. 400–17. Note especially p. 403.

[97] Letters to Ticknor and Fields, in Harding and Bode. pp. 636–7, 638, 639, 640, 645–6.

[98] Perry Miller, *Consciousness in Concord* (Cambridge, 1958), pp. 3–7 and Edwin Way Teale, ed. of *Walden* (New York, 1946), p. 1.

[99] Sophia's letters to Ricketson of Dec. 19, 1861; April 7, 1862; May 20, 1862 in Ricketson, 137–42. See also Edward Emerson, *op. cit.,* 117–8; and Annie R. Marble, *Thoreau: His Home and Friends* (New York, 1902), p. 177.

HENRY JAMES ON THE ROLE OF IMAGINATION IN CRITICISM*

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Henry James's critical writing extended over a full fifty years from 1864 to 1914, and reached its high point in the Prefaces to the New York edition,[1] a unique body of self-analysis. The Prefaces, however, stand apart from the more conventional reviews and essays which reveal the evolution of James as a critic. Two factors are important: James's changing conception of the nature of criticism and the duty of the critic, and his gradually evolving conception of the role of imagination in all creative work.

James was at first more the reviewer and critic than the writer of fiction, but the balance shifted and reviews gave place to extended critical essays. In his early reviewing, James announced positive principles. The critic, he held, was "opposed" to his author, bound to consider the work within the limitations of subject imposed on him, without reference to extraneous theory or critical dogma.[2] James distinguished between "great" criticism, which touched on philosophy in the fashion of Goethe, and "small" criticism, such as Sainte-Beuve's. The critic's duty falls somewhere between the philosopher's and the historian's; he is to "compare a work with itself, with its own concrete standard of truth,"[3] and to rely on his reason rather than his feelings. Matthew Arnold, James felt, possessed "the science and the logic" of the good critic.[4]

This intellectual, judicial view did not mean that James was entirely content to "compare a work with itself." From the first he considered imagination a universal standard. His earliest critical essay discussed George Eliot, and on principle James felt himself bound to seek in her work "some key to . . . method, some utterance of . . . literary convictions, some indication of . . . ruling theory." He found it in George Eliot's comprehensive concern for life and her realistic portrayal of average humanity; but he considered her

* Paper read at the 91st Annual Meeting of the Wisconsin Academy of Sciences, Arts and Letters.

1 Collected and edited as *The Art of the Novel* by R. P. Blackmur (New York, 1934).

2 *Notes and Reviews by Henry James*, ed. Pierre de Chaignon la Rose (Cambridge, 1921), p. 102.

3 *Ibid.*, p. 103.

4 *Views and Reviews*, ed. Le Roy Phillips (Boston, 1908), p. 87.

deficient in imagination, though in comparison with a writer like Trollope who was totally destitute of it she might be considered richly endowed. As compared with decidedly imaginative writers, George Eliot was "exclusively an observer."[5]

Since James somewhat later spoke admiringly of George Eliot's "rich imagination" and commended Anthony Trollope's "purity of imagination," some account must be taken of these striking reversals. In the early 1860's, James made a Coleridgean distinction between imagination and fancy. Imagination would enable the writer to present recognizably living figures, to whom the imaginative reader would respond. The merely fanciful writer could produce cheap and easy effects because he recognized no standard of truth or accuracy. " As in the writing of fiction there is no grander instrument than a potent imagination," James declared, "so there is no more pernicious dependence than an unbridled fancy."[6] In default of acute observation, he noted, a gifted writer might find a standard of truth and accuracy in his moral consciousness. Fancy alone might convey the impression of physical surroundings; the reconstruction of feelings and ideas required imagination.

Within a very few years, James had notably modified his stand. He began by taking a sterner view of the function of imagination, which he now held should "hold itself responsible to certain uncompromising realities."[7] After examining the practice of a number of writers, he concluded that the imagination must conform to facts, but must also provide a degree of sympathetic penetration into its subject to convey the very color of reality. He reassessed his estimate of Sainte-Beuve, whom he found to be a little of the poet, the moralist, the historian and the philosopher, with the littleness of each detectable in his "flagrant default of imagination, depth and sagacity." At the same time, Sainte-Beuve's passion for literature seemed to James "immeasurable, original and delightful."[8]

By 1868 the dogmatic tone has disappeared, to be replaced by an earnest search for justness of characterization of the authors James discussed. His first remarks on George Sand, for example, discuss her "vast imaginative and descriptive powers." Her imagination seemed to him "an immortal imagination, indefatigable, inexhaustible; but restless, nervous, and capricious . . . in short, the imagina-

[5] *Ibid.*, p. 35 f. "The Novels of George Eliot" appeared in the *Atlantic*, Oct., 1866. In reviewing *Felix Holt* for the *Nation* in August of 1866, James had commented that a myriad of George Eliot's "microscopic observations" failed to equal a single one of "those great sympathetic guesses with which a real master attacks the truth." *Notes and Reviews*, p. 207.

[6] *Notes and Reviews*, p. 32.

[7] "Novels by the author of *Mary Powell*," *Nation*, V (Aug. 15, 1867), 126.

[8] Review of C. A. Sainte-Beuve's *Portraits of Celebrated Women*, *Nation*, VI (June 4, 1868), 455.

tion of a woman."[9] Justness of characterization, it is clear, depended for James upon proper appreciation of George Sand's powers of imagination. When he shortly afterward discussed the role of the critic once more, he ignored his more youthful distinctions and declared that the day of critical dogmatism was over, and with it "the ancient infallibility and tyranny of the critic." It now seemed to him his duty to detach from a work under discussion "ideas and principles appreciable and available to the cultivated public judgment."[10]

He proceeded to attack didacticism and sentimentalism in the novel on the grounds that life is too serious for spurious and repulsive solemnity. On the other hand, levity in the novelist is deplorable, for the reader's imagination is likely to be more in earnest than the author's.[11] The imagination James speaks of by 1870, however, includes the notion of artistic arrangement of material, and its working is connected with questions of both realism and morality; "analytic imagination," presenting a scene with "hard material integrity," can leave behind "a certain moral deposit."[12]

In the early 1870's James began the criticism of painting, with interesting results. The use of terms from painting in his general criticism is less important than the extended discussion of imagination which accompanied his observations. His premises for the arts of painting and of writing were so similar that he at times spoke of books as though they were pictures and of pictures as though they were books. He kept his old distinctions between imagination and fancy, but more and more spoke in terms of the artist's purpose. For he now declared that the fanciful artist who recognizes no standard of truth or accuracy does so in pursuit of effect; the man of imagination, on the other hand, deals in the recognizably real and true, bathed in the light of his own great faculty. On the one hand there is "skill . . . invention . . . force . . . [and] *insincerity*," on the other, "something closely akin to deep-welling spiritual emotion. Imagination is the common name for it."[13] He discovered at about the same time that the composition of a work of art could in itself be a work of imagination, as when, examining a canvas of Tintoretto's, he found that the scene had "defined itself to his imagination with an intensity, an amplitude, and individuality of expression, which makes one's observation of his picture seem less an operation of the mind than a kind of supplementary experience of life." To contrast this artist with Titian was for James to measure the distance between imagination and observation. Tintoretto

[9] Review of George Sand's *Melle. Merquem, Nation,* VII (July 16, 1868), 53.
[10] Review of Rebecca H. Davis's *Dallas Galbraith, Nation,* VII (Oct. 22, 1868), 330.
[11] Review of Benjamin Disraeli's *Lothair, Atlantic,* XXVI (Aug., 1870), 250.
[12] Review of Gustave Droz' *Around a Spring, Atlantic,* XXVIII (Aug., 1871), 251.
[13] "The Bethnal Green Museum." *Atlantic.* XXXI (Jan., 1873), 72.

seemed to James to have "*felt*, pictorially, the great beautiful, terrible spectacle of human life very much as Shakespeare felt it poetically."[14]

The imagination, then, had come to be for James at once the power to conceive greatly and to feel greatly, to organize irreproachably the work of art of whatever kind, and to make it "a kind of supplementary experience of life." Without the quality of life there could be nothing, as he felt the paintings of Domenichino showed.

James's notion of the serious function of criticism was undergoing a gradual change, one indication of which was his increased preference for the method of Sainte-Beuve over the supposed scientific method of Hippolyte Taine. Taine might attempt to knock loose chunks of truth with the blow of his critical hammer, Sainte-Beuve rather disengaged its diffused and imponderable essence by patient chemistry, by dissolving his attention in the sea of circumstances surrounding the object of his study. James found Sainte-Beuve's "frankly provisional empiricism more truly scientific than M. Taine's premature philosophy."[15]

He began to remake his own critical practice, and a sympathetic essay on Turgenev in 1874 reveals something of the critical empiricism he had praised in Sainte-Beuve. He found Turgenev a searching observer, but even more a man of imagination, universally sensitive; he could surpass the French realists in appreciation of sensuous impressions and at the same time appreciate impulses outside the realists' scope. Turgenev's view of human life seemed to James "more general, more impartial, more unreservedly intelligent" than those of other novelists.[16] To express his sense of Turgenev's philosophy, James discussed Turgenev's imagination, which he found it impossible to praise too highly for its "intensity and fecundity." No novelist seemed to James to have created a greater number of living figures, to have had so masterly a touch in portraiture, or to have mingled "so much ideal beauty with so much unsparing reality."[17]

This essay coincides with James's revulsion from criticism as he had practised it. His examination of paintings in Italy had convinced him that the whole history of art was the "conscious experience of a single mysterious spirit." He felt he had worked off his juvenile impulse to partisanship, and he now perceived a certain human solidarity in all cultivated effort. "There comes a time,"

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[14] *Transatlantic Sketches* (Boston, 1875), p. 92.

[15] Review of Taine's *English Literature, Atlantic,* XXIX (April, 1872), 469 f.

[16] *French Poets and Novelists* (London, 1878), p. 275.

[17] *Ibid.,* p. 318.

he wrote, "when points of difference with friends and foes and authors dwindle, and points of contact expand. We have a vision of the vanity of remonstrance and of the idleness of criticism."[18] Within a year he was referring to criticism as "deep appreciation."[19]

At the same time he was enlarging his conception of the imagination. Flaubert in *Madame Bovary* revealed what the imagination could accomplish under "the powerful impulse to mirror the unmitigated realities of life."[20] Another writer's "cultivated imagination" gave out in his work "a kind of constant murmur of appreciation—a tremor of perception and reflection."[21] The "true imaginative force" enabled Howells to give his readers not only the mechanical structure of a dramatic situation, but also "its atmosphere, its meaning, its poetry."[22]

There were negative examples as well: Charles Kingsley's imagination died a natural death when the author turned didactic historian.[23] Bayard Taylor's lacked warmth and could not kindle the reader's.[24] Swinburne's was so completely for style that his criticism was worthless.[25] After the Swinburne essay, James apparently realized that he had at times used "imagination" as a term for the making of poetic imagery. Thereafter he sometimes spoke of "the larger sort of imagination" or "the higher imagination," to mark his distinction.

When James discussed Balzac in detail for the first time in 1875, his chief concern was the quality of Balzac's imagination, and in later essays he returned to it again and again. It was for James the great explanatory fact behind Balzac's reality, his vividness, and his systematizing of the *Comedie Humaine*. Its deficiencies explained Balzac's failures of portrayal whenever he attempted to touch the moral life. He lacked moral depth, which James conceived as no commitment to a specific moral code but simply respect for moral questions and a moral ideal.[26]

This sense of morality was henceforth inseparable from James's thinking on the general role of the imagination. The absence of it led to strictures on Charles de Bernard, Flaubert, and Baudelaire, and to criticism of the French realists at large for being deficient in simple understanding of human nature and human experience. With all their gifts they left too much out of account, and actually seemed inexpert whenever they attempted to touch the inner life.

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[18] Review of Victor Hugo's *Quatrevingt-trieze, Nation,* XVIII (April 9, 1874), 238.
[19] *Views and Reviews,* p. 55.
[20] *Nation,* XVIII (June 4, 1874), 365.
[21] *Nation, XIX* (July 23, 1874), 62. He was discussing Emile Montegut's *Souvenirs de Burgogne.*
[22] Review of *A Foregone Conclusion, Nation,* XX (Jan. 7, 1875), 12.
[23] *Nation,* XX (Jan. 28, 1875), 61.
[24] *North American Review,* CXX (Jan., 1875), 193.
[25] *Views and Reviews,* p. 59.
[26] *French Poets and Novelists,* p. 114.

The *Hawthorne* of 1879 is James's most considerable critical production, and in it he was guided by the practice of Sainte-Beuve: he established the background for his portrait of the man and interpreted the background through his central figure. Reviewing Sainte-Beuve's correspondence this same year, he cited the Frenchman's views with approval. "The critic, in his conception, was not the narrow lawgiver or the rigid censor that he is often assumed to be; he was the student, the inquirer, the observer, the interpreter, the active, indefatigable commentator, whose constant aim was to arrive at justness of characterization."[27] He now termed Sainte-Beuve "a man of imagination."

What he meant at this point appears in the discussion of Hawthorne, who was in most respects a man of fancy, but who could give glimpses into "the whole deep mystery of man's soul and conscience" and deal with "something more than mere accidents and conventionalities, the surface occurrences of life. The fine thing in Hawthorne is that he cared for the deeper psychology, and . . . tried to become familiar with it."[28] *The House of The Seven Gables* seemed to James to be "pervaded with that vague hum, that indefinable echo, of the whole multitudinous life of man" which is the sign of a great work of fiction.[29] This same extensiveness James now attributed to the interests of Sainte-Beuve. By 1884 he declared, "the measure of my enjoyment of a critic is the degree to which he resembles Sainte-Beuve."[30]

James's extensive experience as a writer inevitably altered his criticism; he spoke more and more from his own authority and experience. "The Art of Fiction" (1884) was a thoughtful declaration of principles which in part points out that the novel is a direct impression of life and that its value depends upon the intensity of the impression. The writer must work from reality and experience, but reality has myriad forms, and experience is never complete; ". . . it is an immense sensibility . . . it is the very atmosphere of the mind; and when the mind is imaginative . . . it converts the very pulses of the air into revelations."[31] "Imagination assisting," the artist can deal with anything. Experience is practically constituted of the gifts which are designated as imagination, ". . . the power to guess the unseen from the seen, to trace the implications of things, to judge the whole piece by the pattern, the condition of feeling life

[27] *North American Review,* CXXX (Jan., 1880), 56.

[28] *Hawthorne* (New York, 1887), p. 65.

[29] *Ibid.,* p .130.

[30] "Matthew Arnold," *English Illustrated Magazine,* I (Jan., 1884), 242. He held that Arnold resembled Sainte-Beuve, with a larger horizon on the side of religion. But he was on the whole "less complete, less inevitable."

[31] *Partial Portraits* (London, 1888), p. 387.

in general so completely that you are well on your way to knowing any particular corner of it."[32]

This declaration of principles explains why in James's criticism the imagination is so emphasized, why it is the ground of so many of his discriminations, and why he insists upon a description of the artist's imagination as part of the discussion of his work. And with his enlarging view of criticism as practised by Sainte-Beuve, James was shortly to remark that works of art grow more interesting as one studies their connections; indeed, the study of connections is a function of intelligent criticism.[33]

When he again defined the purpose of criticism (1891), he made everything depend upon the qualifications of the critic. "Curiosity and sympathy" form his equipment. "To lend himself, to project himself and steep himself, to feel and feel till he understands and to understand so well that he can say, to have perception at the pitch and passion and expression as embracing as the air, to be infinitely curious and incorrigibly patient, and yet plastic and inflammable and determinable . . . these are fine chances for an active mind."[34] This is complete reversal of the early stand, and James characterized himself when he spoke of "the critic . . . who has, *a priori,* no rule for a literary production but that it shall have genuine life."[35]

The later critical essays frequently reconsider figures James had discussed. All of them emphasize the importance of the artist's imaginative penetration of his subject in ways which parallel James's view of the importance of a sympathetic, flexible approach in the critic. But the essays are now the technical criticism of "a man of the craft," as James termed himself. Flaubert seemed to him now the artist "not only disinterested but absolutely dishumanised"; his failure was not that he went too far, but that he stopped short and refused to listen at the chamber of the soul.[36] Yet James praised *Madame Bovary* as a triumph of the artist's imagination; Flaubert had made the form of the novel interesting, without making the form obtrusive.[37] James's criticism of the erotic novels of Serao and d'Annunzio was not a quarrel with subject matter, but with artistic disproportion and incompleteness; they ignored too much of life. Zola was deficient when it came to private subjects; he could deal only with "the promiscuous and the collective." The great lesson of Zola was that without taste, the imagination could it-

[32] *Ibid.,* p. 389.
[33] *Essays in London* (London, 1893), p. 160.
[34] *Ibid.,* p. 276.
[35] *Views and Reviews,* p. 227.
[36] *Essays in London,* pp .132, 156.
[37] *Notes on Novelists* (New York, 1914), p. 80f.

self break down, as in Zola's later novels. Appeal to "science" seemed to James no mitigation of Zola's folly; for the artist, "science" is his consciousness of life.[38] In the best of his novels, Zola was saved by his immersion in his subject, not by his theory. But beyond a certain point, like Balzac, he failed; neither could deal effectively with the life of the mind, or with the "cultivated consciousness."[39]

All the last critical essays bear a family resemblance; the artistic problem is always the general subject, as it was of the great series of Prefaces written between 1907 and 1909 for the New York edition of James's own work. Nothing essentially new was added to the definitions of criticism or of the imagination until a final statement of the effect of criticism showed an entirely different concern. It was a plea for appreciation of method from the reader and an implied demand that the writer satisfy a cultivated interest in it, the final development of James's concern for composition and dislike of everything loose and formless.

> The effect, if not the prime office, of criticism, is to make our absorption and our enjoyment of the things that feed the mind as aware of itself as possible, since that awareness quickens the mental demand, which thus in turn wanders further and further for pasture. This action on the part of the mind practically amounts to a reaching out for the reasons of its interest, as only by its so ascertaining them can the interest grow more various. This is the very education of our imaginative life . . . we cease to be instinctive and at the mercy of chance.[40]

James's criticism reveals the growth of an artistic mind of high quality, and the evolution of his standards explains the changed estimates of writers he repeatedly considered. This itself is sufficient ground of interest. But there is further enrichment in seeing the advocate of "science and logic" turning from judgment to "justness of characterization" and at last to "deep appreciation," with a final word that the very education of the reader's imaginative life must be a prime office of criticism.

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[38] *Ibid.*, p. 54. James put the matter succinctly in his Prefaces. "With a relation *not* imaginative to his material the story-teller has nothing whatever to do." *The Art of the Novel*, p. 106.

[39] *Notes on Novelists*, p. 156f.

[40] *Ibid.*, p. 315.